The Institute of Science & Technology

The **Journal**

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Reverse of cover page.

The Journal

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Editorial

Welcome ▶

Welcome to the winter edition of The Institute of Science and Technology's Journal. Once again I think that you will find that there are some really interesting and informative articles inside, emanating from a range of science disciplines. My thanks extend to each and all the contributors.

In my opening sentence I intentionally used our full and unabbreviated name to show, in my very small way, my support for a colleague's stand against the wanton use of the acronym. He was one of a group of us where I work who were considering how we could improve the clarity of the descriptions of jobs in my institution so that they could be better understood by independent review panels. His vehement plea at the time was for "an outright ban on acronyms" and then, as he began to observe the beginnings of smiles around the table, he added "no I'm serious". And he was serious, and our smiles were not because we thought it funny, but because we all too had at some time or other felt some of the same frustration brought on by the ubiquitous acronym.

We are in a world where the acronym rules. Invariably, it seems that whatever it is, if it's not got a clever acronym its worth is somehow diminished. In many an example the "catchy" acronym has become the driver of the title which is then adapted to fit it (unlike Dell boy's Trotter International Trading). And as we all know, the acronym is especially prevalent in the world of science and technology, and I suppose in part understandably so because of the often complex and wordy names of projects, equipment or processes. It's also widely used in management speak and I'm reminded of a conversation with a colleague who owns and runs a very successful training consultancy firm. He told me of the time when a high ranking director of a group of companies was explaining to her audience on a flip chart how she assessed her middle managers using a four quadrant graph, plotting an individual's performance against their potential. She used this method to help her to determine where she needed to apply her effort to help and improve her staff. There were however, she said, always a few people that were stuck in the bottom left hand quadrant, and as she said this she wrote CULL on the chart. My colleague considered this for a few minutes and then asked what the acronym stood for. The director looked equally puzzled and explained that it didn't stand for anything; it just meant she got rid of them!

I suspect my trainer colleague found this both amusing and also a little disappointing, as I imagine that there is nothing that really excites a top training professional more than the invention of a cunning little acronym.

So now in support of my latter colleague and the wonderful world of the acronym let me invite you to read on and enjoy our articles featuring LYTT, HEaTED, BBSRC, AHRC, MRC, UKCMRI and NERC to not name but a few.

I wonder how many acronyms there are in this IST Journal edition. Ah! I smell a competition?

No, apologies, that was indeed a bit tabloid of me!

TTFN,
Editor

Letters to the Editor

THE VALERY CHAPMAN AWARD 2010

I was the lucky recipient of the first Valery Chapman Award. This allowed me to attend the 'CLEAPSS Microscope Maintenance Course' at Millfield School, Somerset, in July.

The course was a very enjoyable experience on all levels. It was well run and highly informative, with a high practical content, as you would expect from CLEAPSS. Another bonus which I hadn't really considered before I went was the opportunity it gave me to meet and chat with other technicians. This was the first time I had been able to do this since starting as a school technician 18 months ago.

Having been a microbiologist for most of my working life I had used microscopes extensively, but never really knew how to they fully worked. Now, as a school biology technician I have to be able to clean and adjust them. The course gave me the knowledge and more importantly the confidence to tackle our microscopes and give them a well needed service. Before July I wouldn't have dared to dismantle and service a single microscope.

I would like to thank the Institute of Science & Technology for enabling me to take part in this course. I also hope that the future recipients of the Valery Chapman Award will benefit and enjoy the experience as much as I have.

Hilary Wright,
The Maynard School, Exeter

NATIONAL SCIENCE WEEK

Dear Editor,

In March each year National Science Week is held throughout the UK.

Whilst the importance of retaining doctoral level scientists is widely reported it is often overlooked that much day to day work is carried out by technical and scientific support staff. Joining in local Science Week events presents an ideal opportunity for members to promote both the IST and the role of science and technical support staff.

Over the coming few years many colleges, universities and research institutes will find their budgets restricted and I believe many will see support staff as an easy target. I think it is important that we publicise at every opportunity the important roles support staff perform.

Yours sincerely,

Stephen Gamble
Cambridge

Chairman's view

John Robinson

So the long nights are upon us and the season of mists and mellow fruitfulness is beginning to nudge us into the cold grip of winter. The effects of the Government's much publicised Spending Review are being discussed and the debate rages between left, right and centre as to what the future effects might be. Despite all the impending doom and gloom, one of the first effects seems to have been a 0.8% rise in GDP in October – in stark contrast to the predictions of the economists (a moment of joy!). If you accept that a 0.8% change in anything is significant (rather than just background noise!) then this could be seen as encouraging: perhaps the City likes to see a bit of decision making and action.

Concern for the above has made quite a few public sector employers nervous and voluntary severance and early retirement "deals" seem to be common in the sector. A few, however, are forced into more draconian compulsory redundancies to balance the books. All of which provides the backdrop under which I decided to take early retirement from September this year and my thoughts turn to those who are less fortunate than I am and have to make career changing decisions without retirement as an easy option.

A number of people have asked me how I am going to fill in my time and to be honest, the thought never crossed my mind; experience so far is that my days are as full as they ever were and there is still a trail of undone things at the end of every day!

Technician Council begins to develop

The national situation regarding the status of technicians still occupies our minds. The situation is complex; we are still unsure as to the remit of the Technician Council as their formal terms of reference are still under discussion, although we do know it has met and has been hosted by the Royal Academy of Engineering. We do know however that the proposed registration scheme for technicians will be done via the Science Council (SC); the body that awards Chartered Scientist status to members of non-chartered professional bodies or learned societies. At present the registration scheme proposal seems to be for an entry level and an intermediate level registered technician framework and these would provide a route to achieving Chartered Scientist.

We have approached the SC with an expression of intent for IST to become a member and, ultimately, the right to award nationally recognised registrations and chartered status. Needless to say, this will not happen overnight; although we (the Exec) believe that the necessary checks and balances we will need to have in place to become corporate members of the SC are at the heart of our Bylaws, obtaining the right to confer national status will require the development and implementation of procedures and systems yet to be defined.

We were invited by the SC to join the New Registers Advisory Group which will develop the registration system. This is an exciting opportunity for the STEM community (Science, Technology, Engineering and Mathematics) and the business community to come together. The group's first meeting was chaired by Jon Poole, the CEO of the Institute of Food Science and Technology, food being the largest manufacturing sector in the UK at around 15%. Other members are drawn from the various other institutions representing *inter alia* medical science, physics, engineering, education, biology, brewing, materials and marine science and technology. The project has developed out of Lord Sainsbury's focus on skills and the need for greater numbers of skilled technicians.

The Advisory Group would feed into the Technician Council via the chair and *vice versa* but it was emphasised that the Science Council would need to build and promote the registers as appropriate for its sector. With Chartered Scientist status established as an aspirational level, two additional registers would encourage progression over one's career.

More change for life sciences – just evolution for biologists?

COGENT, the Sector Skills Council (SSC) for chemicals, pharmaceuticals, nuclear, oil and gas, petroleum and polymer businesses, has taken over "responsibility" for the Life Sciences sector, which previously lay with SEMTA, the SSC for Science Engineering and Manufacturing Technologies. Those of you in life sciences therefore can look forward to even more exciting developments: visit www.cogent-ssc.com and search for TechLife 2020.

Sorry for all the acronyms, but they are what they are!

Training and development – don't let it be a soft target for the cuts!

The HEaTED project continues to develop and grow, with many successful skills courses and regional networking events. We do however have concerns about future financial sustainability for this program to develop at the speed that is required. Please do all you can to lobby your employer to subscribe – it's an absolute bargain for employers! The cost per capita is tiny and any employer even in these straitened times should avoid the pitfall of failing to develop and up-skill their staff. Staff development is often seen by management as a soft target when looking to cut costs, but the effects of doing so are insidious and malignant. The effect is only felt when the realisation dawns that your workforce is not up to the task and doesn't have the right skills to deliver the job.

HEaTED needs a home and legal status – your action required!

We are however putting in considerable effort, with some very high level support, to promote our work and seek further funding. Regardless of the outcome HEaTED will continue and it is now time to formalise the relationship between IST and HEaTED by the establishment of a special interest group within IST. To do this all we require is for ten members to express an interest in the formation of the group. Just email office@istonline.org.uk saying that you would be interested in becoming a member of HEaTED as a special interest group within IST. There is no additional cost – it will be included in your usual membership fee. The establishment of HEaTED as an IST special interest group will make the project a legal entity and allow greater input from members in it's direction and governance.

All in all, the news is upbeat; you now have national (government) recognition as a skilled workforce and a major opportunity to voice your views and opinions at the appropriate forum via your professional body.

Harold Ridley and the intraocular lens

Alan Gall, IST Archivist. ▶

The banqueting facilities of Lincoln's Inn, located on an eleven-acre site in central London, provided the venue for a special function on 24 May 2005. Partly organized as a fund-raiser for The Hospital of St John of Jerusalem, it also gave the opportunity to launch an autobiographical book by Eric Arnott entitled *A New Beginning in Sight*.

Eye cross-section

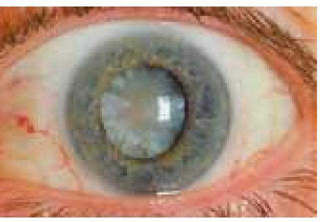
Harold Ridley (phot courtesy of Nic Ridley)

Eric Arnott was one of a small group of ophthalmic surgeons working on the implementation of a new procedure for treating sight disability due to cataracts. This involved the replacement of the cataractous lens with one made from polymethylmethacrylate. This surgical implant was conceived by Harold Ridley and first successfully used in 1949.

Giving an address to the assembled guests at Lincoln's Inn was the son of Harold Ridley, Nicholas Ridley. The following is the substance of his talk about Eric Arnott's book and the intraocular lens.

This evening we celebrate the launch of Eric's book entitled *A New Beginning in Sight* and having been privileged to receive an early copy I know it is 'a good read' as they say in literary circles! And you certainly don't have to be in medicine to understand it or enjoy it - and as much as anything else, it's quite social!

It's partly a love story, the story of Eric's and Veronica's devotion to each other, and partly a story of their resolve to further cataract surgery, that in the 1970s and the 1980s was the most common form of visual disability and which even now accounts for 15% of all operations performed in this country. It tells the story of how a small group of British eye surgeons, starting with my late father Harold Ridley and followed by Peter Choice, John Pearce and Eric Arnott, recognized that something had to be done to cure cataract, a condition that continues to affect one in four of us.



Cataract

In the sunlit uplands of immediate post World War 2 Britain, before the newly formed National Health Service had developed its subsequent bureaucracy, it was possible to be innovative in surgery. Surgeons and senior hospital staff were often figures like that portrayed by James Robertson Justice in some of the 'Carry on Doctor' films, in the enormous power that they wielded within hospitals. They had relative clinical freedom, but that is not to say that they were in any way slipshod in their research, quite the contrary, and by way of example, my father's clinical tests for the intraocular lens surgery that he was to pioneer was undertaken in the white heat of the Battle of Britain, thanks to the Royal Air Force.

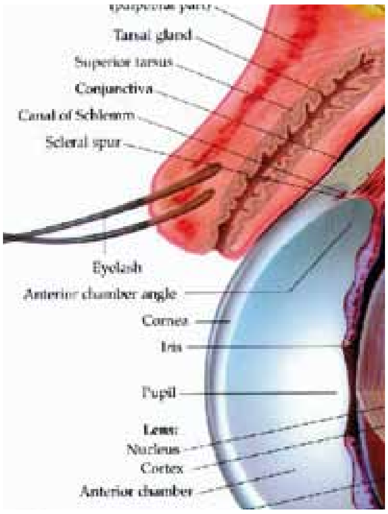
Eric tells the story of Flight Lieutenant 'Mouse' [Gordon] Cleaver, a member of the illustrious 601 Squadron who, on 15 August 1940, had clambered into his Hurricane on being 'scrambled' and having flooded the carburettor of his own Hurricane, had taken another, but he had left his goggles behind. As bad luck would have it, Mouse was hit by enemy cannon fire and fragments of the aircraft's plastic canopy became embedded in both eyes. He baled out of his aircraft in great pain and a short while later came under the care of my father. After 17 operations to remove the inert fragments of plastic, my father enabled Mouse to see again, albeit it through only one eye, and thus the concept of intraocular lens implant surgery for cataracts had started - at least in my father's mind!

But it was only at the end of the war, that my father was able to further his thoughts about lens implants - and later invited Rayners and ICI to help him, with each agreeing to undertake their part of the work 'at cost' in the furtherance of medical science - with Rayners making the lenses from specially prepared clinical grade PMMA, supplied by ICI. So the stage was set for the first cataract operation, which my father successfully performed on 29 November 1949 at St Thomas's Hospital by extracting the cloudy natural lens in a patient's eye and replacing it with a plastic lens.

Plaque outside St Thomas' Hospital

Well, despite almost universal hostility from the ophthalmic Establishment, my father became the base of what could be termed an inverted pyramid of the four British eye surgeons that pioneered cataract surgery. In the early 1950's, Peter Choice further developed my father's original lens, with great success, as did John Pearce. But it was Eric Arnott, who had originally worked with my father at Moorfields and had later moved to Charing Cross Hospital that not only made yet further lens improvements but also became the first surgeon in Europe to perform phacoemulsification, a method introduced by Charles Kelman of America that enabled the cloudy natural lenses to be removed and a new plastic lens to be inserted, making only very small incisions.

Later in this amusing book, Eric also records how he partnered another giant of ophthalmology, the Russian, Slava Fyodorov, in pioneering refractive surgery. And yet later, he tells of how he and Veronica raised money for a mobile cataract surgery unit and traveled to India in their joint mission to help the poor and the partially sighted.



But there's much more in the book than just eye surgery! It's a book about the Arnotts past and present, of life in an Ireland mainly now forgotten, of how the Arnotts owned department stores throughout Ireland and Phoenix Park Racecourse and The Irish Times. It touches on their philanthropy, particularly at the time of the Great Famine, of Eric's privileged background, of how he resolved to practice medicine and, of course, of how Eric met his beloved Veronica and the life that they subsequently led.

From Royal Mail's stamp edition depicting medical breakthroughs

There's also the high life that Eric and Veronica lived - and all the *fascinating* people that they met - of trips from America to Russia and from the Highlands of Scotland to India. It's a book about at least 3 continents and some of their most celebrated people. I wholeheartedly commend 'A New Beginning in Sight' to you!

It seems perfectly obvious to me that Eric must have had considerable ambition for his medical career and it is interesting to note that he has probably achieved the motto in his family crest (which you see on this evening's programme) 'Speratum et completum' - 'Hoped for and realised' - expressing well the success of his career!

On a personal note, I have found it unnatural to continually talk of my father but it's really not possible to explain Eric's very significant contribution to cataract surgery without mentioning him and I would just like to thank Eric for the friendship and support that he showed my elderly father in regularly visiting him in his long retirement. Ironically, tomorrow is the 4th anniversary of my father's death; he would have been in his 98th year and have been very touched by what Eric has said about him.

And finally, I would like to thank Eric for being the guiding light in this evening's entertainment. Eric is now the last survivor of the original four British surgeons that pioneered cataract surgery and through his life's work he has very substantially contributed to a surgical procedure that is now performed worldwide on an estimated 100 million people each year.

A short profile of Harold Ridley

Born 10 July 1906 at the village of Kibworth Harcourt, near Leicester. Full name Nicholas Harold Lloyd Ridley. Educated at Charterhouse (1920-1924), Pembroke College Cambridge (1924-1927). Served as a major in the Royal Army Medical Corps (1943-1946). World Health Organization Advisor on parasitology (1966-1971). Surgeon at Moorfields Eye Hospital (1938-1971) and at St Thomas' Hospital (1946-1971). Elected a Fellow of The Royal Society in 1986 and knighted in 2000. Died at Salisbury 25 May 2001.

Further reading

Arnott, E.J. (2006), *A New Beginning in Sight*, RSM Books.
Apple, D.J. (2006), *Sir Harold Ridley and His Fight for Sight*, Slack Inc.

Thanks to Nicholas Ridley for providing the script used for his talk.

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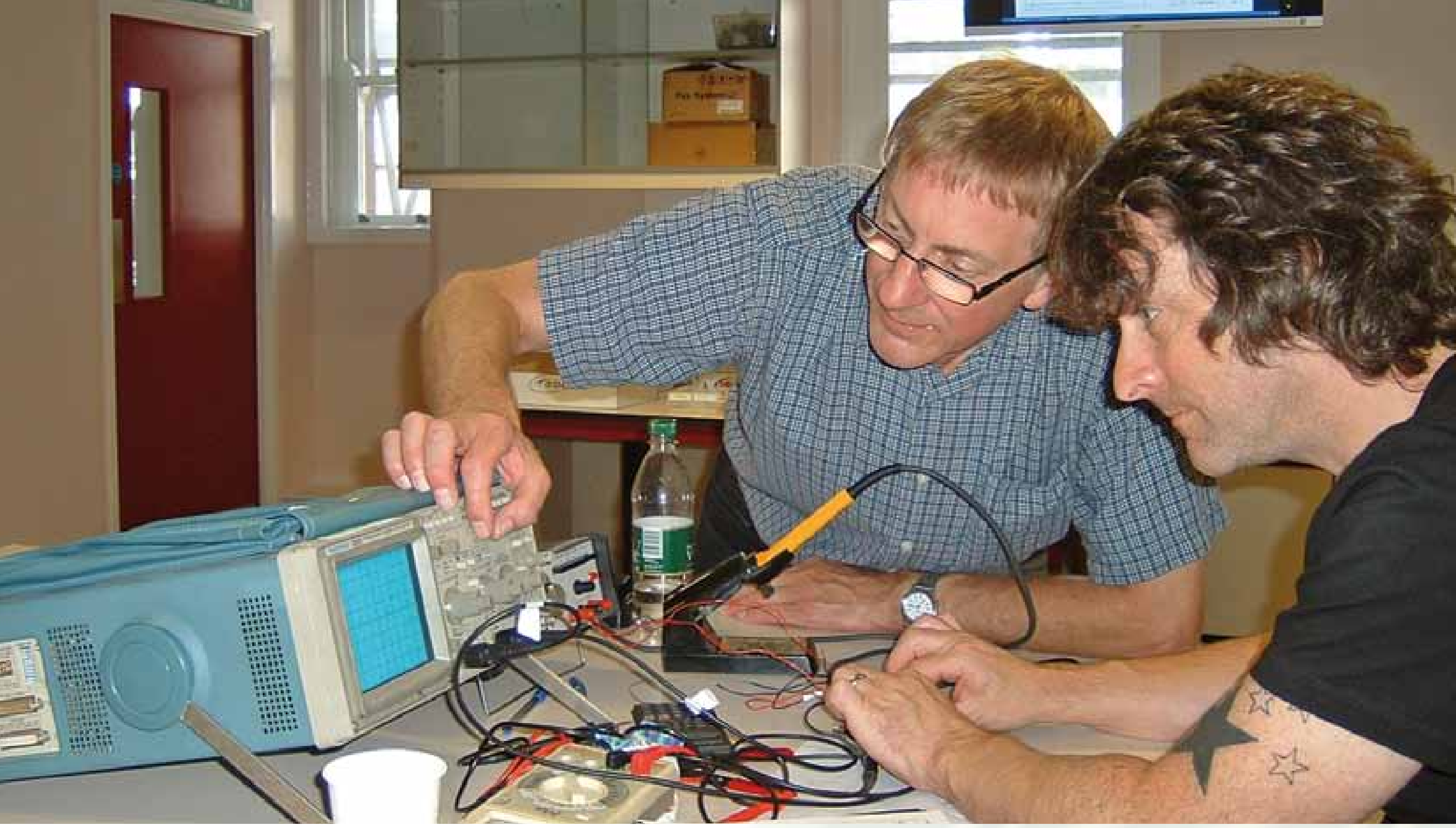


Basic but practical electronics

Bill Potter, an experienced senior electronics technician at University College London, talks about his popular electronics course, which is part of the HEaTED portfolio of events.

Who is the course aimed at?

People attend courses for a number of reasons, from the 'just curious' to the person who needs the training to do their job. As a tutor for this foundation course I cannot be too specific in my content and delivery, and therefore I aim the course at a wide audience. Hopefully the student will read through the course description before signing up, and make a decision as to whether the content is below or above their requirement.

What does the course entail?

The Basic Practical Electronics course is heavily biased towards the practical side of electronics. It is mostly hands-on, with a bit of appropriate theory, and a small amount of actual 'lecturing'. My main teaching methodology is that students retain more information and get more out of a course if they actually do something practical. More of doing, less of just listening.

Prior to the course, it is advisable for students to read though some webpages I have generated which relate to the course. These include copies of the course workbook, an overview of electronic components and some selected external websites with tutorials and videos.

During the day of the course, after a brief introduction at the start of each section, the students construct and test a series of electronic circuits from a workbook. The circuits increase in complexity and cover the basic elements of electronics. As part of the construction and testing the students will also learn to use a selection of tools and a range of test equipment.

After the course, the students can, at any time, refer back to the workbook and to the information on my website.

What will attendees walk away from the course with?

The aim of the course is to give an overview of electronics.

At the end of the course the participant will:

- gain an overview of electronic components
- be able to use electronic components to build simple circuits
- be able to solder correctly
- understand basic electronic theory
- be able to use a selection of test equipment

How did you come to be delivering the course?

Part of my remit when I worked as an electronics technician in the department of Physiology at UCL was to run a three day practical electronics course for all new Wellcome PhD students. From this, I occasionally ran the same course for staff and other PhD students within Physiology and the adjacent (Anatomy & Pharmacology) departments. In 2007, I started to run a one day version of this course, plus a half day Oscilloscope course for the UCL Graduate School. In 2009, following discussion with the UCL Staff Development department and HEaTED, I agreed to run both the Oscilloscope course and the Electronics course for HEaTED, starting in 2010.

How long have you run the course for?

I have been running and organising the original three day electronics course since 1990, the UCL Graduate School courses since 2007, and the HEaTED courses since March 2010.

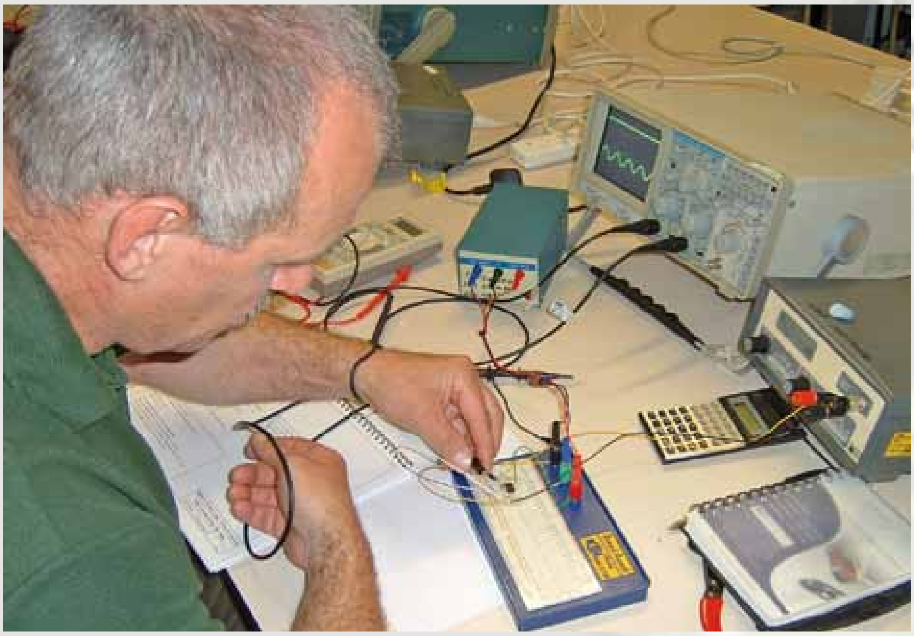
What do you get out of delivering the course?

Even after many years of running electronics courses, I get a sense of satisfaction of passing on my knowledge of the subject in a practical and an enjoyable way. Although the content of each course is the same, the students are always different in personality, knowledge and abilities. The interesting challenge for me is to pitch and adapt the teaching so that everyone is catered for.

What advice would you give to anyone else thinking of running a course?

I would give the following advice:

- It's one thing to know a subject, but the ability to effectively teach others the same subject is different. If you haven't done much teaching, I would recommend that you observe other teachers or tutors in action, and learn for yourself what works and what doesn't work. You may initially end up copying a style or a combination of styles, but through practice you should develop a style that works for you and your students.
- Preparation is a key element. Make sure you have prepared any handouts or materials in advance. I would recommend making a 'running list' for the course day, with timings of key sections. You may not stick to the times, but at least you will know what you have done and what you haven't covered.
- Make full use of any props that are appropriate to the subject. Subjects can be a bit 'dry' if you just use words, either by talking or slides. Spice it up a bit with demonstrations, or even better get the students involved.
- Adapt your style, pace and content to your students if necessary and practicable. Ploughing on regardless of your students is a sure way to lose their attention.



Any comments on what the HEaTED project is trying to do?

Training and development is an important part of motivating individuals. Courses may run within each individual University, but the HEaTED scheme has the advantage that it allows technicians to share their knowledge and experiences with other Universities.

History and development of microbiological culture media

Tim Sandle

Introduction

Investigative bacteriology and mycology requires microorganisms to be studied within the laboratory environment. Many bacteria and fungi can be grown on culture media: a substance designed to create nutritional conditions similar to the natural environment in which the microorganism commonly survives and reproduces (1). Culture media is a general term used to describe a complex or synthetic substance (chemically defined) found in one of two states of matter: either the liquid (broth) or solid (such as agar in a Petri dish) (2)

The cultivation of microorganisms is dependent upon a number of important factors including an optimal array of nutrients, oxygen or other gases, moisture, pH and temperature. Important nutrients include sources of carbon, nitrogen, inorganic phosphates and sulphur, trace metals, water and vitamins. Each nutrient is, in varying combinations, a key ingredient of microbiological culture media (3). The nutrients function as 'growth factors'. A growth factor is a naturally occurring substance, like an amino acid, which is capable of stimulating cellular growth, proliferation and cellular differentiation.

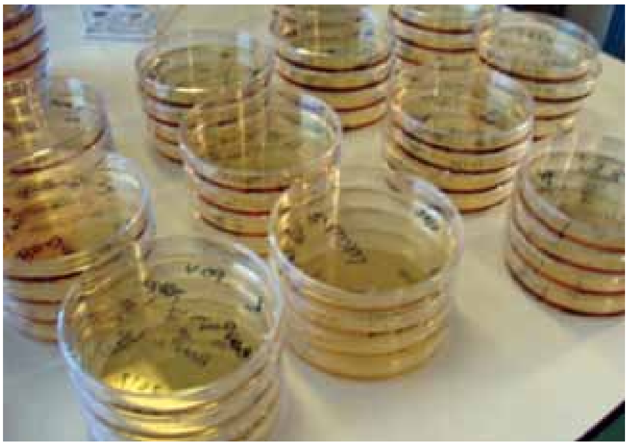


Figure 1: Agar Petri-dishes, from the author's laboratory (copyright Tim Sandle)

Origins

The origins of microbiological culture media date back to the 19th Century when the science of bacteriology was just beginning. In this pioneering time of bacteriology, bacteriologists attempted, with variable success, to grow microorganisms either directly using the food or material on which the microorganism had first been observed or some compound thereof (4). Arguably the first to do so was Louis Pasteur (1922-1985). Pasteur fashioned a media of yeast, ash, sugar and ammonium salts in 1860 (5). A wider application of materials was utilised, and consequently greater success observed, when Robert Koch (1843-1910) discovered that broths based on fresh beef serum or meat extracts (so-called bouillons, the term 'broth' for liquid culture medium being analogous to broth or soup) produced optimal growth (6). Indeed, Koch's work was so groundbreaking that the moniker 'The Father of Culture Media', oft stated in several microbiological text books, is not misplaced.

A significant development on from the liquid medium was with solid media. In 1881 Robert Koch demonstrated a new technique at the International Medical Congress in London. Koch had recognised the difficulties of using broth media for isolation of pure cultures and had looked for solid media alternatives (this inquiry was instrumental in Koch isolating *Bacillus anthracis* (the causative agent of anthrax) for the first time, in 1882, which represented a major step-forward in disease control (7). Initially Koch evaluated media such as coagulated egg albumen, starch paste and an aseptically cut slice of a potato (first used by the German biologist J. Schroeter (8)). These methods proved poor at recovering pathogenic bacteria. After limited, but ultimately encouraging results, Koch moved to a meat extract with added gelatine[1]. The resulting 'nutrient gelatine' was poured onto flat glass plates which were inoculated and placed under a bell jar. This new plate technique could be used both to isolate pure cultures of bacteria and to sub-culture them either onto fresh plates or nutrient gelatine slopes in cotton-wool plugged tubes (9).

Although nutrient gelatine was a major advance, gelatine had two major disadvantages as a gelling agent:

- It turned from a gel to a liquid at 25oC – preventing plates from being incubated at higher temperatures (many common bacteria, mesophilic organisms like those of the genera Staphylococcus, have an optimal growth range of 30-35oC).
- It was hydrolysed by gelitinase – an enzyme produced by most proteolytic microorganisms (such as the genera Clostridia).

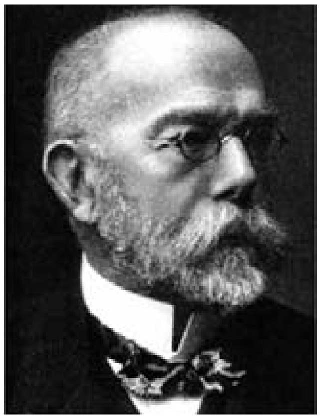


Figure 2: Robert Koch (Source: US National Institute of Health, under Creative Commons Licence)

A year later, Koch's attempts at a nutrient medium were advanced. In 1882 Fannie (or Fanny, there is some variation with the spelling and to compound this she was nicknamed Lina) Eilshemius (1850-1934)[2], later the wife of Dr. Walther Hesse (1846-1911) (who was Koch's assistant), suggested replacing gelatine with agar (10). Fannie Hesse had been inspired by the use of agar to prepare fruit jams and jellies (agar had been used as a gelling agent in parts of Asia for centuries[3]. Fannie had learned of it as a child in New York from a Dutch neighbour who had emigrated from Java).

Agar (or 'agar-agar') is a phycocolloid water soluble polysaccharide derived from red-purple seaweeds (the various species of Rhodophyceae belonging to the genus *Gelidium* and *Gracilaria*). Agar proved to be a superior gelling agent. It is prepared by treating algae with boiling water. The extract is filtered whilst hot, concentrated and then dried. Agar has physical properties which could be readily adapted for bacteriology. Agar melts when heated to around 85oC, and yet when cooled it does not form a gel until it reaches 34-42oC (a physical property called hysteresis). Agar is also clearer than gelatine and it resists digestion by bacterial enzymes. The use of agar allows the creation of a medium that can be inoculated at 40oC in its cooled molten state and yet incubated up 60oC without melting (a useful characteristic when examining for thermophile bacteria). Typically a 1-12% final concentration of agar is used for solidifying culture media.

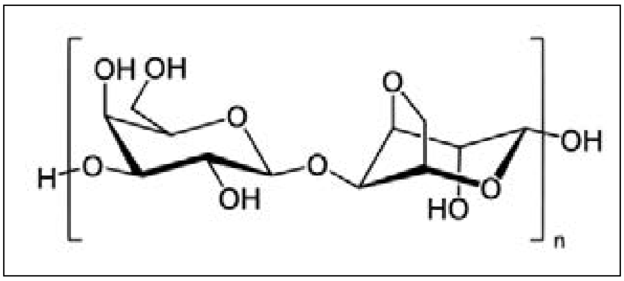


Figure 3: Agarose polymer (Copyright free, Creative Commons)

A further important development for the manufacture of solid media occurred in 1887 when Julius Richard Petri (1852-1921), another worker in Koch's laboratory, was involved in modifying the flat glass plate, common to laboratories, and produced a new type of culture dish for media. This was the Petri dish. Petri used a shallow, circular glass dish with a loose-fitting cover to culture bacteria and other microorganisms, by adding gelatin based culture media into the dish. The key design feature of Petri dish was the use of an overhanging lid, which was in place to keep contaminants out.

There is some dispute, however, concerning whether Petri invented the 'Petri dish', or whether it was in fact invented earlier by Emanuel Klein, a Slovenian scientist working in England. In a book published in 1885, Klein refers to a receptacle for holding a solid growth medium which is very similar to the 'Petri dish'. Moreover, a paper published by an English scientist called Percy Frankland in 1886 also makes reference to something akin to the dish. Whatever the origins, be that lifting of ideas or a process of convergent thinking, the role of the Petri dish in microbiology was and remains of the utmost importance.

For many years glass dishes were used, mainly until the mid 1960s, where advances with injection molding technology lead to Petri dishes being manufactured out of clear polystyrene plastic. These dishes were very similar to the first, glass Petri dishes. The initial batches of plastic dishes remained very heavy. Later, partly driven by a rise in oil costs during the 1970s, the weight of the Petri dish was reduced to save manufacturing costs. The typical dishes reduced from 25-grams to between 15 and 17-grams per dish.

Agar provides the structure for solid microbiological media but it does not provide the nutrients necessary for bacteria to grow. For this 'growth factors' are required. With the initial production of culture media, the primary nutrient sources were derived from meat (as noted by Klebs in 1871 and Nageli in 1880 (11), who were the first to record that bacteria grow well in culture media containing partially digested meat proteins or 'peptones'[4]. Peptones provide in a soluble and assimilable form all the essential mineral content of living material as well as the organic carbon and nitrogen sources.). Although the meat extract used for the earliest culture media was a rich source of many of the necessary growth factors for bacteria, it was insufficient in amino-nitrogen to allow optimal growth of a range micro-organisms. In 1884 Fredrick Loeffler added peptone and salt to Koch's basic meat extract formulation (12). The peptone he used was an enzymatic digest of meat, produced in the 19th Century as a pharmaceutical product, prescribed for nutritional disorders. This peptone added amino-nitrogen, while the salt raised the osmolarity of the medium.

From laboratory to mass production

By the 1890s culture media had developed to a form familiar to microbiologist of the 21st Century: clearer broths; solid media in Petri dishes; and the widespread use of peptones and agar. For example, Frederick Loeffler made a significant advance by developing nutrient broth to cultivate *Corynebacterium diphtheria*. The formulation of the nutrient broth is still widely used today. Such media was largely produced as and when needed by laboratory assistants and on a small batch scale. It became increasingly apparent that there was a gap in the market place for mass produced culture media. The development of commercially produced culture media originated with the meat industry, whereby hitherto discarded by-products from the manufacture of meat products were used to produce culture media. Arguably the most prominent example of this was the German Baron Justus von Liebig who, in the 19th century, established a reputation as the father of modern chemistry making important contributions to research and discovery in agriculture, animal chemistry, pharmacology and food chemistry. The Liebig Extract

1 More often called Jell-O in the USA

2 Born Fanny Angelina Eilshemius in 1850

3 Historical accounts indicate that agar was discovered in 1658 by Minora Tarazaeman in Japan, who noted that seaweed soup formed a gel once cooled (5).

4 Peptones were derived from the enzymatic digest of meat. Peptones were first developed as a nineteenth century pharmaceutical preparation used to treat nutritional disorders. The company Merck was reportedly the first to manufacture peptones for the manufacture of culture media in 1892.

of Meat Company (LEMCO) was formed in 1865 to manufacture and sell Liebig's extract of meat. The main source of meat was from the company Fray Bentos in Uruguay (where cattle were slaughtered mainly for their hides and the meat was a little used by-product).

Liebig developed his meat extract as a food source. His initial motivation was to provide a food source, stable at room temperature, for the growing malnourished poor people in central Europe (a 'beef-tea' which he described as his 'extraction carnis'). This became the company's most famous product: the Oxo cube. It was only later that a use for the waste product from the manufacture of Oxo cubes was found: to manufacture microbiological culture media. By 1924, the OXO Medical Division of LEMCO and the products were sold to hospitals and laboratories (13).

Figure 4: Oxo Factory by the Thames, today (BBC Images)

The driving force for the large scale production of microbiological media in the UK was, as with so many scientific innovations, Wold War II. In particular, the formation of the Emergency Pathology Service (EPS), which was established to tackle epidemics. The EPS eventually became the Public Health Laboratory Service (PHLS)[5]. Oxo Limited became the main provider to the EPS of microbiological culture media[6]. The ability of Oxo to provide media on a large scale was accelerated by the development of dehydrated culture media[7], whereby media was preserved for long periods by removing water. Low amounts of water resulted in the media powder having a low water activity which reduced the possibility of spoilage occurring. In the USA, similar movements towards mass production occurred during the war undertaken by the American Agar Company of San Diego, California and by the Digestive Ferments Company (Difco)[8].

Further advances

At the start of the 20th Century, further advances with culture media occurred. Most of the media used during the 19th Century was non-selective and was designed to grow a range of bacteria. The first step towards diagnostic media was in 1888 when Martinus Beijerinck developed an elective medium (one which uses nutritional requirements to limit what can grow on a plate). Beijerinck wanted to isolate the root nodule bacterium Rhizobium, which is capable of fixing atmospheric nitrogen. To do this he designed a medium containing no nitrogenous compounds. This inhibited the growth of non-nitrogen fixing microorganisms and produced a pure culture of Rhizobium. Beijerinck went on to use another elective medium, based on the ability of certain microorganisms to use CO2 as a carbon source under anaerobic conditions, to isolate the first pure culture of sulphur-oxidizing bacterium *Thiobacillus denitrificans* in 1904 (14).

Although chemicals, such as dyes, had been known to have antimicrobial effects since 1885, (when Paul Ehrlich published work on the inhibitory effect of arsenic compounds on syphilis (15)) they were not incorporated into media formulations until the first selective media were developed in the 1900s. Early selective agents tended to be chemicals and dyes used for other purposes within the laboratory that were found, by chance, to have the ability to inhibit certain microorganisms. Some of the most important developments included:

- 1905: MacConkey, based at the Lister Institute of Preventative Medicine in Elstree, used bile salts to select for lactose fermenting bacteria in faecal samples (16). The level of conjugation in the bile salts determines its selectivity profile: conjugated bile salts are less inhibitory and allow the growth of Staphylococci and Enterococci; while more disassociated salts such as desoxycholate are much more selective, only allowing growth of Enterobacteriacae.
- 1912: Churchman showed that derivatives of triphenylmethane such as gentian violet and brilliant green dyes were inhibitory to bacteria, particularly Gram positives; and crystal violet causes some inhibition of fungi.
- 1923: Muller described a medium using iodine and sodium thiosulphate which react together to form tetrathionate. The selectivity of tetrathionate depends on whether or not an organism possesses the enzyme tetrathionase. Salmonellae and Proteus species possess the enzyme, so can grow in the presence of tetrathionate (17).

In the 1930s, bacteriologists understood more fully the importance of growth factors upon bacterial nutrition and by the 1950s the mechanisms of coenzymes and biochemical pathways became better understood. Another important development was the addition of antibiotics to media. In the 1960s that antibiotics were used in culture media, for the first time, as selective agents (18). For example, Thayer-Martin's publication in 1964 (19), detailing a formulation for the isolation of *Neisseria gonorrhoeae* and *N. meningitides*, using a mixture of vancomycin, colistin and trimethoprim, was one of the most widely documented early examples of antibiotics being used in a selective medium. In parallel with the development of selective media, diagnostic media was produced in the early 20th Century. The main driver for this was the diagnostic importance of haemolytic reactions. In 1919 James Brown used a blood agar to study the haemolysis reactions of the genus *Streptococcus* and from this was able to differentiate alpha, beta and gamma haemolysis, an important step for differentiating different species of *Staphylococcus*, where the correct identification is important for medical diagnosis (20).

5 Today it is the Health Protection Agency

6 Oxo became Oxoid, one of the world's largest brands of culture media. Oxo sold the Oxoid brand to Brooke Bond in 1965. The brand was later sold to Unilver, was then subject to a management buy-out under Unipath, before being sold to Thermo-Fisher,

7 Dehydrated culture media was first developed by Frederick Chopping in 1910, although the techniques were not widely used until the 1930s.

8 Difco, now part of Beckton and Dickinson, is the world's largest provider of culture media. Difco was established in 1895 and was the first company to produce a specific bacteriological peptone, the 'Bacto Peptone', in 1914).

Continuing developments

The discovery of new microorganisms presents new challenges and this requires new isolation methods. For example, in 1977 Joseph McDade and Charles C. Shepard identified *Legionella pneumophilia* as the pathogen which caused Legionnaires disease (21). This required the development of new media both for clinical and water testing applications; in 1983 Barry Marshall demonstrated that isolates from gastric

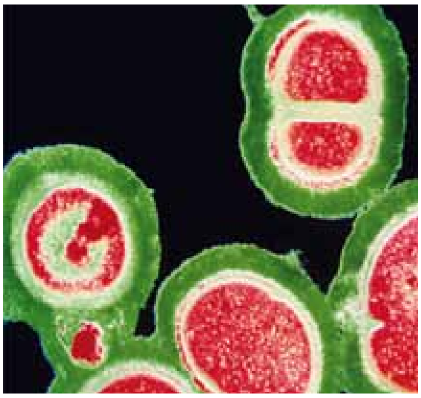


Figure 5: Staphylococcus aureus (under Creative Commons Licence)

and duodenal ulcers all contained a *Campylobacter*-like organism later called *Helicobacter pylori* (22); as recently as 2002, the first Vancomycin Resistant *Staphylococcus* aureus (VRSA) was found in Michigan which led to the development of differential media; and special chromogenic media was developed to specifically detect the emerging pathogen *Enterobacter sakazakii* from infant formula milk. Specialist media like chromogenic media represents another relatively recent development. Chromogens are molecules designed to mimic metabolic substrates which are colourless until they are cleaved by the target enzyme. Once cleaved the molecule becomes both insoluble and coloured, so builds up within the cell. This means that colonies of an organism which possess the enzyme can be easily differentiated from those that do not. By designing a selective base medium and adding chromogenic substrates media can be designed that allow differentiation and identification of groups of organisms. A large number of chromogenic media are now available for organisms as wide ranging as *E. coli* and coliforms, *Salmonella*, *Listeria monocytogenes*, urinary tract pathogens, *Clostridium perfringens*, and *Candida* species.

Media manufacture in the 21st Century shares many similarities with the pioneering manufacturers of the past. The main 'active' ingredient of culture media remains peptones. Today peptones are still largely manufactured from meat (such as liver and heart); but also from milk and vegetable sources (of which pea sources are the most common). Peptones are hydrolysed using either acid or enzymes. In producing peptones the quality needs to be tightly controlled with limits on peptone manufacture and quality control specifications for parameters such as the residual moisture, ash, amino and total nitrogen, phosphates, salt, pH, metal ion content, as well as microbiological tests.

For solid media, agar continues to be produced from seaweed. Developments in processing techniques allow agars with different characteristics to be produced. For example, agars with a low or high temperature gelling or low syneresis (that is, moisture loss). A second important criteria is that solid media has a constant gel strength as the effect on colony morphology and growth can be dramatic. High gel strength media will grow small colonies because the flow of nutrients and removal of toxins is reduced. Low gel strength media will allow the growth of larger colonies, but can be difficult to' streak out' the colony.

There are three main types of culture media: (i) Natural or empirical culture media, (ii) Synthetic or defined culture media, and (iii) Living media.

Initially all types of media produced were what is now described as 'natural' or 'empirical' culture media. Such media is commonly used today. This included utilising substances including milk, urine, diluted blood, vegetable juices, meat extracts and infusions and so on. Most empirical media contain only peptone as the major ingredient (a trypsinized or hydrolysed protein). To cultivate yeasts and moulds, extracts of vegetables and fruits including tomatoes and oranges are utilised. In composition peptones are mixtures containing, in only partly known concentrations and identity, a variety of peptides and polypeptides, proteases, amino acids, carbohydrates and so on, including inorganic and many organic micronutrients. Such core ingredients were often supplemented with 1 % peptone or yeast extract. Culture fluids made from beef infusions were commonly called infusion broth, whereas those made from beef extract as extract broth. Today such empirical media, including simple solutions of peptones or yeast extracts, are sometimes loosely included in the general terms nutrient broth or nutrient solution.

With synthetic or defined culture media, such media consist wholly of dilute, reproducible solutions of chemically pure, known inorganic and/or organic compounds. The formulation and use of these media requires an exact knowledge of the nutritional requirements of the microorganism to be cultivated. A third type of culture media is 'living' culture media. Living Culture Media are made up of groups of living cells as tissues, or callus or an organ used for growing viruses, rickettsias and so forth. Chick embryos are commonly used for cultivation of viruses. Yeasts, moulds and bacteria, if entering as contaminants, are able to multiply in the fluids of the chick embryos as in a culture tube.

Conclusion

Despite the advent of rapid microbiological methods, culture media remains the fundamental tool for the bacteriologist, whether for undertaking research or for regular quality control tasks like environmental monitoring. Many practitioners of microbiology remain uninformed about the origins of their primary 'tool', which to some extent is unsurprising given that few detailed accounts exist (and thus the motivation for this paper). This paper has set out to explain how culture media was developed. In doing so, the development has been placed as relatively recent and one where both the drive for scientific inquiry by pioneering bacteriologists and chance, the links to the meat industry and off-shoots of war, have played a important parts. Since the early days of Victorian development, culture media has undergone steady development over the past one hundred years. Despite better production techniques, lower contamination rates and improved purity, the basic principles of preparing broths and agars remains the same and the legacy of the founding parents of bacteriology continues to be of the utmost importance.

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Tim recently gained his PhD from Keele University (2005-2010). His thesis was a study into the operations of global blood services and plasma fractionators.

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Technical management/leadership development in HE – a new era!!

Bob Hardwick

In the late 1970's it was recognised that technical managers in Higher Education (HE), whilst being well trained and qualified in their own particular disciplines, were frequently expected to supervise staff without being provided with appropriate training or suitable qualifications in management/leadership. In order to address this situation, in 1981, the North East Universities Committee for Non-Teaching Staffs (as they were called at the time), working closely with senior technical managers, introduced a programme entitled 'Leading Your Technical Team' (LYTT). The programme proved to be very successful, being run over 2/3 days in University Halls of Residence throughout the North East of England. The tutors were drawn from Universities within the region and consisted mainly of senior Personnel Officers and experienced technical managers.

The programme went from strength to strength during the early 1980's and following the establishment of Training and Development Units in many HE Institutions (HEI's) during the mid – 1980's and early 1990's, staff from these units became involved with the LYTT programme and this led to the introduction of a number of topical changes. During this period the Higher Education Staff Development Agency (HESDA) was formed to organise and provide training/development programmes for all categories of HE staff. Eventually the LYTT programme was run and organised under the auspice of HESDA and I took on the role of programme director. Another important development at this stage was the widening of accessibility to the LYTT programme, by making it available to all HEI's and their technical managers.

The LYTT programme is specifically designed for HE technical managers new to the role and covers a range of basic management/leadership topics as well as exploring key issues for managers and their staff. Topics include a leadership model, management styles, team building, motivation/delegation, communication, managing change, training/development, people issues, etc. and the course is delivered in a very interactive format. From noon on day one until the conclusion at lunch time on day three, delegates work in small groups on a variety of tasks and exercises which encourages participants to share ideas and views as well as exchanging local procedures and practices. Indeed the programme's success is not based solely on its content but the fact that it allows those attending to share key issues, similarities, problems and strategies with one another. In order to facilitate the above style of learning another important development during this period was the move away from Halls of Residence to purpose built residential training centres or hotels with appropriate training facilities.

Following the transfer of HESDA to the Leadership Foundation for Higher Education (LFHE) in 2004 the LYTT programme has continued to be organised 2/3 times per year and each course usually attracts between 15 and 24 participants, from HEI's across the UK. Evaluation of the individual courses has remained very positive throughout the programme's 30 years and continues to be the starting point for introducing changes or adjusting the content to embrace current issues. A recent development following feedback from technical manager colleagues has been the introduction of an Advanced Leading Your Technical Team (ALYTT) programme. The course content is designed for fairly senior technical managers and is therefore pitched at a far more strategic level. One of the difficulties currently being encountered is recruiting participants for the two programmes with the appropriate prior level of management/leadership expertise, because for attendees to fully benefit from either the basic or the advanced programmes, a prior level of knowledge and expertise is an imperative precursor. One solution to this problem could be an intermediate bridging mechanism between the two programmes, which would serve to address the impasse from basic to advanced level provision.

Having been personally involved with LYTT for twenty plus years, 2010 is my final year as programme director and this short article allows me to take the opportunity to thank the LFHE for continuing to support the (A)LYTT programmes and me since 2004. I also wish to thank all those colleagues who have helped me to deliver the programme over the years and particularly wish to record my gratitude to all those who have attended the programmes and helped make it a very enjoyable and valued experience for myself and many others. Finally, I am delighted to report that my good friend and IST colleague Ian Moulson, 'The Journal' editor has been appointed by the LFHE to replace me as Programme Director. I am absolutely certain that Ian will do an excellent job in his new role and that the programme will benefit from his wide and lengthy experience as a technical manager and LYTT presenter. Given the current situation facing HE, Ian is without doubt the best person to take Technical Management/Leadership into this new era and I extend my best wishes to him.

Bob Hardwick
Programme Director LYTT (1994 to 2010) and IST President (2000 to date)

Tom Ashton and Reg Cuttell

Their contribution to the science and technology of milk processing

Alan Gall – IST Archivist

What do UHT milk, cottage cheese, and chocolate-topped yoghurt have in common? All were developed under the guidance of Tom Ashton for the Express Dairy Company. As one of the most eminent dairy scientists of his time, he served on many official bodies and continued to be active in the field after the age of 80.

Tom Ashton (courtesy of the SDT)

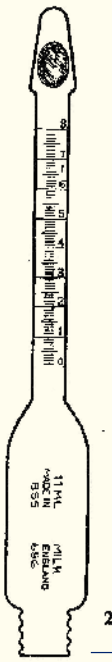
Reg Cuttell (courtesy of the SDT)

His friend and colleague, Reg Cuttell, also made his mark. He was the author of *HTST Pasteurization*, which became a standard work on the subject, and with Ashton a founder member of the Society of Dairy Technology (SDT). Together they formed the Astell Laboratory Service Company Ltd.

Dr Thomas Richard Ashton began his professional career as a bacteriologist with the Oldham Industrial Co-operative Society in 1934 after graduating from the University of Leeds. He returned to Leeds in 1939 to complete an MSc and worked on the bacteriology of milk for a PhD whilst at the Express Dairy Company.

At about the same time that Tom Ashton left university with his BSc, John Reginald Cuttell (known as Reg) became the first service engineer in the dairy engineering department of the Aluminium Plant and Vessel Co Ltd (APV). Evidence that Reg was already an innovative engineer comes from a patent for a variable speed gear, taken out in 1925 when he worked at Marryat & Scott Ltd. His role at APV brought him into contact with many in the dairy industry – including Tom Ashton.

Ashton and Cuttell decided to start a business together. Instead of using their own names in full for the new venture, they created a title by combining elements of their surnames to give Astell.

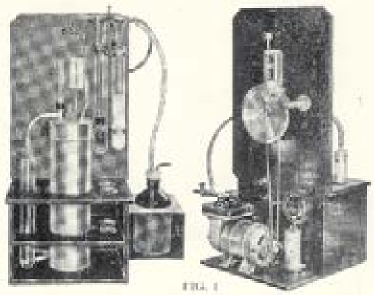


A butyrometer for the Gerber fat test. The tube containing milk or cream is placed in a centrifuge to separate the fat, the level of which can then be determined from the scale markings.

Arrangements for the formation of Astell Scientific Services started in 1949 and the firm received its certificate of incorporation as a limited company dated 5 September 1950. Reg Cuttell and Arthur Rowlands were the nominated directors.

Unlike most businesses, the founders did not take a hand in the daily activities since neither of them ever gave up their existing jobs. In fact, there is no evidence that Tom Ashton even held shares or a directorship. Patent applications make it clear that he was associated with Astell, perhaps as a paid consultant. The actual day-to-day functioning of the business fell to Arthur Rowlands who did give up his job to become a director.

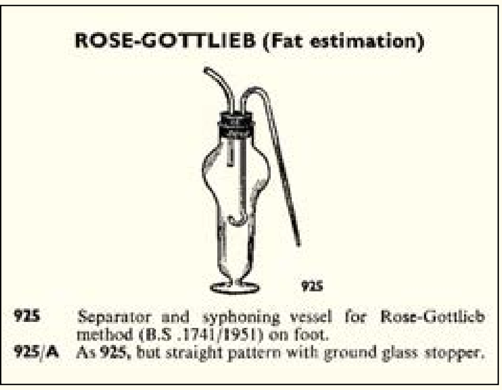
Arthur Rowlands had a good scientific background and experience of bacteriology. After graduating from Aberystwyth University with a degree in agriculture he was granted a two-year scholarship at the National Institute for Research in Dairying (NIRD). For the second year, in 1927, he went to the USA and successfully completed an MS degree at Cornell. After a spell at the Midland Agricultural College, Sutton Bonnington, as head of the Department of Bacteriology, he rejoined NIRD in 1946. Rowlands wrote many papers dealing with bacteriological aspects of milk and served several times as a member of Council for the Society of Dairy Technology over the period 1947 to 1958.



Astell's apparatus for the measurement of the freezing point of milk by Horvet's method

The home of Astell from the beginning, and for nearly forty years after, was 172 Brownhill Road in the London district of Catford. At the start of the 1900s this area was almost totally undeveloped and a visitor to the area would have found woodlands and open fields, with hardly a building in sight. But by the First World War Brownhill Road and dozens of other thoroughfares had been constructed.

It is clear that Astell came into being expressly to cater for the needs of research and analytical laboratories in the dairy industry. The combined expertise of Ashton, Cuttell and Rowlands helped establish the firm as more than just a supplier of standard items. One of the first pieces of equipment was the 'Roll Tube Apparatus' for bacteria counts. This had been devised by Cuttell and Ashton, and patented under the title 'Improvements in or relating to means for forming films from liquids'.



Apparatus used in the Rose-Gottlieb method of fat in milk determination as shown in the 1963 Astell catalogue

The niche market for diary product testing offered an international market and by the issue date of its tenth catalogue, about 1963, Astell had established agencies abroad in 14 different countries. Another event in the 60s was the arrival of Charles Neville Hillier to become joint managing director with Arthur Rowlands. Hillier brought with him Formglass Products Ltd of Hastings, glassblowers able to make the butyrometers and other special pieces of laboratory glassware. Charles Hillier made improvements to the Gerber butyrometer that resulted in a patent, first filed in 1964. Reg Cuttell didn't live to see these developments; he had died in 1957 aged 54. Arthur Rowlands retired from the company in 1969 upon reaching the age of 65.

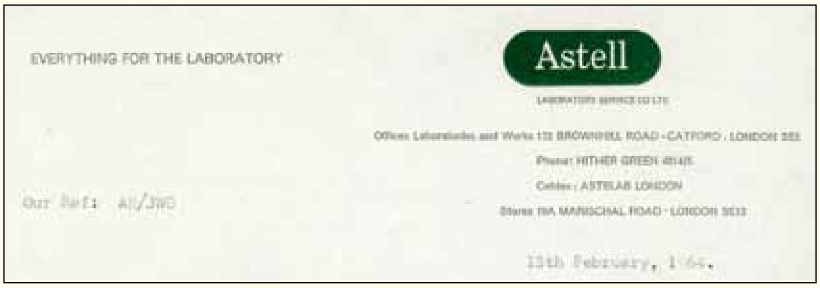
In a very full career, Tom Ashton participated in many noteworthy developments. Direct ultra-high-temperature (UHT) sterilisation of milk by the injection of steam was not legal in the UK at the time. He pioneered the commercial development of an indirect method using heat exchangers. The 1950s and 60s saw the introduction to Britain of cottage cheese and yoghurt – the chocolate-topped version of yoghurt actually being developed by Ashton in his own kitchen. Packaging was another area in which he made significant contributions. On this topic, and production methods, he wrote extensively – some 50 papers in total.

One of Ashton's duties at the Express Dairy Company was to oversee the processing of certain dairy products for the Royal Yacht Britannia. On the occasions when members of the Royal Family ventured abroad, milk was supplied from their own farms to be processed separately from commercial supplies.

Astell's Roll Tube Apparatus for bacteria counts

Tom Ashton continued his professional interests for many years after retirement as research director of the Express Dairy Company in 1976. His standing in the industry ensured that he was a welcome member on the many committees that represented dairy interests from the 1950s to the 1970s. He died in his 92nd year on 17 December 2002.

The Astell Scientific of today manufactures a wide range of autoclaves and sterilizers at its factory in Sidcup. Gone is the dependence on the dairy industry, which it served with great success for many years, both at home and abroad.



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Laboratory science and technology in Venezuela

David Conroy ▶

Introduction

Venezuela is situated in the most northern part of South America, between longitudes 0°51′ – 12°12′ N and latitudes 59°45′ – 73°09′ W. It possesses a total surface area of 916.490 km², stretching from the Andes to the coasts of the Atlantic Ocean and the Caribbean Sea, bordering with Brazil to the south, Colombia to the west and Guyana to the east. The capital is Caracas (known as the Distrito Federal), and there are 24 individual States, each with its own Governor and State capital (e.g. Puerto Ayacucho in Amazonas State, Maracay in Aragua State, Valencia in Carabobo State). The official language is Spanish. The climate is tropical to sub-tropical, becoming temperate to cold according to the height above sea level. There are perpetual snows on the highest mountain peaks of the Andean range.

Once considered somewhat of a backwater, Venezuela became an international player following on from the discovery of extensive oil and natural gas reserves in the Lake Maracaibo region in the 1920's. Other important natural resources include asbestos, bauxite, chalk, clay, coal, copper, diamonds, gold, iron ore, manganese, nickel, sulphur and uranium. There are abundant areas of land and of inland and marine waters suitable for agriculture and fisheries, which produce cocoa, coffee, fish, fruits, plantains, shrimps, sugar etc.

The development and exploitation of these resources led to the establishment of industries, the growth of which required the provision of human resources, particularly in various fields of science and technology. The present article will focus on how those needs for science and technology practitioners were addressed in practice.

The Venezuelan educational system

In Venezuela, a Law passed in 1870 made primary education free and obligatory for all. It became available in rural and urban areas, and consisted of the three R's, Spanish language, and a brief introduction to other general topics. Primary education lasts for 5 years, and is taught by Primary School teachers in private or in State-run establishments.

Secondary education was introduced at a later date, and also lasts for 5 years. It is taught by qualified Secondary School teachers, and leads to a "Certificate of Basic Education". In response to demand, it then became possible to spend a further two years at secondary school, concentrating on the sciences or on the humanities. On successful completion of the course, the certificate of "*Bachiller en Ciencias*" or "*Bachiller en Humanidades*" is awarded. This is the "Baccalaureate", and corresponds to 2 – 3 GCE 'A' levels and 5 'O' levels in the UK. The "Baccalaureate" is awarded conjointly by the Ministry of Education and the school, and all courses conform to a national programme of studies. Primary and secondary educational establishments are identified by the term "*Unidad Educativa*" (UE), usually with an indication of their educational level.

It is possible to obtain the "Baccalaureate" by part-time attendance at evening classes, although that route might require an additional year to complete.

In the 1940's, it became apparent that the supply of people with some form of higher education was not meeting the ever-increasing demands from the productive sector. A Permanent Commission on National Education was established to analyse and evaluate the situation, and to come up with some viable recommendations. These recommendations included a "shake up" of education at the university level in the 1950's – 1960's. A number of new universities were created, usually described as "National Experimental Universities", many of which are named after important historical figures. The existing Teachers' Training Colleges were merged into the new Libertador Pedagogical Experimental University (UPEL).

At the university level, the changes also extended to the names of the first degrees which were awarded. The more traditional "Doctor of Law", "Doctor of Medicine", "Doctor of Pharmacy", "Doctor of Veterinary Medicine" first degrees were renamed as "lawyer", "physician", "pharmacist" and "veterinarian", but those of "Engineer" and "Licentiate" were retained as previously. No higher degrees were available at the time. The Licentiates, all of whom have to present a Thesis in order to obtain their degrees, had a bit of innocent fun by suggesting to their newly "downgraded" colleagues that the latter might need to do a bit of real work, and present a Thesis, in order to obtain a proper "licence to practise" !

It then became necessary to offer formal training at a post-graduate level. Very generous scholarships were provided to suitably qualified Venezuelan professionals to study abroad for Master's degrees and Doctorates, so as to constitute the nuclei for post-graduate training programmes in Venezuela. Among the most popular destinations were included Australia, Canada and other Commonwealth countries, France, Germany, Italy, Spain, the UK and the USA. Experienced experts from abroad were contracted on very favourable conditions and terms of employment to assist in the planning and delivery of the initial post-graduate programmes in Venezuela, and to contribute to "R & D".

The universities have always been very conscious of the important role which they play in society with respect to providing educational opportunities. To cater for the needs of a better educated public, they started to offer "Diploma" courses at the post-secondary level, and in areas of special cultural or other interest (e.g. Management, Modern Languages). Entry requirements include possession of the "Baccalaureate", and the course of study – which is by means of evening classes - lasts from 6 – 18 months. The level of the "Diploma" corresponds to that of the first or second year of undergraduate studies.

To cater for people of graduate standing, the universities offer CPD courses known as "*Cursos de Perfeccionamiento para Graduados*", "*Cursos de Ampliación de Conocimientos*", and similar. Where the course is available as an "optional subject" within a post-graduate degree programme, those passing the examination are awarded a Certificate of Approval of the activity, for which 1 – 2 academic credits can be earned. In all cases, a Certificate of Attendance is given on conclusion of the course.

One of the most innovative results of this educational "shake up" was the introduction of a new first degree which concentrated on the more practical aspects of a subject or area. This new degree, known as "*Técnico Superior Universitario*" (TSU = Higher University Technician), has favourably impacted science and technology training, as will be further discussed in Section 4 of this article.

No degree can be awarded, at any level, by autonomous or prívate universities (or similar) without the course programme having first been officially evaluated and authorised by the National Council of Universities (CNU). The CNU, which represents all of the universities, authorises the particular university to award the degree in its own name. All universities and other such institutions of higher education must be registered with, and are supervised by, the Ministry of Higher Education.

In the general field of science and technology, the principal post-graduate degrees currently available in Venezuela are:

(a) "Specialist": one year of advanced study in the area based on a specialised core curriculum, but without the presentation of a Thesis.

(b) "Master": the same core curriculum as in (a) above, but with additional optional subjects and the presentation of a Thesis (usually 1 – 2 years).

(c) "Doctor": up to one year of advanced study beyond the Master's degree, and the presentation of a Doctoral Thesis (usually 3 – 4 years).

As the position now stands, therefore, the degrees awarded in "science and technology" are as follows:

(i) Third academic level (= first degree): Engineer, Licentiate and TSU.

(ii) Fourth academic level: "Specialist" and "Magister Scientiarum".

(iii) Fifth academic level: "*Doctor Scientiarum*" (or "*Philosophus Scientiarum*" in the particular case of the Venezuelan Institute for Scientific Research, IVIC).

These qualifications are abbreviated to the pre-nominal "Ing." (Engineer), "Lic." (Licentiate) and "TSU" at the first degree level. The post-nominal "M.Sc." or "Mag. Scient.", and "Dr.Scient.", "Dr.Sc." (never "D.Sc.") or "Ph.Sc.", are used at the fourth and fifth academic levels, respectively. The UK M.Phil. research degree in science or technology has no counterpart in Venezuela, where it would be assumed that an M.Phil. = "Mag. Phil." has been awarded by a Faculty of PHILOSOPHY! The concept of a Ph.D./D.Phil., earned as a research degree in Anglophone countries, is quite well understood in Venezuela.

To provide a typical example of the various types of courses available at the post-graduate level in Venezuela, an advertisement published in the national press in October 2010, for activities due to commence in January 2011, is transcribed as follows:

"Simón Bolivar University (USB)

Deanship of Post-Graduate Studies

View of the Library and the Chromo-Vegetal Labyrinth Universidad Simón Bolívar.

Doctorates: Biological Sciences, Chemistry, Computation, Engineering, Humanities and Social Sciences, Letters, Mathematics, Multidisciplinary Sciences, Philosophy, Physics, Political Science.

Master's degrees: Biological Sciences, Biomedical Engineering, Chemistry, Chemical Engineering, Computational Science, Development and the Environment, Electrical Engineering, Electronics, Latin American Literature, Mathematics, Materials Engineering, Mechanical Engineering, Music, Philosophy, Physics, Political Science, Psychology, Urban Transport.

Specialisation: Business Administration and Management, Chemical Engineering, Educational Information Systems, Electrical Energy Distribution, Electrical Energy Transmission, Electrical Installations, Environmental Management, Industrial Design and Maintenance, Mathematics Teaching, Public Opinion and Communications, Public Transport, Telecommunications, Telecommunications Management, Urban Transport.

Professional Development: Ancient and Medieval Philosophy, Modern and Contemporary Philosophy, Philosophical Methodology, Socio-Cultural Matters."

The development of training programmes in laboratory science and technology

One of the earliest measures to be adopted as a result of the recommendations of the Permanent Commission on National Education was the establishment of the National Institute of Educational Capacitation (INCE) to provide a uniform system of "trade training" by means of apprenticeship schemes. This very wide-ranging system has continued to the present, and four such apprenticeships currently include "bioclinical laboratory assistant", "maintenance and repair of medical equipment", "pharmacy assistant", and "veterinary assistant".

The common entry requirements for all of the trades offered through the INCE apprenticeship scheme include: "between 14 – 26 years of age, possession of the Baccalaureate, passing an eligibility test, being actively employed in the area, and being proposed by the employer". Those who do not possess the Baccalaureate are able to take it by attendance at evening classes, before officially embarking upon their apprenticeship. The theoretical bases are covered by attending evening classes, usually twice a week, over a 9 month period. The practical experience is acquired in the place of employment. On termination of the apprenticeship, and on having satisfactorily complied with all of the established requirements, the individual is awarded a certificate as proof of the training received.

In the specific case of the bioclinical laboratory assistant scheme, the theoretical classes cover the following topics: human anatomy, analysis of bioclinical and medical terminology, vital signs, means of administration of medicinal products, general microbiology, First Aid, human relations, and principles of organisation and management. Those readers, who may remember how novice laboratory assistants would often commence their training with cooking and bottle-washing duties, will appreciate how – in the case of a bioclinical laboratory assistant – such training would include a period of time spent in the media kitchen and in wash up.

Prior to the introduction of any formal programmes of study, laboratory assistants received their training by hands on experience in a chemical, medical or other laboratory, directly supervised by someone senior. The example of medical laboratory technologists is a good one to see how progress came about. In the late 19th – early 20th centuries the medical profession was able to provide wider coverage to the population.

Advances in medicine elsewhere were followed very closely, and the need for laboratory assistants soon became apparent. Following a visit to the Institut Pasteur, in Paris, by a group of Venezuelan physicians, a Pasteur Laboratory was established in 1895 in Caracas, to provide diagnostic services. At the same time, Dr. Rafael Rangel (now recognised as the "Father of Bioanalysis" in Venezuela) was appointed as Head of the Laboratory at the Vargas Hospital, also in Caracas. Training in diagnostic laboratory techniques was provided to a number of very eager laboratory assistants, and the idea spread to other parts of the country. A 'Society of Laboratory Technicians of Venezuela' came into being in 1945. The Permanent Commission on National Education formally approved a request by the Central University of Venezuela (UCV) to establish a School of Clinical Laboratory Studies, within the Faculty of Medicine, and which offered a 2 year course of training in 1949, leading to a Certificate as Clinical Laboratory Technician. The reasons given for that request were: "the need to train professionals with a good scientific basis and appropriate laboratory experience to work in the biological sciences and chemistry, to help study endemics and epidemics from the clinical diagnostic point of view."

The name of the School was changed to that of School of Bioanalysis, which awarded the Certificate of Bioanalyst (1956 – 1959), and later that of Licentiate in Bioanalysis (1962 – 1964), when the course became a 4 – 5 year (= 8 – 10 Semester) career as approved by the National Council of Universities in 1962.

Similar developments took place in the Faculty of Pharmacy of the University of the Andes (ULA), the Faculty of Medicine of the University of Zulia (LUZ), the Faculty of Medicine (now the Faculty of Health Sciences) of the University of Carabobo (UC), and the Faculty of Medicine of the University of the East (UDO), in that order of events. The Licentiate in Bioanalysis degree now conforms to a national curriculum over a 5-year (= 10 Semester) course of study.

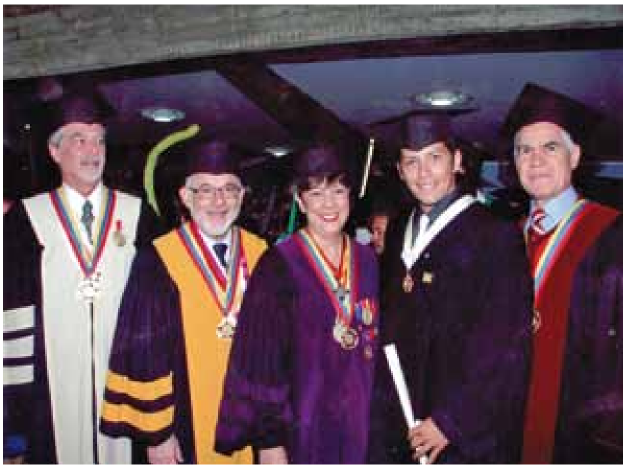
Other areas of laboratory science and technology were a bit slower to develop as professional activities. The increasingly desperate demands and pleas from all sectors for 'something to be done' were satisfactorily resolved by the Permanent Commission of National Education, which recommended the introduction of a higher technical qualification, at a first degree level, known as the '*Técnico Superior Universitario*' (TSU = Higher University Technician). How this degree proved of benefit to laboratory science and technology will be considered below.

The TSU in laboratory science and technology

Introduction of the TSU first degree, in a wide variety of areas, fields and disciplines, has proved effective and popular. Some of the current scientific and technological options available include (but are by no means limited to): agribusiness, agricultural sciences, aquaculture, audio-visual studies and photography, biology, biosciences, chemistry, computation, electronics, engineering, environmental evaluation, food technology, geology and mines, health administration, industrial chemistry, mechanics, and most aspects of the oil and natural gas industry.

The TSU degree is obtained after a 3-year (= 6 Semester) course of study (full-time or its part-time equivalent), and would have the academic level of a 3-year general B.A. or B.Sc. in the UK. The first 2 – 3 Semesters are devoted to the study of core courses in the corresponding field. Optional courses start becoming available during the 4th – 5th semesters. Great emphasis is placed on the practical side of things, and by the 5th semester the students obtain suitable practical experience by placement in outside laboratories etc. in the productive area. The students undertake a supervised 'special project', which they write up and present as a Thesis, or '*Trabajo Especial de Grado*' (= TEG), before an Examining Board.

A TSU degree, as with all other degrees, is awarded during a formal and public Graduation Ceremony, presided over by the Rector and maximum authorities of the institution, in the presence of the Academic Staff and the families and friends of the graduands. The Ceremony is surrounded by much pomp and circumstance, and the graduands wear a black mortarboard and gown to receive their medals and degrees at the hands of the Rector. The Academic Staff also have to wear their corresponding academic dress (at the highest level obtained).



Once the Graduation Ceremony is officially over, everyone meets more informally to partake of a glass of wine and some light refreshments, whilst photographs are being taken.

After having received a TSU degree, a person is able to undertake additional course work, and prepare a new Thesis, leading to the Licentiate degree. For those with much enthusiasm and stamina, the road to the higher degrees of "Specialist", "Magister" and "Doctor" is also open, more often by means of part-time studies whilst in employment. All else being equal, a TSU of 24 years of age, and who is prepared to work extremely hard, could become a full blown "Doctor" after reaching 40+ years of age.

When the TSU degree was originally introduced, the existing universities had a hard time in coping with the demand. The Permanent Commission on National Education therefore recommended the establishment of new universities and similar such institutions to award that degree in accordance with CNU rules and regulations. A number of privately founded institutions have come into being, generally to offer the TSU degree in specialised fields and subject areas. These institutions are variously known as "University", "University College", "University Institute", "Technological College", "Polytechnic Institute" etc., etc. All are officially registered with the Ministry of Higher Education, and their course programmes and degrees have to be approved and authorised by the CNU. The system seems to be working very well in practice, and most members of the teaching staff are contracted on a part-time basis from practitioners with wide professional experience in their areas and from within the productive sector.

Several of the older-established universities have been in the front line of offering TSU degrees. The existing Schools of Bioanalysis, for example, now offer TSU degrees in subjects such as "cytotechnology" and "histotechnology". A private university established in 2006, through its Faculty of Health Sciences, currently offers a 3-year TSU degree in histotechnology, and a 4-year Licenciate degree in histotechnology. A most interesting observation, in that case, is the inclusion in the obligatory course work of "animal histology" and "plant histology", a decision which would extend the professional possibilities of the graduates to work as much in human and veterinary pathology laboratories as in plant pathology ones.

The decision as to what to do next? is very much in the hands of the TSU, often with considerable encouragement and support from the employer.

Employment opportunities and prospects for professional development

The "jobs market" for laboratory science and technology practitioners in Venezuela offers several types of opportunities, in accordance with the capacity and interests of the individual. Jobs can be obtained through personal contacts, by word of mouth, or by responding to advertisements published in the national and regional press. The advertisements provide a brief job description of the post available and the responsibilities to be assumed by the successful candidate. The qualifications are also indicated quite clearly. To sugar the pill, advertisements from the private sector will often mention suitable benefits and incentives, such as a pleasant working environment, ample prospects for promotion within the organisation, private medical insurance and –even more important – a starting salary to be negotiated between the parties. Special requirements of the post, such as a good working knowledge of technical English, are also mentioned in the job description.

The cartoon serves to portray a "realistic response" to the possible fate of highly qualified professional personnel who suddenly find themselves redundant!

Some of the posts, in both the private and the public sectors, may be of greater interest to those who have visions of joining the "back room boys and girls" in a laboratory, whereas the idea of "promotions" (in administrative terms) might sound more appealing to others. A TSU with a good technical background, and a liking for marketing, sales and public relations, could do extremely well as a Technical Sales Representative with distributors or manufacturers of scientific equipment and apparatus, reagents, diagnostic kits etc., and in the provision of technical services to the users of those products. Most employers offer in house training in the use of novel instrumentation, specialised laboratory techniques and similar, as well as providing opportunities to attend evening classes and/or to study part-time for a higher qualification. In addition to CPD programmes, both formal and informal, productive technical inputs are usually acknowledged by means of co-authorship of papers and presentations, and facilities to attend Congresses, Workshops, Seminars, Meetings and the like, are widely available to encourage "promising" members of staff.

The legal retirement age is 60 years. People are able to request early retirement after 25 – 30 years of employment in the same company, establishment or institution. In cases where a laboratory science and technology practitioner has made a good professional name for him/herself, that person could request early retirement at 50 years of age, and become a private consultant or similar in the corresponding field of expertise.

When difficult economic times affect the economy and the market, the possibilities of being laid off must be considered. Those working in the public sector may receive salaries which are much less competitive than those of the private sector, but their jobs tend to be more secure. The current economic situation has been widely commented upon in the Venezuelan press, with fears of a serious brain drain making their appearance on the horizon.

Professional representation

In Venezuela, there is nothing resembling or equivalent to the Institute of Science and Technology, or any other such professional Institutes and Societies in the UK which are legally empowered to award higher qualifications to their Membership. Most of the countries of South America follow the older tradition whereby the interests of a particular group of professionals are represented by a "*College*", duly registered as such for all legal purposes and effects with the governmental authorities. In this respect, the term "College" ("*Colegio*" in Spanish) is derived from the Latin "*Collegium*", meaning an association, corporation or society of people exercising and practising a given trade or profession, as used in the times of Ancient Rome. A "College" has absolutely nothing to do with a "Trades Union".

Specific and well-defined professions have their own "Colleges" (e.g. "College of Accountants", "College of Bioanalysts", "College of Engineers", "College of Lawyers" and so forth. All professionals working in the corresponding area or discipline are legally obliged to be registered with the respective "College", in order to practise. They receive a credential giving their names, their obligatory national ID card N°, and the number of their registration with the "College".

An Agronomist (= "*Ingeniero Agrónomo*") and a Chemical Engineer (= "*Ingeniero Químico*") would both be required to register with the "College of Engineers" (founded in 1861 in Venezuela). Because the "Colleges" are not authorised or empowered to award their own qualifications, there is nothing equivalent to the "Chartered" status (e.g. C.Biol., C.Chem., C.Eng.) as conferred upon suitably qualified and experienced corporate members of the respective professional Institutes and Societies in the UK.

With the advent of CPD programmes, the "Colleges" make arrangements to collaborate with a university to offer short specialised courses and activities, as much for their own membership as for all other interested persons. The Certificate of Attendance is signed conjointly by senior representatives of the "College" and of the university under whose seal it is issued.

The "Colleges" also oversee the professional conduct of their membership. They can impose "cautions" or "temporary suspension" for minor faults, and a member tried and convicted of a serious criminal offence in a Court of Criminal Justice would be "removed from the books". The senior positions within the "College" are obtained as a result of election by the membership. The routine administrative and office work is carried out by permanent employees of the "College".

Conclusions

The author has attempted to provide an impartial overview of laboratory science and technology in Venezuela, and how that has evolved from being a trade to becoming a profession whose practitioners currently enjoy a good status in society. It has also been mentioned how a laboratory assistant possessed of a keen personal interest would be able to reach the highest academic level, through the new route of the TSU first degree. "Where there is a will, there will always be a way!" It is hoped that this information will help others to compare and contrast the situation with that existing in their own countries.

The Membership and student body of the Institute of Science and Technology are encouraged to give every possible assistance and support to the Institute as it continues to explore new avenues for professional development and higher qualifications. The author was elected to Membership of the (then) Institute of Science Technology in the late 1950's, and to Fellowship in the early 1960's. A congratulatory letter received from his former employer in Britain included words to the effect: "I'm glad you've moved on from being a MIST in the UK to becoming a FIST in Argentina. I wish you every success in your future career, wherever that may take you!" It follows that those who have had to "come up the hard way" are the ones who can best encourage others as to how to take fullest advantage of the opportunities which become available to climb the ladder.

AUTHOR

David Conroy, FIScT, is Emeritus Professor of Fish Pathology in the Faculty of Veterinary Sciences of the Central University of Venezuela (FCV-UCV). He started his career as a trainee Medical Laboratory Technician in the Royal Army Medical Corps. Back in "civvy street", he qualified as a Biologist. In 1960 he moved to Argentina to work in the microbiological laboratory of a large prívate company, and continued to study part-time in the evenings. Appointed to the staff of the University of Buenos Aires, he rose to the Rank of Associate Professor and was contracted as a Research Scientist by the National Council of Scientific and Technical Research, CONICET (Photograph below). He has lived, worked and travelled widely throughout Latin America and the Caribbean, and is fully bilingual in English and Spanish. On a basis of "sweat, blood and tears", and much "burning of the midnight oil", he earned a Ph.D. in Biological Sciences for original research undertaken in South America.

In 1976, he was appointed to a personal Chair of Fish Pathology in the FCV-UCV, and made Venezuela his permanent home since then. Closely involved in the development of post-graduate training courses, he has been awarded Honorary Professorships by one Colombian and two Peruvian universities, Honorary Membership of the "Colegio de Biólogos del Perú", and corresponding ordinary membership of the "Colegio de Biólogos del Guayas" (Ecuador). A Fellow of the Society of Biology and a C.Biol., he was the first recipient of the "Briscoe Prize" from the Institute of Science Technology in 1959.

Married to a Fisheries Biologist (!), he has four children: a son and a daughter who are both practising veterinarians, a son who is a mechanical engineer, and a son who took a BA in Latin American Studies (and became a partner in a private company in France selling up-market "high quality fish and seafood products").

Photographs by permission of Wikipedia (Creative Commons Licence)

Photo by Ahilan Parameswaran 2008, courtesy of Wikipedia Commons.

Australian telescopes: a retrospective.

Estelle Asmodelle ▶

Traditionally, Australia has a pretty solid history with optical and radio astronomy but in the past couple of decades the importance of Australian optical telescopes has lessened somewhat. This is largely because they cannot compete with the larger optical devices in other parts of the world.

Newer telescopes are the preeminent instruments in astronomy today, such as: the ***Gran Telescopio CANARIAS***[1] (GTC)(10.4 m) and ***Keck 1 & 2*** (Keck) (10 m each) just to name a few, while others are just coming online now such as: the ***Very Large Telescope Array*** (VLT)(four 8.2 m telescopes, four 1.8 m auxiliary telescopes, and a 2.61 m Survey Telescope). Other extremely large telescopes (ELT)[2] are under construction, such as: ***Giant Magellan Telescope*** (GMT)(24.5 m) due for completion 2018, and also due for completion around the same time is the ***Thirty Metre Telescope*** (TMT)(30 m), followed a few years later by, the ***European Extremely Large Telescope*** (E-ELT)(42 m) optical to mid-infrared observatory.

Not surprisingly ELTs are positioned at very high altitude sites with extremely low humidity such the Paranal Mountain in the Atacama Desert of northern Chile (elevation 2,635 m), or on Mauna Kea on the island of Hawai'i (elevation 4,205 m), both of which are the locations of many of these new generation optical ELTs. Although the hay day of optical astronomy in Australia has past yet Australian research continues undaunted.

Of course there are space based telescopes which are of paramount importance, for the ***Hubble Space Telescope*** (HST) (2.4 m) has changed astronomy and cosmology beyond recognition, and Hubble's successor the ***James Webb Space Telescope*** (JWST) (6.5 m) is an infra-red observatory, due for deployment in 2014, and is destined to take our vision of the universe to an even deeper level.

Conversely, radio astronomy within Australia continues to flourish, while Australian radio telescope facilities have been involved in cutting edge research for several decades. These facilities are: the ***Molonglo Observatory Synthesis Telescope*** (MOST) (consisting of two cylindrical paraboloids, 778m by 12m), and the ***Parkes Telescope*** (PO)(64 m), and also radio telescope arrays, acting as interferometers, are of key importance; namely, the ***Australia Telescope Compact Array*** (ATCA) (6 antennas each 22 m with a separation up to 6 km). The more famous ***Very Large Array*** (VLA)(27 antennas each 25 m, can be separated up to a distance of about 36 km) in New Mexico had dominated Long-Baseline Interferometry which is currently undergoing upgrades to become the ***Expanded Very Large Array*** (EVLA), and also the ***Giant Metrewave Radio Telescope*** (GMRT) in India (14 antennas each 45 meters with up to a separation of 25 km) have both contributed to a larger extent.

Bright future ahead

However, Australian astronomy stands poised to reinstate its significance as a leading contributor to the vastly growing science of radio astronomy as a final nominee for the **Square Kilometer Array** (SKA) (Consisting of 3,000 antennas, each 15 m diameter, extending outward in a spiral from the central core to at least 3,000 kms). Currently the nominees are down to South Africa and Australia while final selection will be made by 2015. The SKA will be 50 times more sensitive, and be able to survey the sky 10,000 times faster, than any imaging radio telescope array previously built and should be fully operative in 2024. If Australia is selected this will make Australian science the leading contributor in radio astronomy in the successive decades.

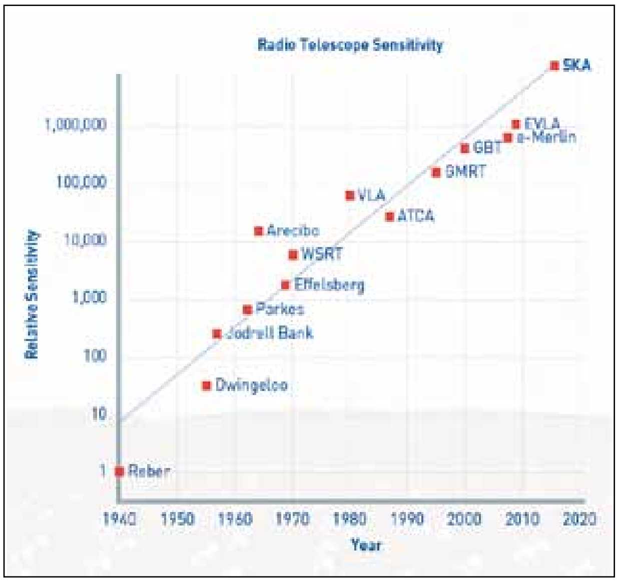
1 Currently the largest optical telescope on the Earth, or in space for that matter.

2 Other even larger ELTs are planned for the future – see Epilogue for details of those programs.

In the meantime Australia is not sitting idle waiting for the final selection but has a step-wise program in place, entitled the **Australian Square Kilometre Array Pathfinder** (ASKAP)(36 antennas, each 12 m). It is also a great precursor for the ASK, as it helps develop the technical ability to make a project such as the SKA function. In fact the project continues to progress on schedule, with five new antennas constructed at the **Murchison Radio-astronomy Observatory** (MRO) during the months of September and October, 2010. The five new antennas brings the total number of ASKAP antennas now standing at the MRO site to six, with the first ASKAP antenna successfully built and trialled earlier in 2010.

Other significant projects in other countries are also progressing, with the **Low Frequency Array** (LOFAR) (25,000 little antennas spread over the Netherlands and several other European countries) and the, once completed, **Atacama Large Millimeter Array** (ALMA) (66 antennae, each up to 12 m). Although these two projects will operate at different frequency ranges to the SKA.

In terms of sensitivity, the SKA project is clearly the most significant thus far as can be seen from this comparison chart.



Relative sensitivity verse Radio telescope sensitivity Diagram courtesy of the SKA

RETROSPECTIVE: It's not possible to mention all the major telescopes that are currently in use around the world or which are proposed in the future as there are so many. Simply for comparison a few big large scale projects have been mentioned to show where astronomy is at this current juncture. However we can't in all honesty look forward without a nostalgic glimpse back at the contribution that Australian telescopes have made to astronomy and cosmology, for it is a glorious past.

Siding Spring Observatory

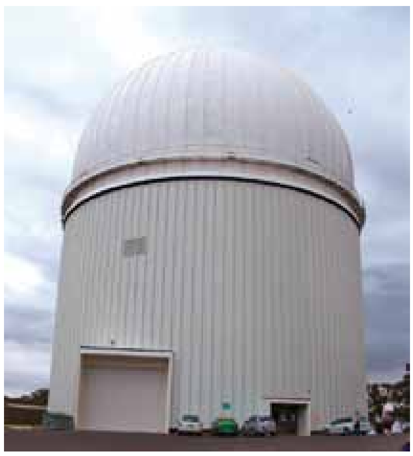
The Siding Spring Observatory (SSO) has historically been the most important site for optical astronomy in Australia. Some of Australia's largest optical telescopes are located next to the picturesque Warrumbungle National Park near Coonabarabran, N.S.W., and approximately six hours' drive from Sydney. The SSO is still today Australia's premier facility for optical and infra-red astronomy. These days many of the SSO optical telescopes are not used in visual imagery but are used more and more to produce digital spectrograph data for analysis by astronomers.

Telescopes at Siding Spring:

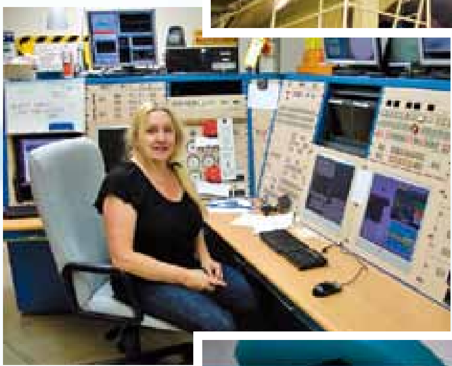
- 3.9 m Anglo-Australian Telescope (AAT)
- 1.24 m UK Schmidt Telescope (UKST)
- 2.0 m Faulkes Telescope South (FTS)
- 1.3 m SkyMapper Telescope (SMT)
- 2.3 m Advanced Technology Telescope (ATT)
- 0.5 m Uppsala Southern Schmidt Telescope (USST)
- 0.5 m Automated Patrol Telescope (APT)
- 0.45 m ROTSE IIIa (ROTSE)
- Korean YSTAR Telescope (YSTAR)
- The HAT-South Project (HAT)
- 40-inch Telescope (Decommissioned)
- 24-inch Telescope (Decommissioned)
- 16-inch Telescope (Decommissioned)

The Anglo-Australian Telescope (AAT), commissioned in 1974, is a 3.9 m equatorially mounted telescope operated by the Australian Astronomical Observatory (AAO). It is equipped with a number of instruments, including the Two Degree Field facility (2dF), a robotic optical fibre positioner for obtaining spectroscopy of up to 400 objects over a 2° field of view simultaneously; Échelle Spectrograph, a high-resolution optical spectrograph which has been used to discover many extrasolar planets; and IRIS2, a wide-field infrared camera and spectrograph. In the last decade this telescope contributed to the very important 2dF sky spectroscopic survey. The newsworthy Hartley Comet was also discovered at the AAT.

The Anglo-Australian Telescope AAT (3 images) (Author at controls in lower image) Photos courtesy Jasmine Cooper 2009.



The UK Schmidt Telescope (UKST) is a survey telescope with an aperture of 1.2 metres and a very wide-angle field of view. The telescope was originally commissioned in 1973 and until 1988 was operated by the Royal Observatory, Edinburgh. It became part of the AAO in June 1988 and now continues to do spectrographic analysis.



UK Schmidt Telescope (above and below) Photo courtesy Jasmine Cooper 2009.

Aligning optical fibres on the imaging plate for the UK Schmidt Telescope.

The Faulkes Telescope South is a part of the Faulkes Telescope Project which is the education arm of Las Cumbres Observatory Global Telescope Network (LCOGT). It is a robotic telescope and provides a fully supported education programme to encourage teachers and students to engage in research-based science education.

The Advanced Technology Telescope (ATT)(2.3-m) was built in the early 1980's. The design of the 2.3-m incorporated three radical features, which at time, had never before combined in a single instrument: an uncommonly thin mirror, an alt-az mount, and a rotating building. The telescope's design and building look similar to many new telescope designs. Imaging is in the form of visual light and Wide Field Spectrography (WiFeS).

Advanced Technology Telescope ATT Photo courtesy Jasmine Cooper 2009.

The SkyMapper Telescope (SMT) has an advanced 1.35 metre modified Cassegrain optics has an f4.79 focal ratio, making the system highly efficient as a photographic instrument. SkyMapper will be among the first of a new breed of surveying telescopes which are able to scan the night-time skies more quickly and deeper than ever before. The SkyMapper telescope provides a deep digital map of the southern sky which allows astronomers to study everything from nearby objects such as asteroids in our solar system to the most distant objects in the universe called quasars. Well known astronomers, such as Brian Schmidt, are currently using Skymapper.

The SkyMapper Telescope (top left) Photo courtesy Jasmine Cooper 2009.

The Uppsala Schmidt Telescope (USST) was moved to Siding Spring Observatory from Mount Stromlo in 1980. It has a field of view three times as large as the AAT, using a spherical mirror with 0.6 m correcting plate. The scope these days is used for the near earth objects program (NEO), and is the only telescope in the Southern Hemisphere used for such. Many important objects have been found using the Uppsala Schmidt, including the McNaught Comet discovered by Robert H. McNaught in 2006.

The Automated Patrol Telescope (APT) is a 0.5 m telescope owned and operated by the University of New South Wales UNSW. Its previous CCD camera imaged a 2x3 degree field with 9.4 arcsecond pixels. The telescope is entirely computer-controlled, with the possibility of remote or fully automated observation. A new camera is currently being installed on the APT. The aim of this telescope is to search for extrasolar planets.

The Robotic Optical Transit Search Experiment (ROTSE)IIIa primary goal is to achieve observations in optical light of the massive deep-space explosions called Gamma-Ray Bursts (GRB).

Korean YSTAR Telescope (YSTAR) operated by the Korean Southern Observatory and is part of a sky survey that looks for variability. This observatory has a 0.5 m telescope with fast F/2 optics covering nearly 3.5 square degrees field onto a 2K CCD, with a slew capacity of 10 degrees per second. It is designed to monitor and detect variable stars.

HAT-South (HAT) is a project to search for transiting extrasolar planets in the Southern Hemisphere, utilizing a network of wide-field telescopes to monitor hundreds of thousands of bright stars, searching for the characteristic dip in light that occurs when a planet passes in front of its host star. The HAT-South telescope commenced operation in October 2009 and is the SSO most recent installation.

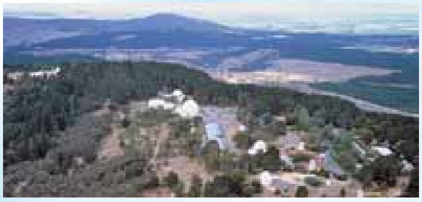
The Hat-South SSO telescopes Courtesy of RSAA

Mount Stromlo Observatory

Mount Stromlo Observatory (MSO) is reported to be the oldest observatory, still operating, within Australia. The MSO is located just outside of Canberra and is part of the Research School of Astronomy and Astrophysics RSAA at the Australian National University (ANU). There's no doubt that the destruction of all the Mount Stromlo telescopes as a result of the bushfire of the 18th day of January 2003 was a major loss for Australian astronomy. Many important optical telescopes were damaged beyond repair but the rebuild has been consistent and the new Mount Stromlo is very different to the one displayed above.

The only telescope to escape the fires was the 1868 15-centimetre Farnham telescope. Redevelopment is largely completed and the Observatory is now a major partner in the construction of the Great Magellan Telescope (AGMT). Much research and development is now underway at MSO but all the observational work is now done at the SSO.

The fire-storm of 2003 swept through part of Canberra,



Mount Stromlo before the 2003 bushfires. Photo courtesy Wiki commons.

the Australian capital, destroying more than 500 homes and severely damaging many more, claiming four lives, and largely destroying the Mount Stromlo Observatory (MSO). From a history of astronomy perspective this is a major catastrophe, as the following historically-significant telescopes were lost:

- 74″ (Grubb-Parsons) Reflector
- 50″ 'Great Melbourne Telescope'
- 30″ Reynolds Reflector
- 9″ Oddie Refractor
- 26″ Yale-Columbia Refractor

The devastation of Mount Stromlo Photo courtesy of MSO 2003.

The Mount Stromlo Satellite Laser Ranging facility. Photo courtesy of Jasmine Cooper 2008.

Mopra

The Mopra Observatory (MO) is part of CSIRO Australia Telescope National Facility (ATNF). Mopra is a 22 m single-dish radio telescope located at the edge of the Warrumbungle Mountains near Coonabarabran. The telescope is primarily used for 3-mm spectroscopy and VLBI[3] experiments. The Mopra Control Desk is located in the control building at the Paul Wild Observatory (see below). Observers carry out their own observing and remote observing is possible from anywhere in the world.

Paul Wild Observatory

The Australia Telescope Compact Array (ATCA), at the Paul Wild Observatory, (six 22 m antennas) is located about 25 km west of the town of Narrabri in rural NSW, roughly 500 km north-west of Sydney. It is operated by the Australia Telescope National Facility (ATNF) which also includes the ATNF Headquarters at Marsfield in Sydney, the Parkes Observatory and the Mopra Observatory.

The ATCA is one of the world's most advanced radio telescopes and is used for more than 100 different observing projects each year. The subjects studied include: early stages of star formation, supernovae and supernova remnants, magnetic fields in galaxies, radio-emitting jets of material from black holes and how hydrogen gas is distributed in the local universe.

Australia Telescope Compact Array (ATCA) Photo courtesy of the CSIRO 2009.

3 Very Long Baseline Interferometry.

In addition to the Compact Array, The Paul Wild observatory is also home to the: Sydney University Stellar Interferometer (SUSI), instruments of IPS Radio and Space Services Birmingham Solar Oscillation Network (BiSON) telescope.

Parkes Observatory

The Parkes Observatory (PO) (64 m) is located 20 kilometres North of Parkes along the Newell Highway, approximately 380 kilometres West of Sydney. It is operated by the ATNF, including the Headquarters at Marsfield, ATCA, Mopra and the Australian Square Kilometre Array Pathfinder (ASKAP).

Parkes Radio Telescope – 'The Dish'
Photo courtesy Jasmine Cooper 2009.

It was the largest radio telescope in Australia but that has now been surpassed by the DSS-43 at Tidbinbilla tracking station which has been upgraded to 70 meters.

The primary observing instrument is the second largest in the Southern Hemisphere, and one of the first large movable dishes in the world. Every year Parkes celebrates its role in Apollo 11, although not as significant as Honeysuckle Creek tracking station, but it was the next key instrument in the event, and was the feature of the Australian movie, 'The Dish'.

Mount Pleasant Radio Observatory

The Mount Pleasant Radio Observatory (MPRO) is owned and operated by the University of Tasmania and is located 20 km east of Hobart. The observatory has two radio telescopes: a 26 m antenna and the 14 m Vela Antenna. The 14 m Vela telescope was constructed in 1981 as a dedicated instrument for observation of the Vela Pulsar. The Vela telescope has tracked the pulsar 18 hours a day, nearly continuously for over 20 years. The 26 m Radio dish came from Orroral Valley tracking station, where it was used for telemetry communications from the NASA Apollo missions to the moon. The 26 meter telescope is used in Australia's very long baseline interferometry network (AVLBI).

The 26 m Orroral Dish at Mount Pleasant Observatory Photo courtesy 2009.

Ceduna Observatory

The University of Tasmania UTAS acquired the Ceduna 1 Satellite Earth Station (30 m) in South Australia in September 1995. The acquisition of the landmark instrument has further boosted Tasmania's high status in Australian radio astronomy by providing the astrophysics group with control of 40% of the Australian (AVLBI) Array. This insures that UTAS will be in a position to play a major role in this area of Australian astronomy and cosmology for years to come.

Narrabri Stellar Intensity Interferometer

The Narrabri Stellar Intensity Interferometer (NSII) was the first astronomical instrument to measure the diameters of a large number of stars at visible wavelengths. It was designed by Robert Hanbury Brown et al, who received the Hughes Medal in 1971 for this work. It facility was built by the University of Sydney School of Physics and was located close the ATAC site. The design was based on an earlier design built by Brown & Twiss at Jodrell Bank in the UK. The NSII operated from 1963 until 1974, and was used to measure the angular diameters of 32 stars. There is virtually no trace of the NSII which remain today.

Narrabri Stellar Intensity Interferometer
Photograph courtesy of Prof. John Davis 1974.

Tidbinbilla Tracking Station

Tidbinbilla Tracking Station (TTS) is in a fairly remote national parks area about 30 minutes outside Canberra. The radio telescopes at Tidbinbilla are operated by the Canberra Deep Space Communication Complex, part of NASA's Deep Space Network.

The Tidbinbilla 70-m (DSS43) antenna and the 34-m (DSS-34) antenna are used for Radio Astronomy together with the (AVLBI), while the other dishes are used part of the NASA Deep Space Communications Complex. The DSS-43 is a 70 m dish and is the largest steerable parabolic antenna in the Southern Hemisphere.

The site dishes are:

- DSS-34 is a 34 m built in 1997.
- DSS-43 is a 70 m constructed in 1976 - extended in 1987.
- DSS-45 is a 34 m built in 1986.
- DSS-46 is a 26 m built in 1967 moved in 1984 from Honeysuckle Creek.
- DSS-49 is the designation of the 64 m dish at Parkes.

Tidbinbilla tracks and relays many NASA space programs, such as Hubble and more recently the EPOXI[4] and WISE[5] missions. There are plans to build up to three additional 34 m beam-waveguide (BWG) antennas by 2015. The first of these will be DSS-35 is currently in preliminary construction stages.

Other tracking stations in Australia are not mentioned as they are not used as Radio telescopes.

DSS-43 - at Tidbinbilla – 70 m (the largest in the S.H.) Photos courtesy of Jasmine Cooper 2008.

The 34-m Beam-Waveguide Antenna DSS-34
Both the DSS-43 & the DSS-34 are used for Astronomy.

AVLBI

The Australian Very Long Baseline Interferometer (AVLBI) is a radio-wavelength VLBI network of telescopes, comprising a flexible set of the antennas at ATCA, Parkes, Mopra, Mount Pleasant, Ceduna and Tidbinbilla Tracking Station. The LBA is operated by the Australia Telescope National Facility (ATNF), a branch of CSIRO (the Commonwealth Scientific and Research Organization), which also operates the ATCA, Mopra and Parkes observatories. The Hobart and Ceduna telescopes are operated by the University of Tasmania, while the Tidbinbilla dish is one of the NASA Deep Space Network tracking stations.

The AVLBI network Courtesy of ATCA 2009.

4 EPOXI is the name for the supplemental mission of NASA's Deep Impact spacecraft.
5 WISE: Wide-field Infrared Survey Explorer

AIGO

Ariel view of AIGO's site at Gingin
Photo courtesy of AIGO 2009.

The Australian laser interferometer gravitational-wave observatory (AIGO) is not strictly speaking a telescope but rather is an interferometer observatory which is used to detect the presence of gravity waves in space-time as predicted by Einstein's general theory of relativity. Loosely speaking gravity waves are referred to as gravitational radiation, although these are not electromagnetic radiation. AIGO is part of the US based laser interferometer gravitational-wave observatory consortium (LIGO). The facility is located in Gingin in Western Australia about 1 hour's drive from Perth. Stage 1 development is now complete providing an 80m interferometer facility, but when stage 2 is complete in the coming decade the interferometer will be 5 km long.

Other telescopes

There are many other facilities run by astronomical societies and amateur groups within Australia and a comprehensive list is displayed on The Astronomical Society of Australia's website (ASA).

Conclusion

Australian telescopes and Radio telescopes have historically been of great significance to the international communities in astronomy and cosmology and it looks very bright indeed for research within Australia with continuing government funding in telescope programs and scientific research as a whole. This is especially true, if Australia is indeed selected as the site for the SKA, for this will rocket Australian science to the forefront of astronomy for many years to come.

Epilogue

Other international ELT projects in the planning stages are:

- *California Extremely Large Telescope* (CELT) (30 m)
- *Giant Segmented Mirror Telescope* (GSMT)
- *Overwhelmingly Large Telescope* (OWL) (100 m)
- *Very Large Optical Telescope* (VLOT) (20 m)
- *Large Atacama Telescope* (LAT)
- *European 50-metre Telescope* (EURO50)
- *Japanese ELT Project* (JELT)
- *The European Extremely Large Telescope* (E-ELT)
- *Large Atacama Telescope* (LAT)

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Her busy work schedule hasn't stopped Estelle from continuing her passion for astronomy and cosmology as she works towards a BSc (Hons) in Astronomy with the University of Central Lancashire, in the UK. She is active in writing about astrophysics, is an associate member of the ***Institute of Physics*** (UK) and a member of the ***Australian Society of Authors*** (Aust.) and more recently ***Women in Astronomy*** (Aust.)

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Barometry without mercury

Adapting to the death of quicksilver: some alternatives to the Fortin Barometer

Kevin Scott

Since mercury released into the environment by volcanoes appears to be of the same order of magnitude as that from anthropogenic sources (1), and the latter is overwhelmingly from the chlor-alkali and gold mining industries, it is very unlikely that the inhibition of mercury-containing scientific instruments will make any significant difference to the concentration of environmental mercury. However, in conformity with the general aims and objectives of the European Union Directive on the subject (2), many research and educational institutions, meteorological observatories, airfields and industrial laboratories are replacing mercury-containing instruments with mercury-free alternatives. Mercury has been one of the most useful assets to measurement science to date and its replacement; particularly in barometry, is presenting an interesting challenge. In turn, this challenge gives rise to a new expansion of scientific ingenuity and creates new techniques and instruments and broadens the scope and potential of metrology. Thus the move away from mercury is not merely troublesome to scientific endeavour, but may actually promote and encourage it. In this paper, some methods and techniques for atmospheric pressure measurement are reviewed and are shown to offer metrological advantages over older mercury based devices.

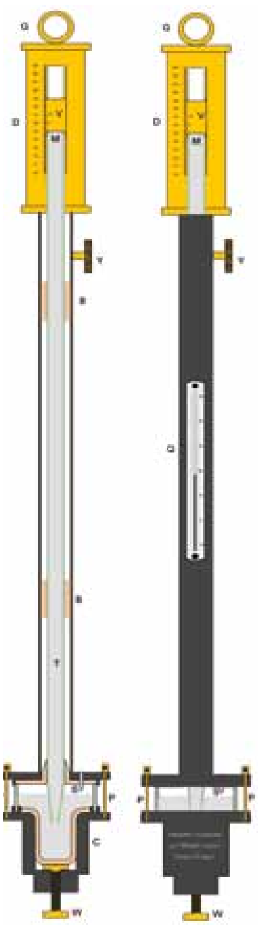

Figure 1 the Fortin Barometer

The end of a long reign: The eclipse of the Fortin Barometer

The Baird & Tatlock version of the Fortin Barometer, extensively used throughout the world, is shown diagrammatically in figure 1. A glass tube T of internal diameter at least 6mm and of reasonably heavy wall is closed at the upper end and has its lower, open end dipping below the surface of mercury in cistern C. This is supplied with a flexible leather lining and the level of mercury in the cistern can be adjusted by means of screw W. Tube T is initially completely filled with dry, clean mercury and then inverted over the cistern. The mercury level in T falls to a height representing the atmospheric pressure. In use, the level in the cistern C is adjusted by means of W so that the surface of the mercury in C just touches the ivory pin S. The scale V and vernier V are used to measure the height of the mercury column by means of adjustment Y. A thermometer is attached to the outer casing. It should be noted that very considerable care needs to be taken over the filling of a Fortin barometer, an operation which is often assisted with a good vacuum pump, to ensure that the Torricellian vacuum above the mercury is not compromised.

There are three corrections which need to be applied to the Fortin barometer for the best accuracy: (a) a correction for temperature, (b) a correction for variation in the acceleration due to gravity, and (c) a correction for the capillary effect of mercury in a glass tube. For a 6mm diameter tube the capillary correction is about 0.91mm to be added to the reading. (a) & (b), however, are variable and need to be applied to the reading obtained from the Barometer.

Correcting for temperature: The barometer is designed to read correctly at 0 deg C. If the linear coefficient of thermal expansion of brass is α at temperature t, the actual pressure is higher than that indicated by a factor of $(1 + \alpha.t)$

The mercury also expands with a volume coefficient of expansion of β. If the density of mercury at 0 deg C is ρ, the density at temperature t (deg C) is $\rho(1\text{-}t.\beta)$

Correcting for g: If g is the local gravitational acceleration and g0 is the standard to which the barometer is calibrated (frequently 980.665 $cm.sec^{-2}$) then the reading obtained needs to be corrected by the factor g/g_0

Overall Correction: To correct for temperature, gravity and capillarity the following equation can be used:

$$P_{(corr)} = \left(\frac{g}{g_{(0)}}\right)(1 - t.\beta + t.\alpha)(P + 0.91) \qquad (1)$$

P = pressure read from barometer in mm

P_{corr}= corrected pressure in mm

g = local gravitational acceleration

g_0 standard gravitational acceleration: 980.665 cm sec^{-2}

t = temperature in deg C.

β= cubical expansion coefficient of mercury = 1.8 $x10^{-4}$

α = linear expansion coefficient of brass = 1.85 $x10^{-5}$

The Fortin barometer has deserved its place as the preferred instrument for measuring the atmospheric pressure, but it has its drawbacks. Its measurement properties can be considered under six headings.

(a) Since the pressure P required to support a column of liquid height *h*, density ρ, under a gravitational acceleration g, is given by

$$P = \rho.g.h \qquad (2)$$

measurements of mass, length and time only are required to determine the atmospheric pressure. This means that the Fortin Barometer is said to be a *primary* instrument.

(b) The readings obtained from a Fortin Barometer are *absolute*. There is no variable offset which needs to be determined for calibration. The barometers described in this paper as replacements for the Fortin instrument are not all absolute. If set correctly at one pressure, they will read correctly at another, but they must be set to read correctly at a time of calibration.

(c) The Fortin Barometer is, to a great extent, *transparent* in operation. What is meant by this is that the operator can inspect the instrument to verify its correct functioning. The cleanliness of the mercury and the glass, the integrity of the meniscus, the correct setting of the mercury level in the cistern, are verifiable by observation. This goes a long way towards the practical usefulness and reliability of the instrument. The only factor, which seriously impairs the performance of a Fortin barometer, is the degradation of the Torricellian vacuum above the mercury. In an instrument containing bright, clean mercury which does not "tail" on the glass, the vacuum is likely to be as good as when the instrument was filled. Tarnished mercury and dirty glass may enable air to creep into the vacuum space during repeated changes in atmospheric pressure. Thus instruments, in which the mercury is not bright, are likely to read low.

(d) The Fortin Barometer has a *high*, *first-order* accuracy. This means that a Fortin barometer will read substantially correctly even if the corrections detailed above are neglected. In other words, the magnitudes of the corrections are small compared with the reading. This is not true of all of the alternative instruments.

(e) The Fortin barometer has *high linearity* and *low hysteresis*. Again this is not true of some mercury-free alternatives. It is not usual to expect an accuracy of greater that +/- 1mm for the pressure determined by a Fortin Barometer. Some alternative mercury free instruments offer an accuracy of 0.1mm Hg. For reasons detailed above, a Fortin barometer may exhibit a large negative *long-term drift* due to mercury corrosion. It also has relatively poor *readability*. Many barometers were produced with expanded scales, but the Fortin relied on a vernier to read fractions of mm. This limits the precision available. Some of the substitute instrument perform much better than the Fortin in these areas.

(f) The standard Fortin Barometer cannot be operated *automatically*. Two adjustments are necessary per reading, and the data has to be recorded manually. Magnificent recording versions were built and electrical methods were conceived for adjusting the mercury level in the cistern automatically, but even with such innovation the Fortin barometer cannot compete with digital instruments in this respect.

The Sympiesometer revisited.

The Sympiesometer, or air barometer was patented by Alexander Adie in 1818 and, even in competition with mercury barometers, became a favoured instrument in the Royal Navy. Figure 2 shows the drawing published by Adie in his patent. Glass bulb A containing Hydrogen is connected with reservoir C by a narrow vertical tube against which lies a moveable scale M adjacent to a fixed scale OP. The glass reservoir and part of the stem contain an oil. A thermometer is provided. At a constant temperature, the height of liquid in the stem is very nearly proportional to the atmospheric pressure. The function is actually a quadratic, but one of very low curvature in the region of interest. The instrument does exhibit a very high negative temperature coefficient, however. As the temperature rises, the gas in bulb A expands and depresses the liquid in the stem. To compensate for this Adie provided his instrument with a sliding scale NM which could be set so that its index corresponded to the temperature read off the thermometer and indicated on scale OP. The pressure was then read off scale NM. In use on ships, the instrument met with considerable satisfaction: The Captain of one of the vessels in the Ross expedition to the Arctic commented: "The Sympiesometer is a most excellent instrument and shews the weather far better than the marine barometer. In short, the barometer is of no use compared to it…. In my opinion it surpasses the mercurial barometer as much as the barometer is superior to having none at all." (Quoted by Adie (1819))

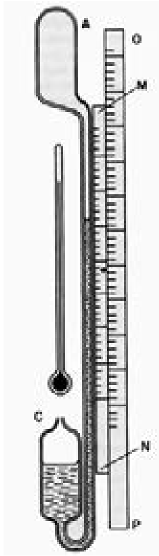

Figure 2 Adie's Sympiesometer. Sketch from Adie's Patent of 1818.

Figure 3 shows a modern version of the instrument manufactured by Meteormetrics Limited.(3) The volume of the reservoir A is controllable using the piston assembly H and used to set the level of liquid in tube B. An inverted thermometer with bulb D is read using Scale F. The pressure is read from scale G after the index on G is set to the thermometer meniscus. The sympiesometer fluid is an aviation lubricant with a very low vapour pressure. The dimensions of the instrument were chosen to give a sensitivity of 2mm/mB to ensure a high degree of readability. The temperature coefficient of the instrument at this sensitivity is 6.65mm/deg C. The thermometer was designed to exhibit this rate to within 1%.

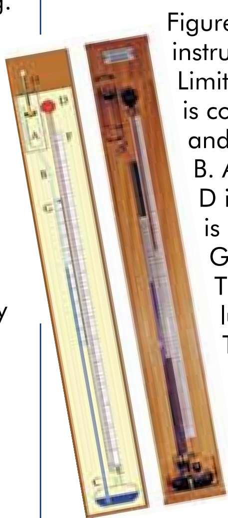

Figure 3 The Laboratory Sympiesometer designed and manufactured by Meteormetrics Limited.

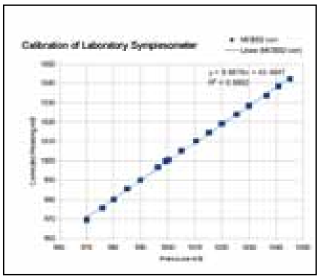

Figure 4 A calibration plot of a Sympiesometer against an NPL traceable standard.

Figure 4 shows a calibration plot of the instrument against an NPL traceable standard. As the theory predicts, the calibration plot exhibits a curvature making the instrument slightly underestimate the pressure at the top end of the scale. The slope of 0.957mB/mB suggests that the volume of the gas in the reservoir A has been set about 4 per cent too high when the instrument was set up. This can be corrected to provide an instrument, which will give an accuracy of about 0.4mB over the working range. Sympiesometers can produce very good results but need to be set up and operated by skilled personnel.

Quartz Bourdon Instruments

Figure 5 shows diagrammatically a quartz bourdon pressure gauge.

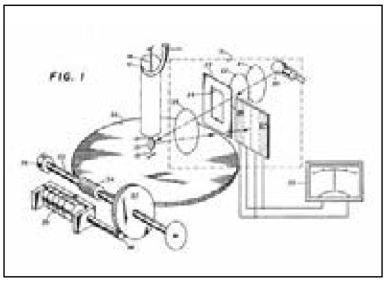

Figure 5 A diagrammatic representation of a quartz bourdon tube pressure gauge taken from two US Patents, Nos 3286529 & 3741015.

Internal pressure in a fine helical quartz tube generates a torque, which tends to rotate the helix. This can be counteracted by a motor, which rotates the helix to maintain an optical null provided by a lamp, sensor and mirror. The turns through which the motor has to rotate to maintain this null is proportional to the internal pressure in the helix. Considerable precision is possible with this arrangement: In a Texas Instruments version, the resolution was found to be 0.005 mB. Clearly these are secondary instruments, and relative, not as opaque as electronic instruments, but prove to be stable, precise and linear. They are, however, bulky and expensive but they generate data, which is, at least in principle, electronically exportable. Figure 6 shows a calibration plot obtained for such an instrument.

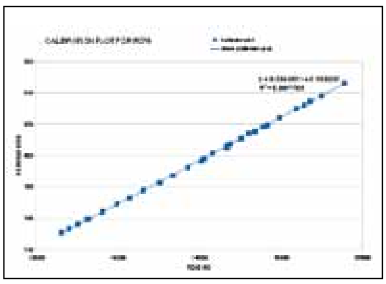

Figure 6 Calibration plot for a Texas Instruments Quartz Bourdon Pressure Gauge.

Electronic Instruments

The engraving of tiny strain gauges on the surface of a silicon wafer has enabled the production of precision electronic barometers and barographs with all the utility and possibilities offered by computer-controlled measurements and data processing. A precision sensor of this type is used in the Meteormetrics Meteor2000 series of precision barographs. Figure 7 shows a sensor of this kind and Figure 8, a digital precision barograph. Figure 9 shows a calibration plot for a Meteor2000WXDL datalogging barograph compared with water manometer measured with a travelling microscope. If the instrument is correctly set in the middle of its range, the plot shows that the error due to the slope will be less than 0.015% (0.15mB) at the extremities in either direction. With 0.1mB precision on the display the uncertainty is +/- 0.1mB. This is about 3-5 times better than a Fortin barometer in very good order. The electronic instrument also matches the Fortin in linearity and low hysteresis. According to an NPL calibration of a Meteor2000WXDL instrument, the hysteresis amounted to no more than the uncertainty of 0.1mB. According to the sensor manufacturers, the long term drift is no greater than 0.27mB/year which is certainly better than an unattended Fortin barometer.

Figure 7 A precision compensated pressure sensor from Sensortechnics.

Figure 8 Meteormetrics Precision Electronic Barograph.

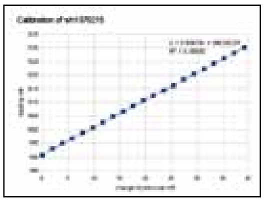

Figure 9 A calibration plot for a Meteor2000WXDL barograph.

The electronic instrument is however, opaque. The operator has no independent means of verifying that there has not been a change of characteristics of the sensor, except by recalibration. The high reliability of the digital units means that this is not such a serious drawback and the effect of the opacity can be alleviated in critical applications by running two or more instruments side by side. The electronic instruments are, by contrast with the Fortin barometer, also secondary and relative in their operations.

Electronic instruments have, however, the very great advantages of signal processing, data management and storage and a wide range of data printing and display options. They are also portable and compact. Thus a Meteormetrics Meteor2000TR electronic Barometric Transient Event Monitor was used to monitor the pressure changes occurring in a commercial aircraft on take off and landing, a task that is beyond the capacity of traditional barometers for many reasons. Figure 10 gives the details of this experiment.

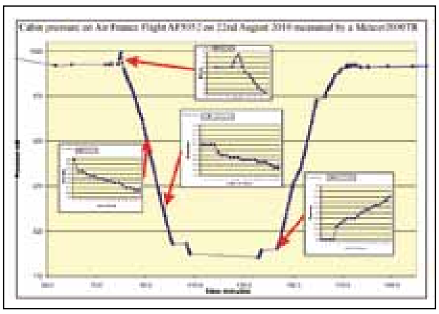

Figure 10 Pressure changes in a commercial airliner on take off and landing. The insets show detailed changes taking place during rapid compression or decompression of the cabin.

The Meteormetrics Absolute Centrifugal Barometer.

The Fortin barometer depends for its operation on the high density of mercury. This results in a relatively short column of about 850mm to accommodate the normal atmospheric pressure at sea level of 760mm. Several pioneers have tried the water equivalent, but it has the inconvenience of being some 10 metres tall, and the water tends to boil into the Torricellian vacuum. The idea of substituting an alternatively dense liquid for the mercury has been explored. Galinstan is a eutectic alloy of 68.5% Ga, 21.5% In and 10% Sn, with trace amounts of copper, and melts at -20 C. Unfortunately the specific gravity of 6.44 would result in 2 metre barometer tubes although the scale would also be correspondingly expanded. The main disadvantage is that the alloy wets glass and would silver the inside of an untreated barometer tube. Treatment of the inside of the barometer tube with gallium oxide would remedy this, but might lead to unquantifiable surface tension effects.

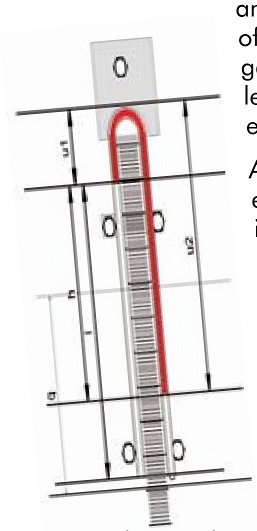

Figure 11 A barometer tube for a Centrifugal Absolute Barometer.

An alternative approach, referring to equation (2), would to be to find a way of increasing the acceleration g. This can be done with a centrifuge. This concept, patented by the author (4), involves a short barometer tube filled with a low-volatility oil and spun in a centrifuge. Figure 11 shows a sketch of the idea and figure 12 shows a strobed photograph of a rotating barometer of this type.

The theory of the device is readily developed:

Referring to figure 8, we can write equation (2) in the form

$$P_a = \rho . h . q . \omega^2$$

and putting S as the rotational rate in rotations/second, we obtain

$$P_a = \rho . h . q . 4 . \pi^2 S^2$$

If the rotational period = T = 1/S and writing α = $4.\varpi 2.\rho$,

$$h = \frac{P_a T^2}{\alpha q} \quad (3)$$

Notice from equation (3) that if the rotational period T is measured, together with the liquid density ρ, and if distance q can be measured, being the rotational radius of the midpoint of liquid column, then from the height h, the atmospheric pressure can be directly calculated.

Figure 12 A strobe photograph of a Centrifugal Absolute Barometer while rotating.

There is, however, a small complication. With the overall length of the barometer tube about 10cm and the fluid specific gravity of about 0.85, the rotational acceleration necessary to give a Torricellian vacuum is about 90g. The end of the tube, which is open to the atmosphere, must be close to the centre of rotation. Otherwise, transverse air velocity passing at right angles to the open tube will reduce the pressure within it. On the other hand under the increased g, the air in the open limb will exert an increased pressure on the fluid surface. Assuming an isothermal atmosphere down the open limb, if M = average molecular weight of air, then

$$P'_a = P_a . e^{-M\frac{l.g.4.\pi^2 S^2}{RT}} \quad (4)$$

Equation (4) represents a correction (amounting to about 2mB) which will need to be applied to correct for the compression of the atmosphere in the open limb caused by the rotation.

The concept of the Absolute Centrifugal Barometer was tested by mounting two barometer tubes with scales behind them on the limbs of a centrifuge. The centrifuge was rotated at various speeds, measured by a stroboscope, and the rotating barometers photographed use flash photography. Measurements from the photographs, as imprecise as they were, verified the theory of operation as outlined above and confirmed the practicality of constructing a barometer of this kind.

The table gives some measurements made at different rotational speeds for which clear photographs were obtained.

QUANTITY	Symb	units	VALUE	VALUE	VALUE	VALUE	VALUE
total length of liquid column	u	m	0.11	0.11	0.11	0.11	0.11
distance q	q	M	0.12	0.12	0.12	0.12	0.12
rotational speed rpm	Sm	min-1	1620.00	1542.00	1662.00	1758.00	1832.00
Density of barometric fluid	rho	Kg/M^3	875.00	875.00	875.00	875.00	875.00
height of barometric fluid	h	m	0.06	0.07	0.06	0.05	0.05
rotational radius	r	m	0.10	0.10	0.10	0.09	0.09
rotational speed	S	sec-1	27.00	25.70	27.70	29.30	30.53
Average Mol Weight of air	M	Kg	0.03	0.03	0.03	0.03	0.03
length of air tube	l	m	0.12	0.12	0.12	0.12	0.12
Universal Gas Const	R	$jMol^{-1}K^{-1}$	8.30	8.30	8.30	8.30	8.30
Absolute Temperature	T	K	300.00	300.00	300.00	300.00	300.00
Exponential factor Z	Z		0.9986	0.9986	0.9985	0.9985	0.9985
Measured Pressure	Pa	Pa	100309.73	100137.99	101348.21	100575.94	100654.92
acceleration		msec-2	1913.85	1733.99	2014.37	2253.80	2447.54
acceleration	g	g	195.09	176.76	205.34	229.75	249.49
Actual pressure		Pa'	100165.29	99995.96	101199.89	100427.12	100503.78

The prevailing atmospheric pressure was 1002 mB. The average of the above measurements is 1004.6 mB, which, considering the difficulty of measurement is to be regarded as a good correlation.

It remains to reduce the principle of the centrifugal absolute barometer to a convenient, accurate and useful instrument. The author is currently engaged in this process. The putative design contains a capillary barometer tube mounted on a printed circuit board containing a microcontroller, several optical meniscus sensors, some carefully placed magnetic sensors, and a RS232 wireless data transceiver. A magnet placed at a convenient point near the rotating barometers allows the microcontroller to make two important measurements: the rotational speed and the radius of rotation. At the same time, the optical meniscus sensors track the movement of the liquid level as the rotational speed increases. The microcontroller can thus make successive measurements at different rotational speeds and calculate a value for the atmospheric pressure according to the equations above. It is expected to achieve 0.1mB precision in this way. This value is transmitted to a non-rotating receiver, displayed or sent to a computer for further processing and presentation. Operating at high g has a further advantage: the capillary effect, normally pronounced in narrow bore tubes is inversely proportional to the gravitational acceleration and so permits the use of tubes of a bore 100 smaller than in non-centrifugal instruments. The centrifugal instrument can either be built into a centrifuge or take the form of a centrifuge tube which can be rotated in a centrifuge whenever the atmospheric pressure is required to be measured.

Conclusions: A comparison table of instrument types.

The barometer user who wishes to replace a Fortin instrument with a non-mercurial alternative has several options with different virtues and drawbacks. Table 2 gives a summary of the main choices available.

TYPE	Primary/Sec	Abs/Rel	Read-ability	Precision	Transparent?	Compensation	Data export?	NPL calib?
Fortin	Primary	Absolute	0.1mB	1mB	yes	low	no	no
Sympies-ometer	Primary	Relative	0.05mB	0.4mB	yes	high	no	no
Quartz Bourdon	Secondary	Relative	0.005mB	0.05mB	no	low	possible	yes
Electronic	Secondary	Relative	0.1mB	0.1mB	no	low	yes	yes
Centrifugal	Primary	Absolute	0.1mB	0.5mB	yes	low	yes	possible

The table suggests that the overall best currently available replacement for the Fortin Barometer is an electronic instrument, calibrated by the NPL. This provides sufficient precision for virtually every purpose, the certification of calibration will answer the criticism that electronic instruments are secondary and relative, rather than primary and absolute as the Fortin barometer is. The exportable nature of the data is also a very valuable asset in metrology and gives the electronic instrument a great advantage over the Fortin.

The Centrifugal Absolute Barometer, if it lives up to its expected virtues offers still further advantages. To exportable data, high precision and readability, it adds primary and absolute characteristics which may make it the preferred precision barometer of the future.

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(4) Scott K.F. UK Patent Application GB1006068.9 An Absolute Centrifugal Barometer. April 2010.

Author

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Science & technology news

Bumble bee intelligence ▶

Engineering and Physical Sciences Research Council

Complicated mathematical problems that can keep computers busy for days can be solved in a jiffy by bumblebees, according to new research.

Scientists at Royal Holloway, University of London and Queen Mary, University of London have discovered that bees learn to fly the shortest possible route between flowers even if they discover the flowers in a different order. Bees are effectively solving the 'Travelling Salesman Problem', and these are the first animals found to do this.

The Travelling Salesman must find the shortest route that allows him to visit all locations on his route. Computers solve it by comparing the length of all possible routes and choosing the shortest. However, bees solve it without computer assistance using a brain the size of grass seed.

"Foraging bees solve travelling salesman problems every day. They visit flowers at multiple locations and, because bees use lots of energy to fly, they find a route which keeps flying to a minimum." - ***Dr Nigel Raine, from the School of Biological Sciences at Royal Holloway***

The work has been funded by EPSRC, the Biotechnology and Biological Sciences Research Council and the Wellcome Trust and received extensive media coverage including articles in the Guardian, the Telegraph and the Independent.

Chemistry is worth over £250 billion to the UK economy every year, says new report ▶

Royal Society of Chemistry and EPSRC

One in every five pounds in the UK economy depends on developments in chemistry research, according to a new report from the Royal Society of Chemistry (RSC) and EPSRC.

Industries reliant on chemistry contributed an astonishing £258 billion to the UK economy in 2007 - equivalent to 21% of UK GDP and supported six million jobs, accounting for at least 15% of the UK's exported goods and attracting significant inward investment.

The findings demonstrate the high calibre, financial worth and excellent value for money of the UK's chemistry research base.

The report looks at 'upstream' and 'downstream' industries - those that produce or depend to varying degrees on chemicals. Using economic data and case studies it provides a dramatic illustration of the true value of chemistry research to the country.

The report, by leading economic forecasting consultancy Oxford Economics, evaluated the contribution of chemistry research to many different industries and found that fifteen key sectors, including health, electronics, textiles and aerospace, are wholly or partly reliant on the chemical sciences.

"The Government recognises the key role that research, technology and innovation will play in rebalancing the economy. As well as the significant contribution they continue to make in promoting the country's economic growth, the chemical sciences offer great potential for helping us tackle the most urgent challenges the planet faces today such as developing sustainable energy sources and advancing new medical treatments." - ***David Willetts, Minister for Universities and Science***

"The products of chemistry and other areas of science and engineering research are present in nearly every facet of the UK economy and these figures not only remind us of the remarkable return on our investment in chemistry research, but also of the imperative to continue developing world leaders in the field." - ***Professor David Delpy, chief executive, EPSRC.***

"Those drawn to the chemical sciences find the subject exciting because it provides profound insights into the world around us and offers extraordinarily creative opportunities. But this report also demonstrates the extent to which developments that are led or underpinned by the chemical sciences contribute to the economic well-being of the UK. It sends a clear message that it is essential for us to invest, and invest significantly, in the continued development of the skills pipeline, from schools to university and beyond." - ***Dr Richard Pike, chief executive, Royal Society of Chemistry.***

It's all in the soil ▶

Biotechnology and Biological Sciences Research Council

In November the John Innes Centre (JIC) announced an exclusive commercial licence agreement for BBSRC-funded technology that enhances the root systems of plants and with it important implications for crop improvement. JIC's technology management company Plant Bioscience Limited (PBL) is licensing the technology to Dow AgroSciences.

The John Innes Centre is an independent, world-leading research centre in plant and microbial sciences with over 500 staff. JIC is based on Norwich Research Park and carries out high quality fundamental, strategic and applied research to understand how plants and microbes work at the molecular, cellular and genetic levels. The JIC also trains scientists and students, collaborates with many other research laboratories and communicates its science to end-users and the general public. The JIC is grant-aided by Biotechnology and Biological Sciences Research Council.

Dow AgroSciences, a wholly owned subsidiary of The Dow Chemical Company (NYSE: DOW), entered into an exclusive commercial licence agreement with Plant Bioscience Limited (PBL) for technology that enhances the root systems of plants with important implications for crop improvement. The commercial licence covers a range of important agricultural crops.

The technology was developed by Dr. Liam Dolan and his colleagues at the John Innes Centre, an institute of the BBSRC on the Norwich Research Park. With BBSRC funding, the team cloned and characterized genes which may play vital roles in anchorage, water use and nutrient uptake in plants. The genes are highly conserved among land plants and the technology has already been shown to be effective in enhancing root systems in transgenic plants of major crops around the world.

"Our research aims to answer key questions in biology and to provide solutions to important problems in food security, energy production, promoting health and combating disease. The technology was born out of basic research in nutrient uptake by plants and demonstrates the importance to agriculture of answering fundamental questions." - ***Professor Dale Sanders, Director of the John Innes Centre.***

"Dow AgroSciences is excited to be collaborating with one of the most respected organizations in the biotechnology industry. By combining our expertise in biotech crops and PBL's innovative technology from JIC, we have the opportunity to enhance a plant's ability to survive stress, increase nutrient utilization, and provide yield stability in challenging years or in parts of the world where there are less than favourable growing conditions." - ***Dan Kittle, PhD., vice president of Dow AgroSciences.***

The technology could bring improved crop varieties to the agricultural market and help open new markets.

"*We are delighted to enter this partnership with Dow AgroSciences. This technology has real potential to benefit agriculture and address global challenges of food production, and Dow AgroSciences' acknowledged strength in developing and commercializing new crop products is the key to achieving this important goal."* - ***Dr Jan Chojecki, Managing Director of PBL.***

The commercial licence covers a range of important agricultural crops.

York's 'Headless Romans' had exotic origins

Arts and Humanities Research Council

New research funded by the Arts and Humanities Research Council (AHRC) at the University of Reading has shown, thanks to isotope analysis, that the 'Headless Romans' found in a cemetery in York came from as far away as Eastern Europe.

The group of 80 individuals, found at Driffield Terrace in York, were buried between the late 1st and early 4th centuries AD. They are unusual because they are all believed to be male and more than half had been decapitated.

A new approach to the chemical analysis of bone and teeth that combined information about the individuals' diet with the type of climate and geological setting they grew up in has enabled the team to narrow down their likely origin. At least two had a diet rich in plant – probably millet – that wasn't grown in Britain at that time.

The researchers, working as part of the AHRC funded project 'A Long Way From Home: Diaspora Communities in Roman Britain', wanted to find out whether these were native Yorkshire-men or incomers, and see whether their origins might be linked to the way they were buried.

To do this, a group of archaeological scientists from the University of Reading and the NERC Isotope Geosciences Laboratory in Nottingham took samples of teeth and bone and analysed isotopes – atoms of the same element with different atomic weights – of strontium, oxygen, carbon and nitrogen.

Scientists normally just look at strontium and oxygen isotopic systems to work out someone's origins. But this time the archaeologists looked at the four isotopes together.

"This approach was very important in this case, because it has given us information about these unusual burials that would have been missed if only strontium and oxygen had been analysed." - ***Dr Gundula Müldner of the University of Reading.***

Isotopes are absorbed by our teeth and bones from our food, drinking water and the air. Their proportions vary around the world due either to differences in regional geology or climate, so they provide important clues about where individuals grew up or spent most of their lives.

"It's the first time that consumers of C4 plant products have been reported for any archaeological period in Britain. Oxygen (O) and strontium (Sr) are fixed in dental enamel as our teeth form. The enamel doesn't change much subsequently, so O and Sr levels can be matched fairly closely to the geology and climate of the place we grew up."

Carbon (C) and nitrogen (N) isotopes are absorbed from our food and can be measured from dentine or bone collagen samples. They tell scientists about terrestrial and marine foods in an individual's diet as well as the balance of plant and animal protein. They also distinguish plants that photosynthesis in different ways to produce different proportions of the isotopes C3 and C4.

However, as most diets look similar, isotopically speaking, over large parts of temperate Europe, C and N isotopes are not usually thought particularly useful for understanding how people have moved around.

18 individuals were tested for O and Sr. The Sr analysis showed that 11 of them grew up on food that wasn't grown locally while two O results were well outside the estimated range for Britain. One of these spent his childhood in a cooler climate and the other in a warmer one.

"Where possible we tested all four isotopes in the same individual," explains Müldner.

In combination, the O and Sr isotopes indicated that just five of the men tested grew up in York. The others either came from elsewhere in the north of England, or as far as France, Germany or central southern Europe or the Mediterranean.

In total 68 individuals were tested for C and N. Five of them were markedly different from local populations. Two in particular had eaten diets with distinctly high carbon isotope ratios, indicating the consumption of C4 plants – or the products of animals raised on them.

The only 'C4 plant' cultivated in Europe at that time was millet, but it was almost certainly not grown in Britain at the time, possibly because the climate was too wet. To have eaten enough of their distinctive diets to produce these unusual isotope results, these two individuals must have come from abroad.

"This was one of the most exciting results for me it's the first time that consumers of C4 plant products have been reported for any archaeological period in Britain."

Crucially, a number of the individuals identified as incomers from the C and N results would not have been picked though Sr and O analysis alone.

Compared to what we know so far from cemeteries across York, the 'Headless Romans' do seem to have much more exotic origins than groups with less unusual burial rites. But the study didn't find any consistent link between their geographical origins and whether they were decapitated.

"If anything it's the diversity of their backgrounds rather than any common origin that was the defining feature for this group of burials." - ***Dr Müldner.***

Leading science institutions sign agreement for the formal establishment of UKCMRI as a state-of-the-art medical research institute

Medical Research Council

Horizontal bisection of the head of an adult man, showing skin, skull, and brain with grey matter (brown in this image) and underlying white matter

The consortium behind the UK Centre for Medical Research and Innovation (UKCMRI) has formally agreed to build the new institute at St Pancras and Somers Town in the London Borough of Camden.

The Medical Research Council (MRC), Cancer Research UK, Wellcome Trust and UCL (University College London) have signed an agreement to set up UKCMRI as a charitable foundation subject to the agreement of the Charity Commission.

When he set out the Government's National Infrastructure Plan in October, the Prime Minister, David Cameron, identified UKCMRI as a key part of the country's future economic development. The plan followed confirmation of the Government's share of funding in the Spending Review. Describing scientific research as "vital to our future economic success", the Chancellor of the Exchequer, George Osborne, announced Government funding subject to approval of the MRC's full business case.

The £600 million Centre will prevent and cure disease, create jobs and harness a sector of the economy in which the UK is a world leader. It will investigate fundamental biological processes underlying human health, and will study diseases that affect people across the UK, including cancers, heart disease and stroke, infections, diseases of the immune and nervous systems and the degenerative conditions linked to ageing.

"I am delighted to be present at the signing of the Joint Venture Agreement for UKCMRI. This will be crucial for British biomedical research in the future. The four partners will create a world class centre with a mix of expertise and critical mass to capture cutting-edge science for the benefit of patients." - ***The Minister for Universities and Science, David Willetts MP.***

UKCMRI will bring together staff currently working at the MRC's National Institute for Medical Research and Cancer Research UK's London Research Institute with researchers from UCL. The institute will house scientists from a range of disciplines including biologists, chemists, physicists, engineers and computer experts to promote novel ways of working. The building, planned by a team led by the architects HOK working with PLP Architecture, is designed to foster innovation by allowing collaboration between different academic disciplines.

The Development Control Committee at the London Borough of Camden will consider the planning application for the building on 16 December.

The UKCMRI consortium

The UK Centre for Medical Research and Innovation (UKCMRI) is an unprecedented partnership between four of the world's leading biomedical research organisations: the Medical Research Council, Cancer Research UK, the Wellcome Trust and UCL (University College London). It will carry out research of the highest quality using the latest technology to advance understanding of human health and disease. The institute will be constructed on 3.6 acres of land at Brill Place, to the north of the British Library in the St Pancras and Somers Town area of north London. For more information visit www.ukcmri.ac.uk.

Building on research excellence

UKCMRI will initially build on the complementary skills and research interests of two of the founders' research institutes, the MRC National Institute for Medical Research (NIMR) and the Cancer Research UK London Research Institute (LRI), together with UCL scientists focusing on physics, computing, engineering, imaging and chemistry.

NIMR is renowned for its research in a diverse range of fields, including developmental and stem cell biology, structural biology, neuroscience, immunology and infectious disease. Its 600 scientific staff are based in laboratories in north London at Mill Hill. NIMR's director is Jim Smith.

LRI has an international reputation for basic cancer biology research, focusing on cell regulation and signalling, tumour and tissue biology, and genomic integrity. Directed by Richard Treisman, LRI has some 500 scientists working at laboratories at Lincoln's Inn Fields, central London and Clare Hall, Hertfordshire.

In addition to funding the cost of building UKCMRI, the founders will provide ongoing research support to the institute. Wellcome Trust support will fund interdisciplinary research spanning biology, chemistry, physics, maths and engineering.

Key facts:

- 1500 staff, including 1250 scientists
- Annual budget of over £100m
- Initial investment of £600m
- 3.6 acres of land
- 79,000 square metres of building

Timeline:

- Summer 2010 – planning application submitted
- 2011 – Construction starts
- 2015 – Construction ends

UK's most wanted: People with the maths & communication skills to save our planet!

Natural Environment Research Council ▶

Living With Environmental Change

Over the next 10 years the UK could run short of people able to tackle urgent challenges such as environmental risks to human health, safe carbon capture and storage and developing new energy sources, unless skills gaps can be plugged.

This is the finding in a report published by the Environment Research Funders' Forum. The report summarises work led by the Natural Environment Research Council (NERC), to examine skills that post-graduates and professionals need to equip them for work in the environment sector.

The "Most Wanted" report identifies 15 critical skills in short supply, including hard-edged skills such as numeracy, computer modelling and conducting field research, and softer skills such as translating research into plain language so that it can be understood more easily.

It also explains why such skills are so badly needed - for example, to allow the UK to develop and apply new technologies, respond to the impacts of climate change and extreme weather, and enable better knowledge and understanding of environmental issues.

Altogether, the review uncovered 224 skills which are needed by businesses, government and academics working on issues which overlap with the natural environment. According to a recent CBI report, businesses across the UK are already struggling to recruit staff with the skills needed to meet demands in some of these areas, and the shortage is likely to hamper economic growth.

"Leading this review gave us an excellent opportunity to examine training and skills plans to address the challenges we face now and into the future. People with qualifications and skills in science and maths will be particularly sought after to encourage economic growth and future prosperity in the UK.

"I urge postgraduate training organisations, funders and employers to make use of this important report, and ensure that we have the right people with the right skills to build a productive economy, healthy society and a sustainable world." - ***NERC's Chief Executive, Alan Thorpe.***

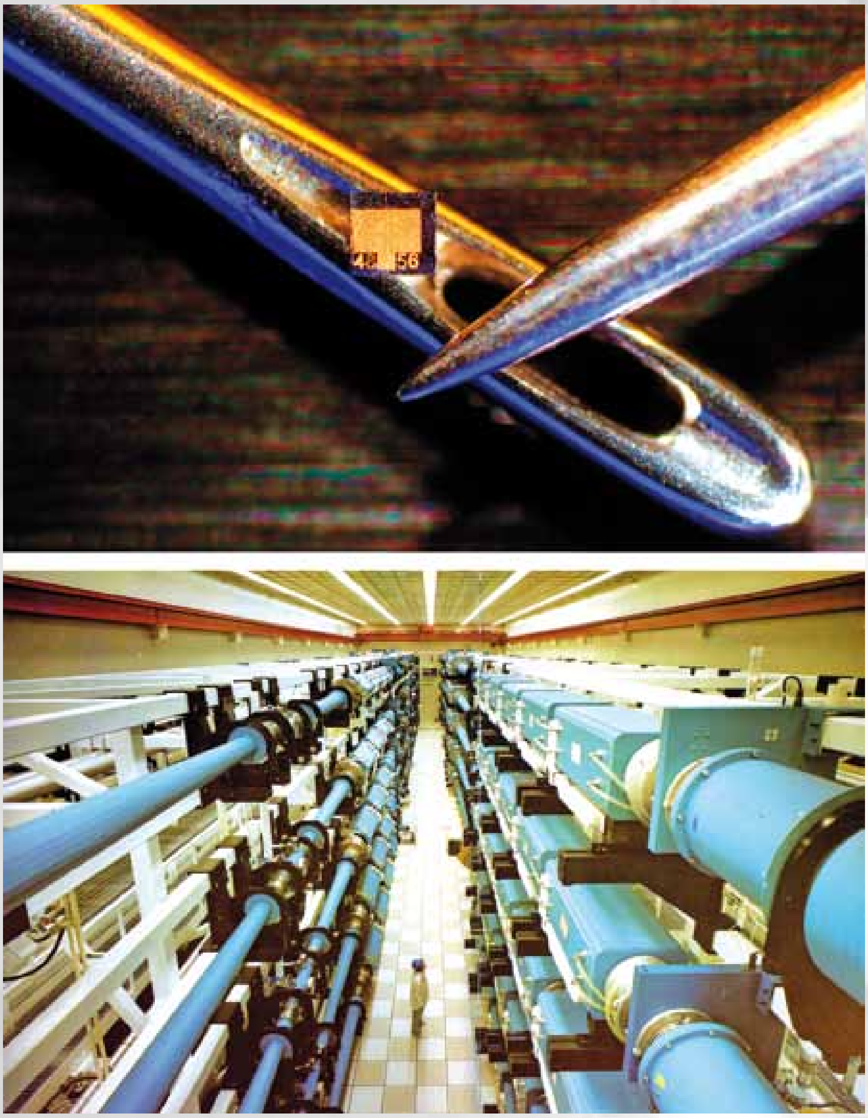
"In preparing the Most Wanted report we consulted widely with the employers of people with the skills needed in the environment sector. The consultations were highly productive and covered government, industry and the research sectors.

"We hope the report will provide a platform to drive much closer collaboration between employers of skilled people and those who provide the training." - ***Deputy Vice Chancellor of Sussex University and member of the review's project board, Bob Allison.***

ALICE shines its way to a European first at STFC Daresbury Laboratory

Science & Technology Facilities Council

A light source of unprecedented brilliance, the technology of which is poised to be responsible for significant advancements in fields such as healthcare, materials science and sustainable energy and to open up vast new areas for scientific exploration that have previously been inaccessible, has been achieved at STFC's Daresbury Laboratory.



Lasers range in size from microscopic diode lasers (top) with numerous applications, to football field sized neodymium glass lasers (bottom) used for inertial confinement fusion, nuclear weapons research and other high energy density physics experiments.

Scientists working on ALICE (**A**ccelerators and **L**asers **I**n **C**ombined **E**xperiments), an R&D prototype for the next generation of accelerator based light sources, have successfully demonstrated Europe's first Free Electron Laser to be operated on an energy recovery particle accelerator, on 23 October 2010.

A Free Electron Laser (FEL) is unparalleled in its capability as a light source, the intensity of light emitted is so strong, and of such exceptional quality, that it can be used to surgically remove a brain tumour without damaging the surrounding tissue and it can even weld metal.

Acting like a conventional laser incorporated into a particle accelerator, the light bounces backwards and forwards between mirrors and can be controlled and manipulated much more precisely than conventional lasers to produce intense, powerful light with extreme precision.

FELs can be used to help us better understand the fundamental processes of life itself as they allow scientists to study chemical reactions in real time, examine how catalysts behave, and increase their understanding of biological processes, such as the behaviour of a virus or the location of a drug on the surface of a molecule.

Particle accelerators themselves normally consume huge amounts of energy and can therefore be very expensive to run. However, as an energy recovery particle accelerator, ALICE is able to recover and re-use a proportion of its energy, making it more efficient and using significantly less energy than a conventional accelerator. Minimum energy is used to create the best possible beams of light.

ALICE's demonstration of the Free Electron Laser in the infra-red region of the spectrum was achieved at 27.5 million electron volts and is Europe's first energy recovery accelerator to do this. The same technology could be used to create light from infra-red through to X-rays.

"This is a fantastic achievement and all of those involved in this project have worked tremendously hard to demonstrate this capability, which is the first of its kind in Europe. Reaching this milestone has confirmed the UK's ability to build, develop and demonstrate its scientific skills and techniques in this field and given us some exciting prospects for the future of next generation light sources. This is technology that will change people's lives for the better and make our environment a cleaner place." - ***Professor Keith Mason, STFC's Chief Executive***

"This technology will open up completely new research opportunities for scientists in both universities and industry that were previously inaccessible. The impact of this technology is set to be huge, from studying a drug on a cell membrane to gain a deeper understanding into how drugs behave in the body, to a better understanding of the mechanisms behind solar cells with a view to improving techniques for cleaner energy, this is a giant step in the development of a major FEL facility for the UK scientific community." -***Professor Jim Clarke, Head of Magnetics and Radiation Sources Group at STFC Daresbury Laboratory***

Academics at the University of Liverpool are already researching the applications of this 4th generation light source in nanobiology, whilst scientists at Imperial College London want to use the light to manipulate gas molecules into precise orientations at an instant in time.

"The completion of the UK's first free electron laser opens the way to sub-cellular imaging of processes taking place in living cells with considerable potential for advances in both fundamental science and the treatment of disease." - ***Liverpool's Professor Peter Weightman, who is leading biological research on ALICE***

About free electron lasers

Free Electron Lasers (FELs) are an increasingly important kind of light source. Standard lasers can be very bright sources of visible light but they soon fade away in the deep ultra-violet and x-ray regions of the spectrum. FELs represent a radical alternative to conventional lasers, being the most flexible, high power and efficient generators of tunable coherent radiation from the infra-red to the X-ray.

FELs can have the optical properties that are characteristic of conventional lasers such as high spatial coherence and a near diffraction limited radiation beam, but FELs combine a high energy electron beam and a magnet called an undulator in such a way that all of the electrons emit light of the same wavelength at the same time, producing huge bursts of light. The latest FELs produce pulses of X-ray light that are powerful and fast enough for scientists to take stop-motion pictures of atoms and molecules in motion.

ALICE

Accelerators and **L**asers **I**n **C**ombined **E**xperiments

In April 2009, scientists at the Stanford Linear Accelerator Center (SLAC) in California, USA for the first time announced lasing of a Free-Electron Laser, the Linac Coherent Light Source (LCLS), in the hard X-ray region at a wavelength of 1.5Å (1.5×10^{-10}m). This was a landmark event in the history of light-source science that will open up vast new areas for scientific exploration. Another powerful new research X-ray FEL facility, the European XFEL, is currently being developed at the DESY (Deutsches Elektronen-Synchrotron) laboratory in Hamburg for use by researchers from 2014.

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The rise of the learned societies phoenix?

Stephen Gamble

It would have been impossible over the last few months not to hear about the massive cuts being made in UK public spending. These reductions will involve cuts in various parts of the education and research systems and downsizing or closure of various government-run scientific and engineering organisations. But could this particular, very large, cloud have a silver lining for learned societies such as the IST?

Many years ago I moved from a routine hospital pathology lab to work in a medical research establishment. In the pathology lab many of the staff were members of the Institute of Medical Laboratory Technology (now the Institute of Biomedical Science). In the research environment I also encountered members of the IST and other people who were members of the Institute of Biology (now the Society of Biology). The main thing that members of these organisations had in common was that many of them were working towards their institute's professional examinations. I started in the scientific profession at the time that national qualifications such as the Higher National Certificate (HNC) and the Higher National Diploma (HND) were taking over from the institutes' lower examinations. Most people looked to the professional institutes for their post HNC/HND study.

Over the years qualifications have crept up and the institutes' higher examinations have been squeezed out. Now it seems that you need at least a honours degree to get a job that twenty years ago you could obtain with a HNC (or an Ordinary National Certificate (ONC)). If you expect to progress now, it is likely that you need a masters degree or a doctorate instead of one of the institute's Fellow/Member qualifications. I believe that the professional institutes have lost out on many potential members in recent years as people do not need to join to undertake professional qualifications and progress their careers.

Teaching budgets at universities have been cut and fees to students are being increased from just over £3000 per year to between £6000 and £9000 per year for undergraduates. Already a one year full time masters course costs between £5000 and £6000, so if similar levels of fee increases apply here the minimum cost could be £10,000 with a potential maximum of £18,000. For many people these fees will be unaffordable. Some people might be fortunate enough to have their fees paid by their establishment or by a bursary from a research council. With budgets under pressure the number of people supported by these means will be at best static but more likely fall.

Phoenix depicted in the book of mythological creatures by F.J. Bertuch (1747-1822). Wikimedia Commons.

Whilst the government's cuts might result in fewer job opportunities for members of organisations such as the IST, I believe it also presents a great opportunity (and challenge) for the institutes. All three institutes I have mentioned above (IST, IBMS and SOB) have, in recent years, developed very good Continuing Professional Development (CPD) schemes. In addition, the IST is very actively involved in the HeaTED scheme. I see the time is ripe for the resurgence of the professional institute's own professional development qualifications and the CPD schemes as a springboard to launch these.

Rather than trying to vanquish the dragon, this is a particular beast the IST, and others, have the ability not only to tame but also to ride.

From the archives:

Some stories of the brewing industry

Alan Gall

An old joke tells of a man who drowned in a vat of beer. His wife goes to see the head brewer and asks 'Was it a quick death?' The brewer shakes his head sadly, 'Not quick at all, he climbed out three times to visit the toilet.'

Napoleon once called the English a nation of shopkeepers. His nephew[1], however, might very well have described us as a nation of publicans when he came to live at Chistlehurst, in the 'hop county' of Kent. Following the Beer Act of 1830, which allowed any householder to brew and sell beer from his or her front parlour, the number of licensed premises had mushroomed. By the time that the Wine & Beer House Act of 1869 put control of licences back in the hands of local magistrates, the number of public houses had about doubled. In areas of dense population this led to the proverbial 'pub on every corner'.

One expected effect of the 1830 Act failed to materialise. The legislation was intended to provide increased competition for the common (commercial) brewers by encouraging the production in beer houses. Low volumes and indifferent quality put a brake on this and in most parts of the country it did not account for a significant proportion of the total output. The commercial breweries had the advantage of economies of scale and the means to employ new technology. Moreover, they were beginning to acquire property and build up the tied-house system.

All this resulted in virtually every town having a commercial brewery or two and some, dozens. The country was once peppered with them. As an example, the Post Office directory for Liverpool in 1873 lists around 70 local breweries. *Friedrich's Gazetteer of the Breweries of the British Isles* lists nearly 200 brewery locations in London from 1877 to near the date of publication.[2]

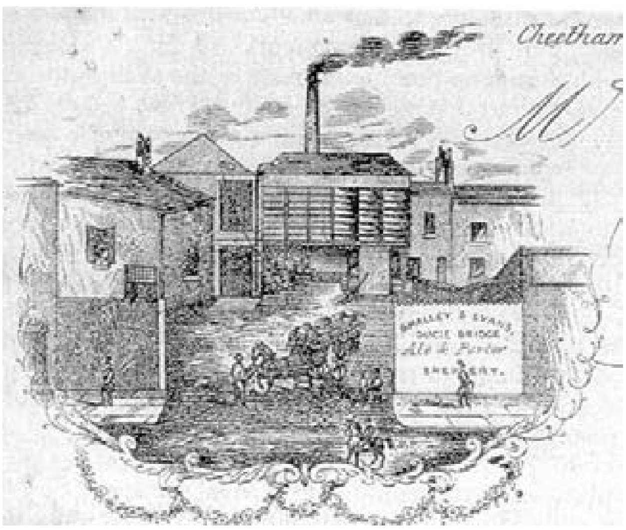
1 Charles Louis Napoleon Bonaparte lived in exile from 1870-1873 at Camden Place, Camden Park Road, Chistlehurst. The building still stands and is used by Chistlehurst Golf Club.

2 Although a few of these are probably agencies for out-of-town concerns.

Miasms in Manchester

Karl Marx's collaborator on the Communist Manifesto of 1848, Friedrich Engels, visited Manchester. He was mostly appalled by what he saw. This is one of the scenes described in his 1844 book, *The Condition of the Working Class in England:*

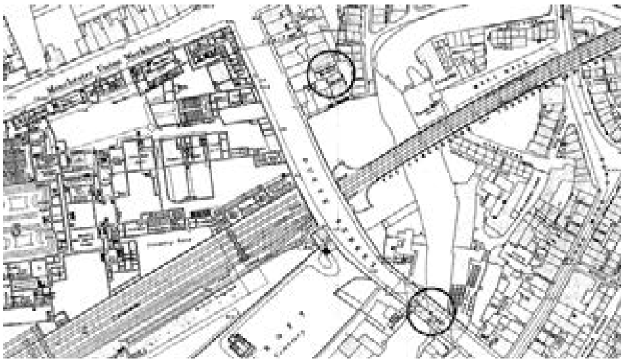
The view from this bridge [Ducie Bridge], mercifully concealed from mortals of small stature by a parapet as high as a man, is characteristic for the whole district. At the bottom flows, or rather stagnates, the Irk, a narrow, coal-black, foul smelling stream, full of debris and refuse, which it deposits on the shallower right bank.



The Ducie Bridge Brewery. Smalley and Evans moved to much larger premises - the Chorlton Road Brewery in Hulme, Manchester. (Courtesy of Joseph Holt Ltd)

In dry weather, a long string of the most disgusting, blackish-green, slime pools are left standing on this bank, from which bubbles of miasmic gas constantly arise and give forth a stench unendurable even on the bridge forty or fifty feet above the surface of the stream.

A short distance further on from Engles' vantage point, not far from the banks of the said River Irk, stood the Ducie Bridge Brewery. 'Miasmatic gas' must have been a concern to brewers of those days as the following warning appears in *A Dictionary of the Art of Brewing:*



This map of 1849 shows the positions of Ducie Bridge and the brewery.

Miasmatic air is fatal to beer; for miasms are the effluvia of putrefying organic bodies. Manure, closets, and filth of any kind engender miasms.

The Ducie Bridge Brewery offered limited scope for expansion and the occupiers, William Smalley and Joseph Evans, were successful enough to need extra room.

Joseph Holt, who had been brewing at even smaller premises, located behind a pub, moved in during 1855. Despite the dangers of miasms, Holts spent about five years there before moving to the newly-built Derby Brewery, where they are still operating today.

Bringing home the bacon

On Saturday 14 July 2012 the town of Great Dunmow will be celebrating a centuries-old tradition when married couples will be invited to compete in the Dunmow Flitch Trials. Open to couples from anywhere in the world, they need to prove their devotion to each other. The prize is half a pig. Generally known as a flitch (or side) of bacon, this animal carcass became the trademark of Dunmow Brewery Ltd. Charrington United Breweries Ltd acquired the brewery in 1965, which in turn merged with Bass, Ratcliff and Gretton Ltd in 1967.

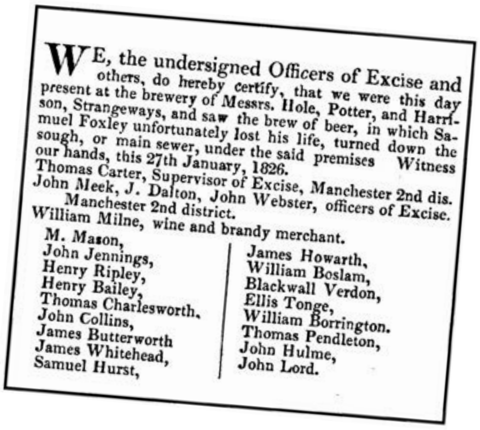
Bodies at Boddies

The first Henry Boddington (1813 – 1886).

In March 1878 two men died of suffocation at Boddington's Strangeways Brewery, Manchester. The manager, a Mr Littlewood, had made his rounds during the early evening and noted that two labourers, Nathan Robinson and Frederick Bradley, were working as usual. Robinson kept a key to one of the stables so his disappearance was first noticed when one of the carters needed a horse. Littlewood, who lived in a house adjoining the brewery entrance, was alerted and a search made of the buildings. Both Robinson and Bradley were found in a vat containing barm (used yeast) to a depth of six inches. It was speculated that Bradley had somehow fallen into the vessel, closely followed by Robinson in an attempted rescue. Both were overcome by carbon dioxide.

Fifty-two years earlier the Strangeways Brewery had been the site of an equally tragic misfortune. In 1826, six years before the arrival of Henry Boddington as a junior employee, the proprietors were Samuel Hole, Richard Potter and Robert Harrison.

One Samuel Foxley was due to empty a copper of hot wort (unfermented beer) into a cooler. He failed to appear on time so the task fell to another of the brewery staff. The reason for Foxley's absence was soon explained – his body lay at the bottom of the emptied vessel. He had apparently lost his footing whilst attempting to measure the depth of liquid with a pole.



WE, the undersigned Officers of Excise and others, do hereby certify, that we were this day present at the brewery of Messrs. Hole, Potter, and Harri-son, Strangeways, and saw the brew of beer, in which Sa-muel Foxley unfortunately lost his life, turned down the sough, or main sewer, under the said premises Witness our hands, this 27th January, 1826.
Thomas Carter, Supervisor of Excise, Manchester 2nd dis.
John Meek, J. Dalton, John Webster, officers of Excise. Manchester 2nd district.
William Milne, wine and brandy merchant.

M. Mason,	
John Jennings,	James Howarth,
Henry Ripley,	William Boslam,
Henry Bailey,	Blackwall Verdon,
Thomas Charlesworth.	Ellis Tonge,
John Collins,	William Borrington.
James Butterworth	Thomas Pendleton,
James Whitehead,	John Hulme,
Samuel Hurst,	John Lord.

Concerned that customers might be put off drinking their beer, Hole, Potter and Harrison assembled a posse of pub landlords and others to witness the disposal of the tainted wort. A notice in the *Manchester Guardian* followed.

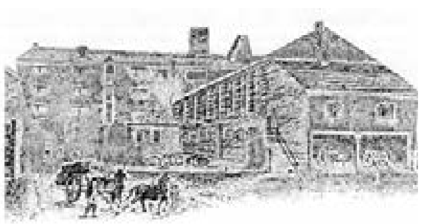
Inside the gates at Boddingtons. Mr Littlewood lived in the house adjoining the brewery entrance.

Make mine a Mottrams

Some people will do anything for a free drink. Proof of this came in 1831 when a freak accident at St Stephens Brewery in Salford unleashed a torrent of beer that flowed out of the premises and into a stagnant pool containing rotting animal carcasses.

The incident occurred in February when the weather conditions had changed from cold and frosty to unseasonably warm. A vat containing about 350 barrels of porter burst, demolished a wall and 'rose in an instant to a height of several feet in the place.' *The Manchester Guardian* described what happened next:

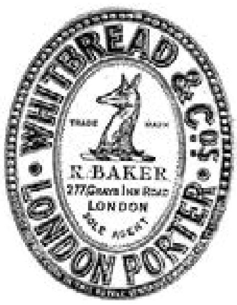
The liquor then ran down a declivity from the brewery to a sort of pit outside the gates, containing stagnant water, the bodies of dead dogs and cats, and other putrid and offensive matters…hundreds of people were seen greedily swallowing the now filthy potion! – The estimated loss occasioned by this unfortunate accident, it is said, is not less than £500.



The owner of the brewery, John Mottram, died the following year and the business eventually ended up with his son Richard Elliott Mottram in control. R.E.Mottram was a Salford Councillor for over thirty years and his son (another Richard) joined his father on the council and was Salford's Mayor 1894-98. In the same year as R.E.Mottram's death (1895), Mottram's Brewery Ltd was formed. Two years later it was bought by the Cornbrook Brewery Company of Manchester, itself a long established concern and subsequently one of the first to introduce 'tank beer'[3] .

How peculiar

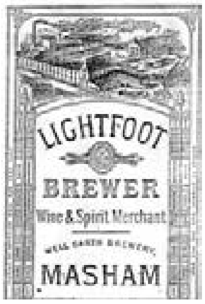
Porter is a dark beer said to be called after the London porters who preferred this beverage to other ales. The Brewer, published in 1856, describes it thus:



Its chief distinction lies in its peculiarly agreeable flavour … these characteristic qualities are produced by hops of a peculiar quality, and malts prepared and dried by a peculiar process, assisted by a peculiar method of conducting the fermentation.

So now we know.

Even more peculier



The famed 'Old Peculier' strong beer from T & R Theakston Ltd of Masham takes its name from an ancient ecclesiastical court that had rights over certain church and local affairs. As a brand name, the idea of the Peculier did not originate with Theakstons. It was acquired in 1919, along with Thomas Lightfoot of the Well Garth Brewery and had been in use by them since about 1870.

Thomas Lightfoot's Seal of the Peculier.

Family fortunes

Big money could be made out of the industry. A case in point is Henry Robinson's Wigan Brewery, founded around 1790. Henry had a son called George and a daughter, Nancy[4]. George died in his forties, about five years after being declared a lunatic. Madness must have run in the family as Nancy's daughter Ellen, heiress to her grandfather's eighty-odd public houses, was the subject of an 'order made in lunacy' in 1872[5]. Nancy had married Thomas Morris and Ellen Ann Robinson Morris was born about 1829. Ellen later ran the brewery.

On the death of Ellen Morris in 1915 her effects were said to be worth £545,727, a fantastic sum in those days. A legal wrangle then ensued because she had died intestate. If it could be proved that Nancy had been born before her parents' marriage, and so be illegitimate, then the spoils would pass down Ellen's father's side of the family, otherwise the members of her mother's side would be the beneficiaries. There was much at stake as the maternal next-of-kin had already raised £210,000 by mortgaging their shares. A court case[6] settled the matter – deciding that Nancy had not been born out of wedlock, despite efforts to prove otherwise.

The Wigan Brewery continued to operate after Ellen was deemed unfit to be in charge. In September 1894 it was put up for auction with its 86 public houses. The successful bidder was Magee, Marshall & Co Ltd of Bolton, itself taken over in1959 by the large regional brewers Greenall Whitley & Co Ltd.

Beyond the pale

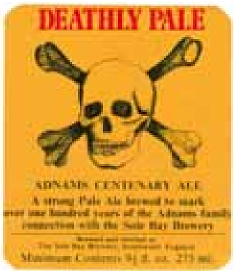
For its centenary celebrations in 1975, Suffolk brewers Adnams produced a 9% abv beer with the intended name of 'Deathly Pale'. Bottle labels were printed and delivered. Adnams then had second thoughts about the skull and crossbones and renamed the brew as Centenary Ale. Some hand-labelled bottles did, apparently, leave the brewery, as did a quantity of

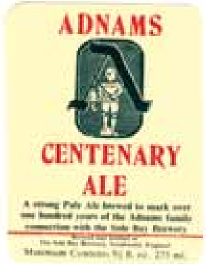
3 Pasteurised and filtered beer, delivered to the pubs by tanker.

4 Nancy must have taken a dislike to her name, which she changed to Ann and appears as such in the 1841 and 1851 census returns. She died 21 March 1869.

5 There are some indications that Ellen's condition was not severe. A relative reports that Ellen sent letters that did not give the impression of being written by a mad woman.

6 Mayhew v Halton, reported in *The Times*, 18 May 1918.

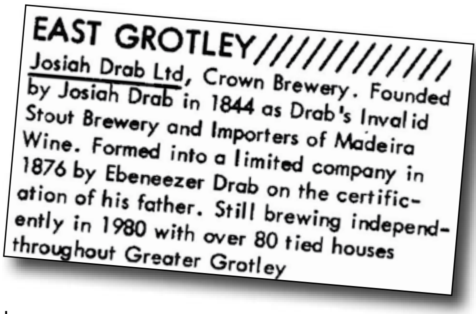




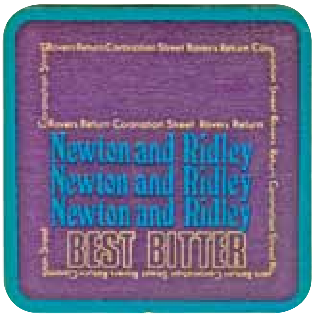
unattached labels. Whether or not it would have been a successful product with the original motif we will never know.

Wo ist mein Drabbs?

Following on from 'the beer that never was' comes 'the brewery that never was'. In the publication *Where Have All the Breweries Gone?* is an entry for the totally fictitious Josiah Drabb of East Grotley. Unfortunately, when Manfred Friedrich of Heidelberg compiled his monumental gazetteer of British breweries he did not recognise this as a joke by the publisher and Drabbs entered his directory at number 1607.



EAST GROTLEY//////////// Josiah Drab Ltd, Crown Brewery. Founded by Josiah Drab in 1844 as Drab's Invalid Stout Brewery and Importers of Madeira Wine. Formed into a limited company in 1876 by Ebeneezer Drab on the certification of his father. Still brewing independently in 1980 with over 80 tied houses throughout Greater Grotley



Newton and Ridley of the Stag Brewery in Weatherfield are suppliers of fine ales to the Rovers Return on Coronation Street. But visitors seeking out this famous tipple, at perhaps the Flying Horse, the Laughing Donkey or the Weatherfield Arms, are no more likely to find it than they are to be served a pint of Drabbs.

Trade marks

The Bass red triangle has the distinction of being the first trade mark registered under the Trades Marks Registration Act 1875. Bass achieved this by sending a member of their staff to spend the night outside the registrar's office. Periodically, disputes would break out when other brewers attempted to use marks similar to the triangle. One case, involving Nicholson & Sons Ltd of Maidenhead, reached the House of Lords[7].

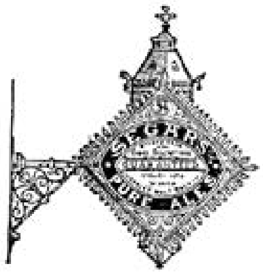
Bass used various colours of triangle; red, blue and white to indicate which of their three breweries had made the beer, and purple for export.

Shown here is a selection taken from the Trade Marks Journal (TMJ).

Matthew Brown & Co Ltd, The Brewery, Pole Street, Preston.

TMJ 9 June 1926. A year after this registration, the company moved to the Lion Brewery at Blackburn after acquiring Nuttall & Co (Blackburn) Ltd. Scottish & Newcastle Breweries bought them in 1987 and brewing ended in 1991.

Amanda Henrietta Butcher, Anchor Brewery, Stonehouse, Devon. TMJ 10 May 1882. The business merged with four others to form Plymouth Breweries Ltd in 1889. Bought by Courage Ltd in 1970 and brewing ceased in 1983.



Halsall Segar & Co, Bevington Bush Brewery, Liverpool. TMJ No 694, 1889. The origin of the Liverpudlian expression 'to be bevvied' (drunk) or 'a bevvy' (a drink of beer) has been attributed to the Bevington Bush Brewery.

Halsall[8] was actually Mr Segar's Christian name. The firm expired in 1896 when taken over by Peter Walker & Sons (Warrington & Burton) Ltd.

Hoare & Co, Red Lion Brewery, Lower East Smithfield, London.

TMJ 20 May 1891. Hoare was one of the largest London porter brewers, with an output of 200,000 barrels c.1880[9] . Bought by Charrington & Co Ltd in 1933, it brewed its last batch on 23 June 1934.

7 *The Times*, 9 December 1931.

8 Named after his place of birth, Halsall, a village in the Ormskirk district of Lancashire.

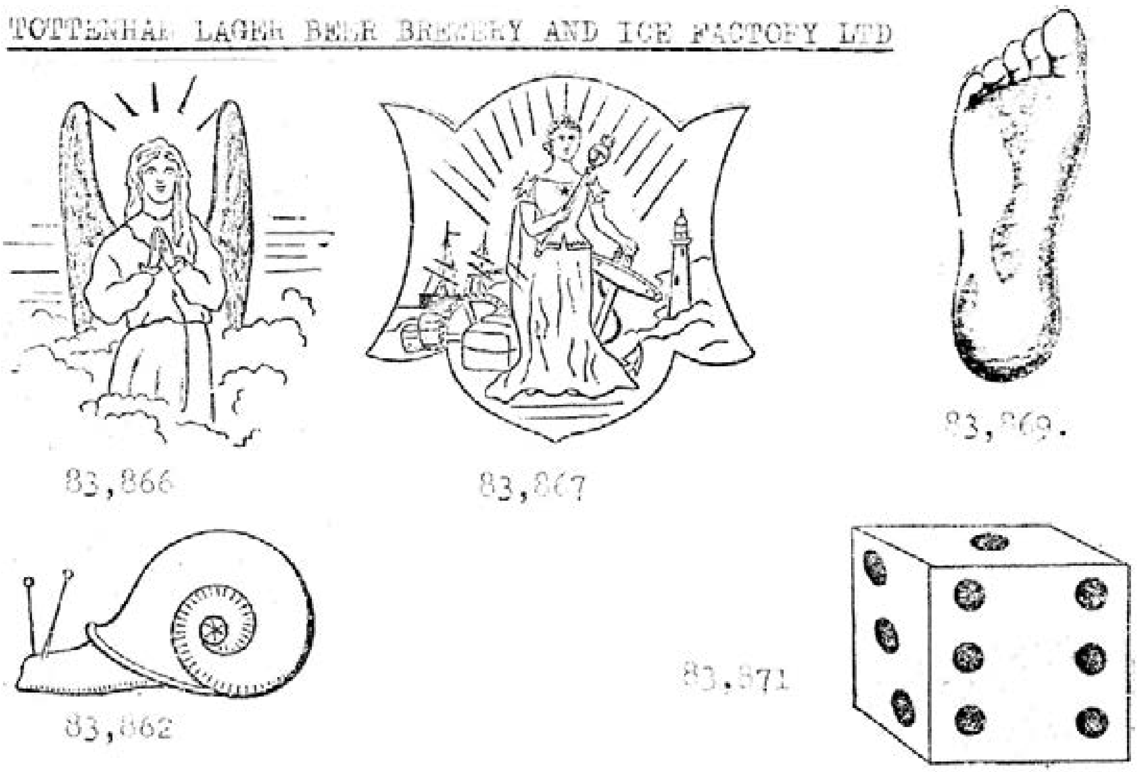
9 Gourvish & Wilson (1994), p79.

J.G.Swales & Co Ltd, Naval Brewery, Hulme, Manchester.

TMJ 23 March 1949. This company managed to stay in business for over a hundred years but towards the end, at least, the beer earned the title 'Swales Swill'.

Relief came in 1971 when Boddingtons Breweries Ltd acquired the Naval Brewery's 38 pubs and six off-licences. Michael Jacobson (1978) reports in *200 Years of Beer* that two years on from the change to Boddingtons' beers, trade in the former Swales houses had increased by 97%!

The Tottenham Lager-Beer Brewery and Ice Factory Ltd, Portland Road, Tottenham, London. TMJ 20 March 1889. Reformed in 1895 as the Imperial Lager Brewery Ltd. The brewing side was abandoned in 1903 when the business became Imperial Cold Stores Ltd.



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Other sources are as indicated in the text or the notes.

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Dr K Christie BSc PhD
Terry Evans MIScT
Ian Gray MIScT
Dr LJF Youlten MB BS FRCP MRCS PhD

Past Presidents

Prof REM Bowden DSc MB BS MRCS LRCP
Prof RG Harrison MA DM
Prof FW Jane PhD DSc
Dr A Nechvatal BSc MSc MRSC CChem
Prof JC Robb DSc FRSC
G Pratt FIScT
Prof DJ Waddington BSc ARCS DIC PhD
Prof FR Winton MD DSc MB BS MRCS LRCP
Lord Perry of Walton OBE MD DSc FRCPE

IST New Members

July 2010 – November 2010

NEW MEMBERS LIST

Membership no.	Members name	Grade
T14705	Mr B O Omoruyi	MIScT
T14706	Mr B S Ayoade	MIScT
T14707	Mrs C E Ogolo	MIScT
T14708	Mr D Doocey	MIScT
T14709	Mrs H Stone	MIScT
T14710	Mrs A P Turnbull	MIScT
T14711	Mrs C Hodgkinson	MIScT
T14712	Mr S Lyons	MIScT
T14713	Mr D W Harrison	MIScT
T14714	Prof. D A Conroy	FIScT
T14715	Mr I A Orowole	AssocIScT
T14716	Mr V M Botelho	AssocIScT
T14717	Mrs R Izegbu	MIScT
T14718	Mr O M Yahaya	AssocIScT
T14719	Mrs M Hannah	MIScT
T14720	Dr O D Enadeghe	MIScT
T14721	Miss F Omoz-Oarhe	MIScT
T14722	Mr M D Holmes	MIScT
T14723	Miss E Turton	MIScT
T14724	Mr. E Ayevbuomwan	MIScT
T14725	Mr.A I Olalere	AssocIScT
T14726	Miss A L Yeo	AssocIScT
T14727	Mr R A Edgar	MIScT
T14728	Mr B Shuaibu	MIScT
T14729	Miss P O Izevbigie	MIScT
T14730	Mrs E G Oshodin	MIScT
26 IN TOTAL		

MEMBERS REINSTATED

T08786	Mrs I A Onifade	MIScT
T13702	Mr D R Feld	MIScT
T14200	Mr H Abdul	MIScT
T14703	Mrs S L D Waite	MIScT
4 IN TOTAL		

Members News

Our congratulations go to **Tim Sandle**, a member for 23 years and a regular contributor to the Journal, who recently gained his PhD from Keele University (2005-2010). His thesis was a study into the operations of global blood services and plasma fractionators.

What is the IST?

The Science Technologists Association was formed in 1948 and granted a certificate of incorporation in 1954 to become the Institute of Science Technology (IST). Its past traditions lay in the promotion and development of the science and practice of laboratory science technology. A further name change was agreed in 2007 to the Institute of Science & Technology in order to broaden our focus area.

As we know, the world of science and technology moves forward at a tremendous pace and is one of continual and rapid change. This modern technology-driven world has opened up many new and exciting fields of science. Increasingly, the multi-disciplined approach towards developing new and innovative solutions is changing the face of industry, research and education.

The IST itself has continued to move forward and expand its own horizons so that it can best position itself to support its members and their needs in the 21st century.

Who is it for?

We now reach out to provide individual and focused professional support to a wide group of specialist, technical, and managerial colleagues in a broad range of environments such as science, engineering, industry, local authorities, schools, FE, HE, research/analytical/health facilities, government departments, and many more in the UK and overseas.

Our aim is to make the Institute all embracing and, in order to achieve this, help/advice networks, skills training, specialist forums, recognised qualifications, continuing career development opportunities and guidance will be available to the membership.

Recognition of professional standing is high on our agenda and, most importantly, expansion of the vibrant community of specialist, technical and managerial colleagues who will work together to help make a difference and shape the future.

Why join?

IST can help by supporting and developing your

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

Help us maintain, build and expand the (IST) community. **Together we can be a voice to be heard and listened to.**

To join or learn more about the IST go to Web: www.istonline.org.uk or Email us at: office@istonline.org.uk

Article submissions for the IST JOURNAL

We welcome article submissions from all areas of science and technology, including article submissions which cover new technological advances, diverse technology 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 are as follows:

1. Article submission deadlines;
   - Summer edition is **31st May**.
   - Winter edition is **30th September**.
2. Articles should be submitted electronically in Microsoft Word .doc format with images sent separately as JPEG files. This is our preferred option; please contact the Editor for other formats.
3. **Short articles:** these can be submitted in any length up to roughly 1500 words.
4. **Major articles:** these should normally be no longer than roughly 4000 words. Please contact the Editor for longer submissions as they may need to be serialised.
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.)* Articles that fail to meet basic standards of literacy may be declined by the editors.
7. Articles should be submitted as separate email file attachments. The email should clearly state "Journal Article Submission" and be sent electronically to office@istonline.org.uk

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. You can view them at web address http://eeepro.shef.ac.uk/ist/. To log on, your user name is your email address* and your personal password is your IST membership registration number.

***Have we got your email address?** 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.

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
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

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
....	....
....	....
....	....
....	....
....	....

Continued overleaf

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.

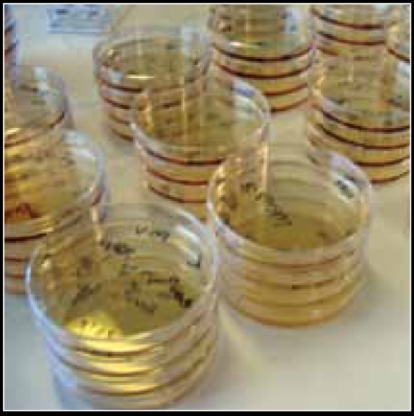
www.istonline.org.uk

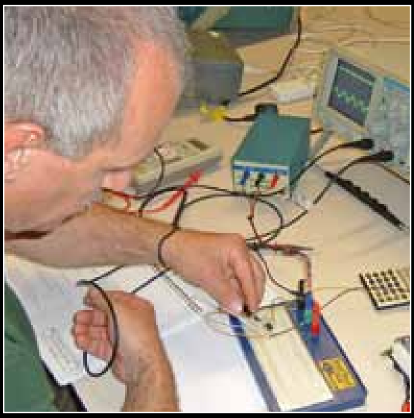
Reverse of cover page.

The Institute of Science & Technology

The Journal

Winter 2010





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