Vol. 8 No.2 Mar 2006

ChemoSense

EDITORIAL

Artificial Olfaction

By Graham Bell

Director, Graham Bell and Associates
g.bell@atp.com.au

Analytical chemistry can tease out molecules from an air sample and describe each in exquisite detail, but it can't tell what the odour was: a rose, coffee or chocolate? The list of molecules gives no answer. Odour is a human experience. The molecules that stimulate the odour experience are called odorants. The human sense of smell is called olfaction. When we create devices that sniff, we are either looking analytically for specific molecules (as in drug detection) or the "smell of something," or for a smell that has no known source but that a person can identify (usually in terms such as "horrible stink") when it is present in the air they are breathing.

For the last 20 years scientists and engineers have produced a number of devices that emulate the sense of smell: so-called electronic noses, or e-noses. These have had varying success in a range of applications, some of which are described in this issue of ChemoSense. Like the list of molecules from a chemical analysis, the signals from the e-nose sensors

cont. pg 2

The Industrial E-Nose: Protecting People and Profits

Graham A. Bell [1,2] and Winston Wu[3]

[1]School of Medical Sciences, UNSW,
and [2]E-Nose Pty Ltd, Australia,

[3]School of Electrical and Information Engineering,
University of Sydney, Australia.
g.bell@atp.com.au

Industrial development has brought prosperity to nations and populations, but at a considerable cost. With growing concern for environmental degradation in every industrialized country, air and water quality is becoming an important issue requiring immediate control. Adequate control is impossible, however, without adequate measurement, particularly of airborne chemical compounds in the air we breathe. Previous reviews published in *ChemoSense*, have drawn attention to these issues and to the need for better psychological and instrumental technologies to measure environmental odour and chemical emissions (Bell, 2001; Walker 2001; Srivastava and Levy 2002; Hibbert and Barnett, 2002), while Bell, (2004a) has described a new generation of robust industrial-strength electronic noses that might make a difference to measurement and control of unwanted environmental odour.

This paper addresses the costs and benefits of maintaining acceptable outdoor air quality around industrial plants. Will the contribution made to environmental air measurement by artificial sensory systems, known as electronic noses, be worthwhile? What effort and investment is required by operators of smell-

cont. pg 2

INSIDE:

TM

E-Nose Pty Ltd
Graham Bell and Associates Pty Ltd
Centre for ChemoSensory Research
ISSN 1442-9098

EDITORIAL CONTINUED

Artificial Olfaction
continued

give no immediate answer to the identity of the odour. But now that is changing. As more data are obtained, the patterns of electrical signals from the e-noses are being matched with the human experience of smells. Once the device has had sufficient experience, it can put a name to the pattern that a human has taught it. The new generation of industrial electronic noses will report back to its owner in the understandable terms of odours. Artificial olfaction has arrived.

In this issue we also look at the possibility of holding an international gathering of chemosensory scientists and industrialists in Cape Town, South Africa. It will be the first meeting of its kind in Africa and will introduce many eminent scientists to the people of Africa, and Africa to them. Your support will be greatly appreciated■

The Industrial E-Nose: Protecting People and Profits
continued

emitting industries, and will e-nose technologies meet their expectations? Will the new systems provide the kind of information needed, be reliable and valid and withstand the rigors of continuous operation? Finally, what will e-noses need to deliver to gain acceptance from regulatory bodies?

There is now widespread acceptance among regulatory authorities that unpleasant smelling volatile compounds and gases, mixed with environmental air, impact negatively on quality of life, and in many situations, on human health. This has not always been the case in industrialized countries (see Walker, 2001, Shusterman, 1992). Smelly and unhealthy air results from industrial practices that include: venting of industrial gases and fumes; waste and by-product processing; vehicle and machine exhausts; combustion of coal and other fuels; uncovered drains; dumping of industrial materials into open pits; open ponds and processing lagoons; spraying and aeration of effluent; and drying of sludge in the open air. In many cases, these polluting industrial emissions are carried into residential and other communities, with resulting discomfort, consternation and complaints to environmental protection authorities (EPAs).

Inspector Nose

Most EPAs employ a "registered nose" - a person with a good sense of smell, who is sent to the site to sniff the air, and make a determination of the strength and quality of the odour. While this person might arrive at the site sooner than sample collectors using bags (see below), judgement of odour intensity can be hampered by sensory adaptation, which is the phenomenon by which odours cease to be perceived after repeated sniffing. Sensory adaptation explains why workers can manage to work in intensely smelly environments: after a while they can no longer smell it (see review by Bell, 2001). In addition, the inspector's judgment of hedonic quality (liking/disliking) of the odour is subject to the criticism that he is

Figure 1: Aeration stage of sewage treatment. Photo by David Wang, courtesy of South East Water Ltd., Melbourne.

cont. pg 3

The Industrial E-Nose: Protecting People and Profits

continued

only one person with likes and dislikes that may be unrepresentative of the community. Hedonic measurements are valid when made with a panel of people representing a community or consumer group, (usually numbering 25 - 30, but sometimes as high as 100) and dealt with by various statistical tools (see Lawless and Heymann, 1988). Furthermore, the inspector's hedonic judgment is not made in the same context as those of the complainants (disruption of the quiet enjoyment of the amenities of home life - human activity that is enshrined in pollution legislation). Add to this, the likelihood that the odour has changed at the site, by the time the inspector arrives.

The high cost of non-compliance

In the Australian state of New South Wales (NSW), as in other states and industrialized countries, companies allowing odours to be emitted into the atmosphere have begun to feel the effect of air pollution laws introduced in recent years. The maximum penalty in NSW for a corporation guilty of air pollution is $250,000, as well as, in the case of a continuing offence, a penalty of $120,000 per day for each day the offence continues. Companies can be ordered to make structural changes to their premises and the environment, and pay the EPA's legal costs, in addition to their own.

Several cases have been prosecuted for environmental odour emissions in NSW in recent years (see www.environment.nsw.gov.au). These resulted from complaints, such as those described in one case as "vile and sickening stench" that could be smelled at a distance of four kilometres. An abattoir in Orange was ordered in 2004 to spend $30,000 to relieve stagnation of effluent ponds by restoring a 900m section of a creek. It was also ordered to pay $40,000 for the EPA's legal costs.

In the same year, another meat processor, in Wagga Wagga, was ordered to spend $32,000 on tree plantings, and to pay $40,000 for the EPA's legal costs. In addition, the company made improvements to a bio-filtration system, a ventilation system and replaced roofing and cladding on a rendering plant at the time of these events.

Whose smell is it?

In some cases, companies will argue that their operations are not the cause of the smell. However, the defense that "it's not my smell" is becoming more difficult to make, as shown by a recent case, in 2005, in which the NSW EPA successfully prosecuted *three* companies near Maitland, for the odours in a general area. The court found that there was reason to accept that all three companies were contributing significantly to the smell problem. Two of the companies were food manufacturers and another was a waste oil treatment plant. They were ordered to make significant changes to their plants and operations to reduce odour emissions within a three month period.

Current methods: Dynamic olfactometry

At the present time, measurement of outdoor odours still relies heavily on a "batch process": dynamic olfactometry or analytical chemistry. In the former method (see Gostelow et al., 2003), air is collected in bags and taken to a lab, where its concentration is measured in terms of amount of dilution the sample needs before a panel of judges can no longer detect its presence against an air control (perceived threshold measured by dynamic olfactometry). The number of times a unit volume of air is diluted down to the threshold level is said to be the concentration in Odour Units. This is sometimes reported in terms of the number of times a standard cubic metre of air (Odour Units/m3) was diluted to the human detection threshold. EPAs generally impose a uniform requirement in terms of Odour Units (OUs) on different industries with entirely different odour emissions, on the assumption that dispersal of odours with equal OU scores, have the same impact on a human perceiver at a known distance from the source.

This holds true if dispersal causes equal and uniform dilution of odours (orderly chemical gradients), and in terms of the distance from the source at which the odour is no longer perceivable. Odours, however, are susceptible to complex flow and dilution behaviour, and are often moved in swirls and "packets" away from a source (Atema, 1996), so a less concentrated odorant might travel further (in an "eddy") and remain effective longer than more concentrated one. Odour Unit measurements are therefore likely to be weak predictors of complaints. Odour Units find their main use in before-and-after measurements of the same odours, and until e-noses find widespread use and acceptance by EPAs, this is likely to remain their main value.

Growing concern

Industrial clients whom the authors have interviewed recently express increasing concern about the cost and the reliability of dynamic olfactometry. In an unpublished study reported to the authors, a company employed two independent providers of dynamic olfactometry to measure the same odour, and the results "bore no resemblance to each other". There are several possible reasons for this: odour does not remain constant in the sample bag: it deteriorates with time and has variable adsorption to different types of bag material (see Gostrelow, et al., 2003). Use of different types of bag or sample vessel and holding the sample for varying lengths of time before the threshold measurements, could cause a significant difference between the two companies' scores.

Another reason for different results could be that the two companies' panels of human subjects differ significantly in odour detection acuity. Expert panels require continuous "calibration", against standard tastes or odours, and their acuity can change with practice. The longer one participates in a panel, the more familiar the cues to detection become, so, despite careful selection of panelists, after a period of panel service, practice effects will become significant in determining individual and group data, and the panel will no longer perform as "normal people" do. Threshold measurements are particularly susceptible to practice effects and unforeseen individual variations (see Lawless and Heymann, 1998).

There is a need for competing dynamic olfactometry companies, to co-operate to standardise their techniques (despite the existence of published national and international protocols and standards - see review by Gostelow et al., 2003) and to publish reliability and validity studies, to

cont. pg 4

The Industrial E-Nose: Protecting People and Profits

continued

restore confidence in their market. Acceptance by EPAs of dynamic olfactometry as a method of measuring relative concentrations of emitted odours remains the strongest reason for using it. The Odour Unit as a measurement, is poorly related to GC-MS (Gralapp et al., 2001), has little if any bearing on perceived strength of different odours (but is well correlated with odour concentration within a two- odorant mixture - see Noble et al., in Gostelow et al., 2003, p.18), and may have no bearing at all on the degree of repulsion an odour might cause, except that at very high concentrations, nearly all odorants become unpleasant due to their stimulation of the trigeminal nerve (see Alimohammadi and Silver, 2002).

Analytical Chemistry: GC-MS

The other "batch method" usually begins with an air-sampling method followed by preparation (by adsorption onto fibres or dissolving the gaseous compounds into a solvent) of the sample for gas chromatography and mass spectrometry (GC-MS) (see Powers, 2001). The measurements provided by GC-MS come in the form of a chart showing named compounds that were detected in the GC and identified by the MS. This information can be useful in understanding what the air has been comprised of, so that action might be taken to reduce particular components.

The spikes on the GC chart seem to imply size or proportion of contribution of the compound to the mixture of compounds. However, this is seldom the case, unless the analysis has been performed on equipment capable of delivering such information, or if a person sniffs a parallel outlet of the GC and makes notes on the chart about the quality and strength of each spike (the so called "sniffing GC" method). In addition, the strongest smelling and most significantly characteristic component in the air sample may not even register on the GC trace (Brunke and Schmaus, 1995). The main value of GCMS analysis is for plant operators to be informed of the actual molecular composition of the airborne compounds being emitted from the site, in case any can be diminished by a known method.

Costs of odour measurement

The amount of information produced by current methods is hardly adequate to meet the demands of communities and regulators. They are also slow and costly. Companies that are the subject of odour complaints, are usually given time to attend to the problem by the EPA. They are advised to measure their problem, make changes and then measure the effect of the changes. The onus is on the company to arrange and pay for the measurements. The costs for dynamic olfactometry can be as much as $500 per sample at current prices, while GC-MS can cost up to $1000 per sample. Since many samples need to be taken at various locations and at various times of day, large bills ($10,000 to $40,000) are common in these circumstances.

E-Noses go Industrial

Electronic noses are moving from being research tools in the laboratory where they have cost in the region of $50,000 to $100,000, to being portable and deployable as multiple units for considerably less. Mass production will ensure considerably lower prices in future. A small single-sensor device is already available as a "give-away" with the purchase of a health-care product. Meanwhile, the cost of litigation, fines for breaking air pollution laws and the cost of compliance with court-imposed orders is likely to continue to rise, far in excess of the costs of installation and maintenance of continuous air quality monitoring.

Continuous and Real Time

A study of an e-nose at a NSW meat works in 2002-2003 (Bell, 2004b) showed that e-noses can be built and run continuously in the most hostile of industrial environments, a rendering plant, continuously for several months. After initial set-up, the e-nose, with on-board sensitivity controllers, required very little daily attention. In this study, a daily record of the previous 24 h continuous functioning of the device was e-mailed from its country location to Sydney. This involved a few minutes of a company environment manager's time: a relatively small investment by the client. However, with appropriate web-based communication, the e-nose could be directly accessed at a remote base as well as on site, and if desired, an operator could observe the smell status of the site in real time. Any or all sensors showing an out-of-the-ordinary level of activity could be used to alert the operator to the need for further on-site investigation and action.

In the second part of the study, the e-nose was set-up on an outdoor wall and endured extremes of heat and cold for several months without malfunction. The sensitivity of the array was adjusted downward in the rendering plant and upward in the outdoor setting. As the intensities of odour at various measuring locations on large sites varies, it is necessary to determine by means of a few short trial recording sessions, the optimal sensitivity settings for the sensors.

The setting-up of an industrial e-nose requires a small initial investment of time and effort that can be done by the client's staff or by the supplier. The client usually needs a period to familiarize himself with the new power of measurement and control that the e-nose provides. The mysteries of "squiggles on paper" soon give way to new understanding of the daily and nightly functioning of the site in terms of odours. The e-nose data can be correlated with weather station information, human off-site assessments of strength of odour from air samples, as well as operational information obtained simultaneously.

Moving the e-nose around the site in the initial stages provides data for the development of recognition algorithms for specific odours. When the e-nose is located near the site boundary, in the path of an odour plume, it can alert the operator of both the presence of the plume and the likely source of the odour.

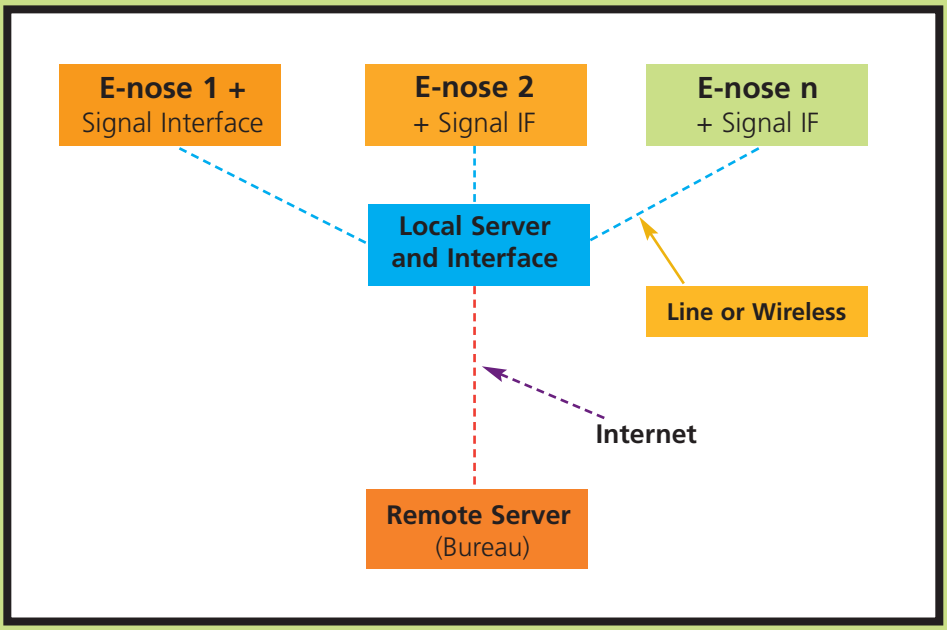
Networks of e-noses

The production of reliable e-noses has become easily affordable in terms of the

cont. pg 5

The Industrial E-Nose: Protecting People and Profits

continued



costs that might otherwise be incurred under anti-pollution law. A scheme for networking e-noses on a single site and between sites has been proposed (Wu et al, 2002), and is illustrated above:

The local network is co-ordinated through a local server and connects with the other site via a communal remote server. The internet is used to transmit the data to the remote location, which can be anywhere the internet is accessible.

A reticulated lattice (a net) of e-noses could give a detailed picture of the movement of smell across a terrain and provide accurate information upon which to model dispersion of odours across a wide space. At the present time pollution modelers have only the most minimal odour data upon which to build odour dispersion models. E-Noses will revolutionize their craft.

E-Noses to control and cut costs on odour abatement equipment

How is it known that odour abatement equipment installed on an industrial site is working properly or is inefficient and possibly wasting energy? It is very difficult to know, when odour measurement is inadequate. Until the coming of the e-nose there was no direct measurement of what was going into or out of the equipment. In the case of bio-filtration, a system breakdown can end up adding odour to the environment with all its attendant problems. E-Noses offer a means of saving costs on inefficient running of such equipment and even of directly controlling the equipment.

Calibrating the e-nose against human olfaction

While the nature of complaints of environmental odour is often based on human perception and judgment, bringing evidence of human olfactory perception to court has always been a great source of confusion and dispute. Calibration of e-nose performance with properly measured human olfaction should provide the EPAs with the information they need to be convinced that the e-nose is a "next generation" tool for odour measurement and better than anything currently available. There should come a time, soon, when the necessary data will have been collected and EPAs will accept the e-nose output as an objective, valid and reliable measure of what humans would be smelling in "normal" conditions. Whether this will displace the Odour Unit as the measurement or will co-exist with it in the regulatory world, only time will tell.

So, finally, e-nose air monitoring systems, either as single units or networked as sentinels, will measure continuously the fluctuating levels of smelly or unhealthy compounds in the air, in human perceptual units, yet independent of vagaries, such as practice effects, that make human threshold measurements highly variable and unreliable. Gone will be the limitations of sampling and measuring batches of odours. And Inspector Nose will not have to worry again about arriving in time to "catch the whiff," nor that his own sensory adaptation and out-of-context hedonic assessment might render his judgments unsafe.

REFERENCES

Alimohammadi, H. and Silver, W. (2002) Chemesthesis: Hot and cold mechanisms. *ChemoSense*, **4**(2), 1-2, 4-6, 9.

Atema, J. (1996) Eddy chemotaxis and odour landscapes: Exploration of landscapes with animal sensors. *Biological Bulletin*, **191**, 129-138.

Bell, G.A. (2001) Odour management for health, productivity and quality of life. *ChemoSense*, **3**(2), 1-4.

Bell, G.A. (2004a) E-Noses to silence smell complaints. Continuous real-time monitoring heralds a generational shift in pollution control. *ChemoSense*, **6**(3), 14-15.

Bell G.A. (2004b) A Meat Industry Electronic Nose, *Meat Processing Environment Forum Proceedings "Closing the Loop"*, published by Meat and Livestock Australia Ltd, July 2004, ISBN: 1 74036 563 1. www.mla.com.au

Brunke, E.J. and Schmaus, G. (1995) New odor-active constituents in sandalwood oil. Part 2: Isolation, structural elucidation and synthesis of nor-alpha-trans-bergamotenone. *Dragoco Report*, **6**, 245-257.

Gostelow, P., Longhurst, P., Parsons, S.A. and Steutz, R.M. (2003) *Sampling for Measurement of Odours*. London: IWA Publishing.

Hibbert D.B. and Barnett D. (2002) Chemical sensor and e-nose program, *ChemoSense*, **4** (3), 8-10.

Lawless, H.T. and Heymann, H. (1998) *Sensory Evaluation of Food. Principles and Practice*. New York: Chapman and Hall.

Powers, W.J. (2001) Development of procedures for odour evaluation techniques. *Proceedings of 1st IWA International Conference on Odour and VOCs: Measurement, regulation and control techniques. Sydney, Australia*, March 25, 19.

Shusterman, D. (1992) Critical review: The health significance of environmental odor pollution. *Archives of Environmental Health*, **47**(1), 76-87.

Srivastava A.K. and Levy D.C. (2002) Gas Sensor Monitoring of Environmental Air Quality, *ChemoSense* Vol. **4** (3), 1-2.

Walker, J. (2001) Odor as an environmental impact. *ChemoSense*, **3**(4), 1-3,8-9.

Wu, W. and Levy, D.C. (2002) An internet-coupled odour monitoring system. *Proceedings of the Australasian Association for ChemoSensory Science*, p.23.

AACSS 2005:
"The Happiest Meeting in Paradise"

Another wonderful AACSS Annual Scientific Meeting took place in December 2005 at Heron Island on Australia's Great Barrier Reef. Fifty participants and sixteen friends and family members gathered to enjoy the location and the science.

The Scientific program, assembled by Program Chair, **John Prescott**, began with a great plenary talk by **Tom Finger** on "The Evolution of Taste." There followed over the next four days, ten oral sessions, a poster session and a total of 39 presentations, all of the highest standard.

The sessions were arranged as a serial sequence of sessions (none in parallel) with generous time allocations to all speakers. This format, scheduled to fit with island activities, stimulates intellectual discourse and brings people together in sessions who might normally be at a parallel one. Heron again worked its special magic.

Six students were financially assisted by AACSS to attend and three won a cash prize of $100 in recognition of the excellence of their presentations. They were: **Narelle Tunstall** (with C G Warr, A "gene trap" screen to identify novel olfactory genes in *Drosohila*"); **Takahiro Honda** (with N L Amy and C G Warr, "Identification and characterisation of genes involved in olfactory signal transduction in *Drosophila* ") and **David T Y Wang** (with D Levy, S. Simpson and G A Bell, "An investigation of using signature-image in odour identification for electronic olfactory systems").

Included in the program was a delightful and informative wine tasting. Wines were donated by members from as far as France (thank you **Thierrie Talou**), plus a great range sponsored by The Foster's Group (thank you **Viv Boghossian** and Heron Resort for co-operation and generosity).

The Saturday night Seafood Banquet

cont. pg 7

AACSS 2005: continued
"The Happiest Meeting in Paradise"

was another great success.

Bags, badges, booklets, banners, signage, T-shirts, hats, delicious food bars, wine and small torches added to a wonderful conference experience. The meeting was sponsored by CSIRO's Food Futures Flagship, Uncle Toby's, The University of Queensland's School of Biomedical Sciences, Brain Growth and Regeneration Lab, The Foster's Group, E-Nose Pty Ltd and the quarterly bulletin, *ChemoSense*. Valuable assistance was also obtained from the Heron Resort, and Groups Manager, **Gayleen McEwan**. The Resort again excelled in everything it did, with a generous package of incentives, clean, comfortable accommodation and superb food. **Wendy Burchmore** of Sunlover Travel (formerly the Queensland Tourist Bureau) provided important assistance to all participants and essential back-up to the Conference Organiser, **Graham Bell**.

The AACSS Annual General Meeting elected a new Treasurer (**Coral Warr**) and two new committee members (**Judith Reinhard** and **Richard Newcomb**) to the AACSS committee, joining **Ann Cunningham** (President), **John Prescott** (Vice-President) and **James St John** (Treasurer).

The Meeting decided that 2006 would comprise a break from the annual scientific meetings so that energy could be concentrated on a meeting in **Adelaide** in **May/June 2007**. In the light of representations from Tom Finger concerning the ISOT July 2008 meeting to be held in the USA, it was agreed that the next meeting at **Heron Island** should take place in **December 2009**.

A veteran conference-goer was heard to remark at the end of the conference, that it had been "the happiest meeting I've ever been to". Amen to that.

Photos courtesy of Sue Kinnamon, Caroline Payne, Briony Leibich, Marien de Bruyne, Judith Reinhard.

Useful Chemical Senses Book

Tastes and Aromas: The Chemical Senses in Science and Industry, Edited by Graham Bell and Annesley J. Watson. 214 pages. Published by UNSW Press and Blackwell Science, 1999. ISBN: 0-86840 769 0. Hard Cover. Price: US$ 30 / AUD$ 40 (includes tax if applicable, postage and handling). Order from: g.bell@atp.com.au

A limited number of this extremely useful volume are, for a short time only, available at a 50% discount. *Tastes and Aromas* has been hailed as a great teaching aid and resource for the practicing sensory scientist. Written by leaders in their fields as fundamental information, the volume retains its value and is rich in scientific and practical quality. Beautifully packaged in hard cover, it will continue to be a durable reference for many years to come.

Chapters include mini-reviews by (first authors) Stoddart; Bartoshuk; Youngentob; Prescott; Lyon; Weller; Bell; Saito; Lambeth; Noble; Morgan; Best; Barry; Sullivan; Key; Mackay-Sim; Atema; Hibbert; Barnett; and Levy.

Content covers the chemical senses in human culture; fundamentals of smell; taste; pungency; oral touch and pain; applied sensory evaluation; cross-cultural studies; perfumery and flavour chemistry; wine preference; psychophysics; sensory mapping; physiology of odour encoding; anatomy, growth and aging; emerging chemosensory technologies; sensors; marine chemical signals; electronic noses and chemosensory machines.

Avail yourself of a copy while these limited stocks last.

Every sale will support *ChemoSense.*

Order from: g.bell@atp.com.au ■

Receive ChemoSense free

Send "subscribe" message to g.bell@atp.com.au

(Send "remove" to quit)

NEWS

Announcement

The 2006-2007 ROSE MARIE PANGBORN SENSORY SCIENCE SCHOLARSHIP

One $14,000 Sensory Science Scholarship will be awarded for the 2006-2007 academic year to support a Ph.D. student who intends to teach and conduct research in the area of sensory science at the University level. This scholarship is awarded in honor of the memory of Professor Rose Marie Pangborn, who initiated the scholarship fund to encourage the education of Sensory Scientists intending to pursue academic careers. This year, the award is generously being supported by GlaxoSmithKline Consumer Healthcare.

Applicants for the scholarship must be enrolled in a Ph. D. Program such as Food Science, Nutrition, Psychology or Physiology. The planned or on-going dissertation research must be on a sensory topic under the guidance of a recognized sensory scientist. Candidates will be evaluated on the basis of their academic record, intended research in human sensory science, commitment to a career in teaching in the field of sensory science, and support determined by letters of recommendation. The Board of Directors of the Sensory Science Scholarship Fund (SSSF) will determine policies governing the award and will select recipients.

Applications, including all required documentation must be postmarked no later than May 1, 2006. For additional information and application forms contact Dr. Rick Mattes, Purdue University, Department of Foods and Nutrition, 700 W. State St., W. Lafayette, IN 47907-2059, USA Phone - 765-494-0662 FAX - 765-494-0674 email - mattes@purdue.edu

Application forms are also downloadable at: http://www.cfs.purdue.edu/sssf/

Past recipients include: John Hayes, Derek Snyder, Cheryl Armstrong, Zuzana Drobna, Dr. Terri Rosett, Dr. Nicolette van der Klaauw, Dr. Sophie Bonnans, Dr. Jeanine Delwiche, Dr. Liz Gwartney, Dr. Thomas Heinbockel, Andrew Smith, Barbara Guggenbühl, Elba Cubero-Castillo, Randy Lee, and Lotika Bhatia Savant ■

Vol. 8 No.2 Mar 2006

NEWS

E-Noses for Flock Management

Graham Bell E-Nose Pty Ltd

As the leading producer of wool in the world and a sizeable contender in red meat markets globally, Australia has a huge interest in economical management of large flocks of sheep and herds of cattle.

Wendy Laursen reported in the February 2006 issue of IEE Review (www.iee.org/review) that progress is being made to bring electronic technology to the management of Australia's vast sheep flocks. Most outback flocks typically consist of 10,000 sheep, and are located in the arid and unpopulated regions of the continent, on properties that can extend up to 50,000 hectares.

Old Farmer Brown...

No longer are sheep farms run by families, where several strong sons could once be relied on to help the farmer do the lifting and man-handling of the sheep. Most sheep farms now have only one person to do this work, and typically it is a man approaching 60 years of age. Add to this the pressure of downward prices and of the number of sheep required for a viable operation: now between 4000 and 6000 sheep per individual farmer or farm hand. Handling larger numbers of animals to sustain a sheep business, requires urgent introduction of new labour-saving technologies.

Enter the E-tag

In both sheep and cattle industries, the electronic RFID (radio frequency identification) tag, has opened the door to the technologies that can save the weaker farm operations and make the entire animal production industry more financially viable and productive. RFID tags are now familiar to most city car users, who now pass through road tolls without stopping. They consist of a small electronic radio transponder that is

Figure 1. Experimental RFID sheep race (courtesy of Sheep CRC)

cont. pg 11

NEWS

E-noses to facilitate flock management continued

Graham Bell E-Nose Pty Ltd

attached to the animal, usually on the ear. A characteristic signal is received at a stationary point and registers the identity of the tag on the passing animal.

Every e-tagged sheep moving through a race or gate can now be identified and the event recorded in a computer file at some remote distance. The data can be transmitted across a wide expanse to the farmer's computer, by wireless or cable. The farmer now has a way to log data about individual animals, remotely and automatically, as never before. What is now needed is information that can be recorded at the same time as the individual animal is identified: information that assists in the efficient and timely management of the flock.

Open sesame: the "e-sheep®"

The Australian Sheep Industry Cooperative Research Centre (Sheep CRC) has designated a program in its portfolio of research to providing some of the e-technology that can now find a place in flock management, thanks to the ubiquitous "e-tag" (see www.sheepcrc.org.au). This joint venture between leading sheep research, educational and commercial organizations aims to enable farmers to control the movement, weighing and feeding of individual sheep, all from the comfort of the farm office. The farmer can partition the flock into management groups according to the data and use an automated gate to sort the flock into different paddocks or areas where specific procedures can be carried out.

Early trials on farms by the Sheep CRC have shown that set-up costs are tolerably low and savings in labour in one instance have allowed a farmer to manage two farms situated 130 Km apart. The electronic weighing station, gate activation and RFID-transponder are run on12 volt batteries, replenished by solar panels. The sheep pass through the system in their daily feeding and watering routine. The precise daily weight measurements mean that as soon as they reach marketable weight they can be drafted for sale. This saves feed, fuel, labour and that precious outback commodity: water.

If an animal does not have an e-tag it is drafted into a separate paddock - making it a nice surprise for any visiting feral pig or goat which finds itself providing extra farm income instead of competing for feed and water.

Patterns of weight gain can be recognised in pregnant sheep and can discriminate between those carrying one or two embryos. Ewes with weight levels below expectation can be drafted off for supplementary feeding.

In the shearing shed the e-tags also reduce errors and allow barcode stickers to be printed and attached to fleeces or pathology samples. Fleece quality and health information can then be fed back to the individual sheep's records. Sheep with best fleece quality can be used for breeding and the worst can be culled. Groups with similar quality wool can be shorn together, thereby improving the uniformity of the packaged wool.

Sniff sniff, is that ewe?

The challenge is now to add more e-technology to this framework, to produce even greater gains for the farmer and the industry as a whole. Possibilities include automatic medicine dispensing, facial recognition and other visual inspections (e.g. checking nose or eyelid colour for health signs, such as anaemia) and odour diagnostics for parasitic infections, fleece rot, foot rot and blow-fly strike.

Fleece rot occurs more commonly in rainy areas when sheep are soaked to the skin and a severe inflammatory and necrotic condition sets in. Fly strike occurs when the blow-fly lays its eggs on these moist areas of skin or fleece, and maggots invade the sheep's flesh, causing pain, fever and, if left too long, death.

E-Nose Pty Ltd has provided an e-nose for diagnosis of sheep pathologies as part of the on-going Sheep CRC e-sheep® program. The sensor array in the E-Nose has been tailored to recognise the complex mixture of odours produced by the presence of maggots and micro-organisms as well as decaying fleece, skin and muscle tissue.

The e-noses can be mounted on the e-sheep race, or hand-held for more detailed inspections, and will provide extra information to alert the farmer to problems needing attention in specific individual animals or groups of animals. The identified sheep will be drafted into a separate area for treatment and recovery. This procedure will save time and money on unnecessary effort and medicines directed to whole flocks instead of individuals. It will allow early detection and action and allow quarantining of individuals which might spread a condition into the flock.

The outlook is very promising for the animal production industry as e-noses, optical recognition devices, weighing and still-to-be-imagined technologies are introduced in the coming years. The key to this advance has been the RFID "e-tag", without which the new e-technologies might be too difficult to implement.

Figure 2. Experimental sniffing of fleece using an e-nose from E-Nose Pty Ltd.

The new systems will need to develop the mathematics for the system control, based on much further research, and the hardware will have to cope with some rather extreme outdoor conditions. Then there is implementation and training of both animal and operator. One thing is certain, the farmer will be able to spend less time flexing his aging muscles in the hot sun, and more time at rest, in the cool of the farmstead or air-conditioned vehicle.

Acknowledgement: *Wendy Laursen, IEE Review, and Australian Sheep Industry CRC: Prof. James Rowe, and Ms Deborah Maxwell.*

Paradise in South Africa

By Graham Bell

After our successful chemosensory meeting at Heron Island in December 2005, I have come to South Africa to see what it might offer members of AACSS and other international chemosensory scientists in the way of a spectacular "paradise" meeting venue. It is hard to go past Cape Town...one of the most spectacular places on the planet.

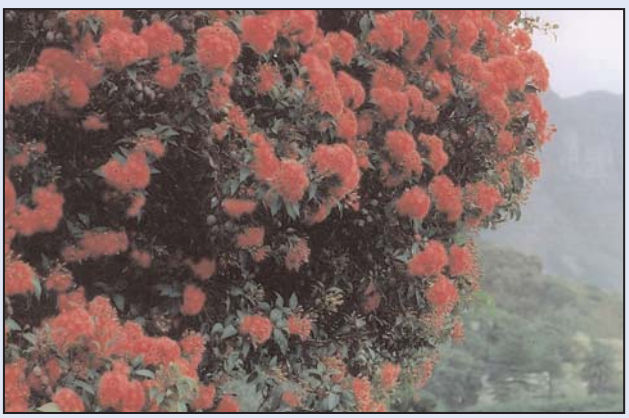
Plans are now afoot to hold an African regional chemosensory and chemometrics meeting near Cape Town, in 2007, probably in beautiful Stellenbosch, the cradle of wine culture in the region, from where Napoleon sourced his favourite dessert reds. ChemoSense will carry more information as it comes to hand. If you can offer assistance or sponsorship, please contact Hettie Schonfeldt: hettie.schonfeldt@up.ac.za

Why South Africa?

With apartheid well and truly over, South African Scientists are now free and eager to meet the rest of the world and to show-case their local talents and attractions. Expertise resides in wine science and many forms of agricultural and animal research. This "young" scientific community is holding out its hand to the world. By going to Africa and participating in a meeting there, we can take into Africa the scientific world, while we have the thrill of the African experience as well as a high quality scientific discourse.

Is it Safe? Would you go?

Yes. All of what is good about South Africa is now easily and safely accessible, and for very little investment. *The Rough Guide and Lonely Planet* give plenty of good advice and are a good place to start thinking and planning a great time in Africa.



Starting in the magnificent city of Cape Town, I was overwhelmed by the geographic majesty of the great mountain and peninsula. Cape Town and surrounds are just amazing...the whole place is a global treasure and "not-to-be-missed". To die without having set foot on this corner of the world would be a great pity.

What are the negatives?

It's not difficult to appreciate that two big issues still dominate the country: crime (the ubiquitous razor wire and now electric fencing) and HIV-AIDS. Regarding both issues and the visitor, it pays to be careful at all times. I didn't visit HIV clinics and so was unable to "see" any obvious evidence of the crisis. For personal safety, we followed advice about locking cars and doors and not flashing cash or shiny trinkets about. We learned to watch out for each other at ATM machines.

cont. pg 13

Paradise in South Africa continued

Are the people happy?

Most people of all ethnic types in South Africa grumble if you ask them if things are getting better. Housing, jobs, and quality of life are all below expectation. Yet there is so much growth to be seen, and the economy is growing at 6% p.a. Perhaps true happiness hinges on the rugby and cricket scores, which have been a bit depressed in recent years.

What else is there to do once we're there?

We leave Cape Town and head for wide open spaces, the Little Karoo, Knysna, Storms River, the Wild Coast, the Drakensberg and the game camps of Imfolosi, Royal Swaziland and Kruger. (Next time we might do the west coast, Namibia and the Skeleton Coast.)

The game parks are being magnificently developed, expanded and equipped for local and international tourism. The thrill of being amongst "big game" is indescribable. One is left with a list of "what we saw": lions, cheetahs, a leopard, rhinos (scary when encountered on foot), buffalos (stay clear), elephants (abundant in number and not in must), hippos (what a life!), antelopes, wildebeests, giraffes and dozens of lesser animals and birds...all in their natural habitats.

There are very few restrictions on what you can do and where you can go by car or on foot. Hiking amongst lions, elephants, buffalos and rhinos is a special treat to be experienced. Mountain paths lead to precipices - at which you are perfectly free to do as you wish. This seems to be a country which hasn't yet been discovered by insurance lawyers. There is a relaxed feeling that is enviable in "this modern age".

So, please think about another meeting in paradise: this time an African experience is calling you.

Photos: Ann Williamson and Zoe Bell.

Upcoming Events

26-30 April 2006

AChemS
Sarasota, USA
Abstract Deadline: 13/1/06
www.achems.org

8-11 May 2006

Enviro 2006 Conference and Exhibition
Melbourne Exhibition & Convention Centre
Melbourne (see advert in this issue of ChemoSense)
Contact: Rosalind Vrettas, Ph. +61 (0)3 9741 4679
rvquitz@bigpond.com

9-12 July 2006

39th AIFST Convention:
"Festival of Food"
Adelaide Convention Centre
Adelaide, South Australia
Contact: aifst@aifst.asn.au

2-4 August 2006

8th Sensometrics Meeting:
Imagine the Senses
Ås, Norway.
Contact: www.sensometric.org

4-8 September 2006

European Chemoreception Research Organisation (ECRO)
Granada, Spain
Abstract deadline 1st May 2006
www.ecro.cesg.cnrs.fr

26-29 September 2006

Second European Conference on Sensory Consumer Science of Food and Beverages. A Sense of Diversity
The Hague, The Netherlands
Abstracts deadline 30 April 2006
Contact abstracts: www.eurosense.elsevier.com
Contact general: Clare Moloney at eurosense@elsevier.com

21-25 October 2006

Society for Neuroscience
New Orleans
Info: www.sfn.org

May/June 2007

(watch ChemoSense for details)
AACSS
9th Annual Meeting
Adelaide, South Australia

ChemoSense (ISSN 1442-9098)
Web: http://www.chemosensory.com
Published by **E-Nose Pty Ltd**
P.O. Box 488 Gladesville, NSW Australia 2111
Ph. (+61 2) 9209 4083 ; Fax (+61 2) 9209 4081

Production Team
Editor: Graham Bell, g.bell@atp.com.au
Advertising: Brian Crowley, b.crowley@atp.com.au
Design and Layout: Lawton Design Pty Ltd

Coming up in ChemoSense

Sense of Fat
Your mini-review
Why chilli?
*Visit our Site: www.chemosensory.com