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David Grice measures up.

made to measure

Alastair Sarre meets three unsung heroes of the scientific world, members of a modest legion whose talents range from counting kangaroos to constructing DNA.

You've probably heard the old joke about how many Irishmen (or politicians, or feminists) it takes to change a light bulb. Well, how many CSIRO technicians does it take?

Just one. Not very funny (let's face it, few light-bulb jokes are), but it does illustrate a point. Technicians – or techies as they are commonly known – specialise in no-fuss solutions to practical, real-world problems. They are usually essential to the functioning of scientists, who may have oodles of brainpower, but not necessarily the practical acumen to implement their ideas.

Techies make up about one-third of the CSIRO workforce, yet their contribution to science doesn't always get the recognition it deserves. They come in several different varieties: some are lab-based, some do their best work in the field, and an increasing number are more at home on the computer than on the range.

CSIRO Plant Industry senior technician Lynda Graf spends a large part of her life in the laboratory. Jars full of chemicals line the shelves, centrifuges whirr and computers hum. One machine, about the size and shape of a cappuccino machine, is perched on a bench next to her desk, clicking loudly every few seconds.

It's an environment in which Graf obviously feels comfortable. And she speaks with something approaching fervour about her chosen field, molecular biology.

'It took off as a discipline only 15-20 years ago, but already it is at the forefront of the biological sciences,' she says. 'Anybody involved in molecular biology is really doing state-of-the-art laboratory work.'

She says that in her business, the best techies are good with their hands and have a healthy dose of common sense. They also have something else: intuition. 'Unless you have some sort of feeling for what you're doing, some sort of appreciation for it beyond the basic steps, it's difficult to get complex reactions to work and to detect complex problems,' she says.

Graf began working in a lab straight after leaving high school. It was meant to just occupy her for the summer holidays, but it became a career. 'I just loved the work and I loved the environment. I loved everything about it,' she says.

After 10 years in the lab at the Austin Hospital in Melbourne, she realised that a science degree would help her career prospects. She completed this and worked in a biochemistry lab for several years before moving to Canberra and a job at Plant Industry. For most of her 10 years there she worked for senior principal scientist Dr Paul Keese, who has since left the division.

Her current work is centred on the aforementioned cappuccino-like machine. This is a DNA synthesiser. As the name suggests, it makes DNA.

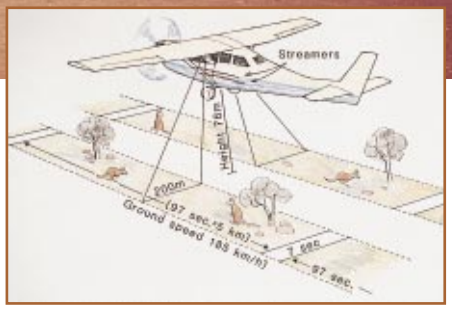
DNA contains the genetic code by which almost all living things are created. It consists of four different kinds of nucleotide building blocks, or bases – adenine (A), guanine (G), cytosine (C) and thymine (T). Scientists at Plant Industry and other CSIRO divisions request the production of particular DNA segments, and Graf programs the machine to produce it. She inserts a polystyrene matrix with one of the four bases chemically attached to it; the machine then draws out – in sequence – the bases from bottles attached to the machine, using organic chemistry to join them to the growing DNA chain. The finished product is cleaved off using another chemical reaction involving ammonia.

Artificially synthesised DNA has many research uses. It plays a role in DNA sequencing, which is the working-out of the genetic code for different biological attributes. Why do scientists want to sequence DNA?

'Gene regulation and gene expression are "it" for a molecular biologist,' Graf says. 'We want to know what parts of the genome (or entire genetic code) are doing what. Some of them code directly for proteins and enzymes that do certain basic reactions in a plant or animal, and some of them regulate the processes.'

By determining which genes do what, Plant Industry scientists aim to engineer crop plants with in-built resistance to diseases. They have already had some success in engineering resistance to the potato virus, and are currently working on genetically fortifying wheat, maize and barley against rust, a fungal disease.

Graf says that most scientists understand the importance of the technician to the



An aerial survey technique for counting kangaroos, developed by Wildlife and Ecology technician David Grice, enabled the first scientific estimate of Australia's kangaroo population.

success of projects. 'Good scientists want good technicians,' she says. 'The scientist might design the experiment, but the technician has to get it to work. Many scientists might have good ideas, but they're not necessarily good with the practicalities.'

David Grice, a senior technician at CSIRO Wildlife and Ecology, agrees. He says that the hands-on approach of technicians can offer scientists valuable insight into their experiments.

'Technicians get really close to the data,' he says. 'The scientist tries to do that, the good scientist does, but having hands-on analysis of the data you begin to get a real feel for what's happening. So scientists often rely on technicians to check whether they've got the right picture or not.'

Grice has worked with the division since graduating from university in 1982 with a Bachelor of Applied Science. His supervisor for 12 years was the late Dr Graeme Caughley, one of Australia's most respected ecologists. He was interested in population dynamics, which led him to develop an aerial survey technique to establish trends in kangaroo populations and to relate those to pasture biomass. Grice became expert in counting kangaroos – red, eastern grey, western grey and euro – from low-flying aircraft.

The actual technique is simple enough: the plane maintains a height of 76 metres and a speed of 100 knots (about 185 km/h). Two people, one on each side of the aircraft, count the kangaroos they see in a 200 m strip on the ground. Each counting period lasts for 97 seconds, so an area of 1 km^2 is surveyed.

Using this technique, Grice and other counters were the first to establish a scientific estimate of the kangaroo population across the entire continent (excluding the eastern highlands). It could be hairy work at such a low flying height, particularly when buffeted by strong winds. On two occasions, engine failures necessitated an emergency landing.

Investigating kangaroo population dynamics hasn't been Grice's only task. In his 15-odd years as a field-oriented technician, he has organised and participated in many field surveys, expeditions and experiments involving wombats, small native mammals, deer, seals, rabbits and, more recently, extinction processes. He needs a wide range of skills: in the analysis of data, in construction and maintenance, in living and surviving in remote locations, in identifying plant and animal species, and in handling wildlife. He's particularly adept at handling kangaroos.

'The reds are lovely animals to handle,' he says. 'They don't bite or scratch much. 'The eastern greys struggle a bit more, the western greys are really stroppy and the euros are like sumo wrestlers.'

But fieldwork has its drawbacks.

'It may sound glamorous, going away on field trips for up to six months of the year, but it would be an understatement to say that being away so much has a significant impact on your private life,' he says.

Nor is it always particularly exciting.

'You have to accept the monotony of some tasks: science is 90% perspiration and only 10% inspiration. And you often put in many more days' work than you're paid for because of your interest in the work and your commitment to the scientist.'

Grice says the intense contact between scientist and technician during long stints of fieldwork often bonds them together, creating a loyalty that improves the effectiveness of research.

'The type of relationship you have depends on the personalities, and the enjoyment you get out of the job depends on the sort of scientist you end up with,' he

In the CSIRO Plant Industry laboratory, technician Lynda Graf synthesises DNA to help molecular biologists engineer crop plants with inbuilt disease resistance.

At CSIRO Forestry and Forest Products, Julian Mattay has helped Dr Dave Sheriff to predict the effects of nitrogen fertiliser, temperature and humidity on carbon assimilation (uptake) in *Pinus radiata*. Using data collected during glasshouse trials, Mattay plotted three-dimensional surfaces enabling the simultaneous effects of experimental variables to be easily visualised. Results of the modelling work have helped to explain variations in biomass production between *P. radiata* plantations grown in different locations. Carbon assimilation was found to increase linearly with foliar nitrogen, to decline exponentially as leaf vapour pressure increased, and to prefer a temperature range of 14-38°C.

says. 'I had an excellent relationship with Graeme (Caughley): he'd come up with the ideas and I'd implement them for him. We'd then collaborate to analyse and write up the study – it was a combination of the best parts of science.'

Grice is now a technician to Dr Mike Austin. With Austin's interest in modelling the distribution of eucalypt species, working for him involves a radical change for Grice.

'It's like launching into a whole new and challenging career,' Grice says. 'It requires more computing skills, using modelling in a new way for me. But in terms of ecological principles, trees are just long-lived stationary animals with dispersing juveniles!'

One technician who knows a bit about modelling is Julian Mattay, a senior technician at CSIRO Forestry and Forest Products, based at Mount Gambier. He's one of an unusual breed of people who enjoy – indeed revel in – mathematics and statistics. 'I can't really explain it,' he says. 'It's fun – that sounds terrible! I enjoy it, always have.'

Mattay learned most of his skills on the job, having started with CSIRO more than 30 years ago in Hobart. He says maths and stats are essential tools in science, but not all scientists have a complete grasp of them.

'Many scientists have a fairly basic understanding of statistical "recipes", but not much understanding of some of the implied assumptions that they're making over their data or experimental layout,' he says. So, he plays the role of statistical troubleshooter, and where possible is involved in experimental design. He's also the local computer guru and team photographer.

But much of Mattay's work is concerned with models: these use data collected during field experiments to develop mathematical relationships between variables. Since our information can never be complete, models play an important role in allowing scientists to use the known to predict the unknown.

This is illustrated by an ongoing project between Mattay and scientists Dr Ray Correll at the CSIRO Centre for Mathematical and Information Sciences and Dr Sadanandan Nambiar at CSIRO Forestry and Forest Products. The original experiment was set up by Dr Nambiar to determine the turnover – growth, death and decay – of a tree's fine roots. This would be useful, for example, in estimating biomass partitioning between the above and below-ground components of the tree and in understanding response to drought.

Estimating such turnover presents an immense challenge to scientists, since fine roots grow, die and decompose rapidly, leaving no visible trace. They are also so abundant that assessing turnover for an entire tree is virtually impossible. So the project team devised a sampling strategy that involved taking core samples of soil around trees on a monthly basis and analysing the content, size and weight of fine roots at different depths in the soil profile. The project benefited from what Mattay calls 'a little tribe of faithful technicians', which spent its time picking little bits of roots out of soil eight hours a day for 30 months.

Mattay's role is to take the data and adapt existing models to 'fill in' the missing information.

'The model uses the fluctuation in live and dead root material to make a minimum estimate of the amount of new live root material: how much has died and how much has actually decomposed and vanished,' he says. He has also done modelling work to predict wood yields and growth rates for six eucalypt species using existing data with Dr Phil West, and the effects of nitrogen fertiliser, temperature and humidity on carbon assimilation in *Pinus radiata* with Dr Dave Sheriff.

So, three different techies, three perspectives on the lot of the technician. One issue on which their views seem to converge is motivation. It isn't derived from the modest financial rewards or the limited scope for promotion.

For David Grice, using science to achieve the conservation of our wildlife has been a life-long goal.

'As field technicians, we were out there coping with different conditions, handling wildlife, doing new research that nobody had done,' he says. 'So it was exciting to think that we were doing something with such long-term value. With Caughley, we were feeding into conservation biology through our work on population dynamics. Mike Austin's work feeds into it through an equally valid but quite different pathway.'

Lynda Graf says that while the global perspective is important, it's difficult to keep it in view all the time. For her, enjoyment comes from immersion in the science itself.

Julian Mattay takes a similar view.

'For me, it's the interest in maths,' Mattay says. 'There's always a slightly different problem. It's a challenge; it's interesting because it's dynamic. There is always the need or option to learn a bit more and to apply what I learn to what I'm doing.'

A B S T R A C T

Technicians specialise in no-fuss solutions to practical, real-world problems. They make up about one-third of the CSIRO workforce and are essential to the functioning of scientists, yet often fail to receive due recognition. Some are lab-based, some work in the field, and others are at home on computers. Their tasks range from collecting and sampling plants and animals, to predictive modelling and manufacturing DNA.

Keywords: **molecular biology; DNA synthesis; population dynamics; kangaroos; wildlife surveys; forest ecology; mathematical modelling; experimental design.**

More techies' tales

John Owen

Tackling tall timber

JOHN Owen works in CSIRO Forestry and Forest Products' Tree Improvement and Genetic Resources Program. Much of his time is spent in forests across Australia and Papua New Guinea, pollinating trees, and collecting seed and scions (material for grafting) from treetops.

Access to the forests can be difficult, but the height of the trees' canopy, which may be 40 metres from the ground, presents an even greater challenge for Owen and his colleagues.

'We do controlled pollinations of different tree species, often using an elevated platform or "cherry picker",' Owen says. We then collect the seed from these trees to germinate for field trials in which trees of superior growth and form are selected.'

Owen is also a dab hand with a Ruger 308, another technique used, with great care, to remove seed-laden branches and scions from treetops (see story on page 4). The thin, growing tips of superior trees are then grafted onto seedlings in an arboretum, forming a live plant store and seed source – at a manageable height.

Owen has been at CSIRO for more than 20 years, and before that worked for the Victorian Forestry Commission. He says there's a lot of theory in science, but a lot of practical input is needed to get the job done. That's where the technicians prove invaluable.

An important part of Owen's job is to maintain identities of collected specimens and associated data collation. He says as technicians gain experience, they tend to become more involved in data analysis. He has co-authored some 20 research papers, a part of the job which he finds tremendously rewarding.

Picturing scenarios

ASK Cher Page about her job, and she'll tell you she does the number crunching. And as computer technical officer for the Climate Impact Group at CSIRO Atmospheric Research, she has no lack of numbers to crunch.

Page provides the pictures that climate researchers need to communicate their findings. That generally involves conjuring meaningful graphs and images out of numerical databases. For this she draws on her degree in maths and computer science.

'I talk to the scientists and find out what their needs are for an end product,' Page says. 'Then I gather the raw information and manipulate it using software packages, or a programming language called Fortran.'

Scientists then use the pictures to help verify their interpretations of the data, to present research results among their peers, and to illustrate the significance of their work to a wider audience.

With colleagues in the Climate Impact Group, Page is working on the development of OzClim, a 'user friendly' software package that generates climate change scenarios and simulates potential climate change impacts on the environment and primary production for regions of Australia.

'I'm not sure how many scientists recognise the work done by technicians, but in this division they certainly do,' Page says. We're all specialists in our own field: they supply the idea, I have to put it into practice.'

A leading librarian

THE life of a librarian can be full of new experiences. In fact, for Tricia Larner, the past four years have seen never a dull moment.

Since 1994, Larner has managed the Tropical Beef Centre's Library and Information Service at CSIRO's Rendel Laboratory in Rockhampton. Her responsibilities range from managing a site library and a beef industry information service to facilitating the adoption of electronic resources, such as scientific journals.

'The push is to get information to the desktop which is great news for both the librarians and the scientists. We're exploring issues such as cost, perpetual access to archive copies, copyright, licensing agreements and training,' she says.

In August this year, Larner won the Queensland Special Librarian of the Year Award, the first time for a regional librarian. During research for a masters degree, she is investigating the best way of making an intranet (an organisation's internal Internet) successful as an information resource for researchers. She is also developing an instructional CD-ROM for beef producers, to help them get started on the Internet.

'In today's electronic information environment, scientists can suffer from information overload,' Larner says. 'Librarians have the skills and the expertise to filter the relevant information from the vast array available, ensuring staff have flexible access to current information vital to their research, thereby saving time and money.'

Bryony Bennett

Cher Page

Paul Holper, CSIRO Atmospheric Research

Tricia Larner

The Morning Bulletin, Rockhampton