Taking the prickle out of wool

Research carried out for the Australian Wool Corporation by the Monash Physiology Department in collaboration with the CSIRO has determined why certain fabrics feel prickly when worn next to the skin.

By monitoring the activity of fine nerves in the skin, Dr Paul Kenins found that the prickliness of wool, for instance, depends on physical irritation caused by skin contact with the ends of coarse wool fibres, which directly stimulate the body’s pain sensors.

In people who are sensitive to wool this can cause itchiness and even skin reddening, but Kenins found no evidence to suggest that these people were actually allergic to wool.

"Australia’s wool industry is a $3000 million a year business and, as prickliness is a problem for some consumers, it is an important economic question," Kenins said.

Kenins now is working at the CSIRO Division of Textile Industry in Geelong. His findings should help manufacturers to design fabrics which are more widely acceptable in the marketplace.

The research group of which he is a member is looking at ways of reducing the itchiness of coarser wool grades. It already has come up with an objective test which allows fabric manufacturers to test their product for prickliness.

The project originally was conceived by Dr Russell Garnsworthy of the CSIRO.

Information on unpleasant sensations detected by the skin — such as heat, cold, and pain — is relayed to the central nervous system by the smallest nerves, the C-fibres. So a neurophysiologist was needed to do the investigation.

Garnsworthy talked his idea over with Associate Professor Rod Westerman of the Monash Physiology Department and it was Westerman who coaxed Kenins out of retirement on a citrus farm in southern Queensland, and took responsibility for supervising the project.

Kenins had had wide experience in Australia and overseas with C-fibres. He had developed the necessary expertise to be able to dissect out and record activity from individual nerve fibres.

He used a fine probe of platinum wire to record the reaction of all the different types of sensory nerve fibres in a rabbit’s leg when the skin of the leg was rubbed with coarse wool fabric on a 50-gram roller.

Of the sensors that he tested, he found that only those normally associated with transmitting pain responded differently to prickly as compared with non-prickly fabrics.

"It usually requires a strong sensation to fire off the pain fibres. And fabrics do not generate large forces during normal wear, so there seemed to be no obvious reason why they should stimulate the pain fibres."

At that point the focus of the study shifted to working out what it was about wool that caused these nerve sensors to fire.

Kenins was able to select fabrics from the wide range available to the CSIRO that differed only in a single characteristic, such as weave or coarseness.

Almost by accident he started looking at the longer hairs which project one or two millimetres from the fabric surface, and it was here that he found his answer.

Initially it is these fibres that carry the whole weight of the fabric when it comes into contact with a surface (such as skin). The strength of the force necessary to bend them depends on their radius. And those coarse fibres which need more than 75 milligrams (3/40 gram) to bend them are capable of exerting enough pressure on pain sensors to trigger off three out of four of them.

In fact, the CSIRO group has shown there is a very good correlation between the prickliness of a fabric and the number of hairs per square centimetre that exert a force.

* Australia’s $3000 million a year wool industry will benefit from the study of fabric prickle.

MONASH REVIEW
CAT-scanning sees through rock

Out of the hospital and down the mine

The seemingly miraculous technique of CAT-scanning, which uses the computer to build three-dimensional images of what’s inside the body, is now being applied to mining geology, and could help locate obstacles and reservoirs of gases and liquids.

Researchers at Monash and Macquarie universities and the CSIRO Division of Radiophysics are co-operating to develop CAT-scanning to “see” through solid rock.

They hope to find ways of using the technique to provide a sharp TV picture of the fine geological structure of mines, which will show where ore bodies, obstructions, fractures and pockets of gas and fluid are located.

The aim is to put together a marketable package which, for a few thousand dollars, will produce detailed images to allow mine engineers to plan how best to extract ore at minimum risk to men and machinery, said Dr Steve Edwards of Earth Sciences.

Most people associate CAT- (computer assisted tomography-) scanning with medicine. To many who have been subjected to it, it seems an expensive, almost magical way of “looking” into the body and generating three-dimensional computer pictures of what is inside.

In fact, far from being magical, it is relatively easy to understand how it works.

A patient is placed on a table and surrounded by a circle of hundreds of X-ray sources. Each source emits X-rays which travel in straight lines through the body to a receiver on the other side.

How strongly they are received depends on the material through which they have to pass. Those which have to penetrate bone, for instance, will show different characteristics from those which do not.

The circle of sources is rotated completely around the patient so that each part of the body is penetrated by rays from many different directions, and all possible ray paths are traced through the body.

This generates an immense amount of data which is recorded and stored on computer. By summing the information from the ray paths through each point in the body, the computer can build up a picture of the characteristics of the material at that point, hence a three-dimensional picture of the inside of the body.

But there is no reason why the technique should be restricted to medicine. For example, at Chisholm Institute telephone poles have been scanned to determine the site of insect attack. And it has been suggested that tomography could be used to locate ancient bones in fossil-bearing rock.

Nor do X-rays have to be used exclusively. Down a mine, for instance, a series of small explosions at different levels in a borehole can produce seismic waves which can be recorded, using a bank of geophones in another borehole nearby. This data then can be used to generate a two-dimensional picture of the sheet of rock between.

Unfortunately, says Edwards, it is not quite as simple as that. First, unlike X-rays, seismic waves tend to be deflected by the material through which they pass, just as light is bent when it passes into water. So seismic waves travel in curves, which are a lot more difficult to analyse.

Second, part or even all of a seismic wave can be reflected at a boundary between two different materials, and so one wave may break up into many components travelling many different paths and arriving at the receivers at different times.

Third, as a mine cannot be surrounded by point sources, and the number and placement of bore holes will be limited by time and money, as will the numbers of explosions and receivers, so any image must be constructed from much less data than is fed into a medical CAT-scanner.

It is this confusion that Edwards and his colleagues are trying to sort out. “At the moment we can produce fuzzy maps, where
we would like to be able to generate clear images."

In order to do that, the researchers must find ways of choosing and enhancing those characteristics of the recorded seismic waves which are important to building a clear geological picture, and removing those features which are unimportant and confusing.

Also, because data is collected on site, usually in less than ideal circumstances, the solutions the researchers come up with, must be able to cope with sparse information of varying quality.

The data is recorded digitally in the computer, that is, as a series of numbers. In essence, the research project involves putting together a group of mathematical equations which will transform that series of numbers into a comprehensible picture.

Luckily, Edwards says, they have a powerful ally in the software developed to ensure the clarity of satellite communications, and to produce meaningful pictures from remote sensing.

In fact, one way of looking at geological tomography is to think of it as using the characteristics of seismic waves to construct a picture of what is underneath the ground, in the same way that a camera uses the characteristics of light waves reflected from surfaces to construct a picture of what is above ground.

And the mathematical equations used to massage the data perform the same role as filters in a camera, and thus are called filters by those who work with them.

"What we are really trying to do is build up a software toolbox of filters we can use to massage the data, filters which will allow us to enhance discontinuities or boundaries. We hope to end up with a complete toolbox of perhaps 300 or 400 different image processing tools," Edwards said.

So, using sophisticated software developed at the CSIRO Division of Information Technology as a base, the group has put together a huge image processing package, begging and borrowing what they could, and writing their own programs to cover what they could not find elsewhere.

Edwards said that to knit the whole package together, the group was looking at producing a many-branched hierarchical access system to get to the various image-processing tools. The scheme would resemble the "expert systems" developed in artificial intelligence work, he said.

The package would also be able to integrate numerical data with descriptive information from on-site geologists. This would be done by constructing shapes to fit the description given by the geologist, and then using them to generate numerical data.

The research has been helped immensely by recent rapid advances in computing and image processing which make it possible to sit at a specialised computer terminal and build and change images in seconds. Previously, manipulating the large sets of data was time consuming and laborious. Such a specialised system has recently been installed at Monash.

From the beginning of the project the group has worked closely with industry. In fact, BHP has donated $15,000 a year towards the research, which supplements an Australian Research Grants Scheme allocation of $30,000.

Equally important has been the support of the Australian Coal Industry Research Laboratories in providing real sets of mine data to test progress in the research.

• Diagram showing wave energy arriving over time at a vertical string of geophones hanging between 25 metres and 80 metres in a borehole. It is possible to see reflections off several coal seams. The data is from the Hunter Valley, inland from Newcastle.
Rare earth minerals set to become better known

Recent research could give the mining industry a shot in the arm.

New materials for permanent magnets and high temperature superconductors both incorporate rare earths, and Australia is a principal supplier of rare earth minerals.

ONE OF THE foundations of modern chemistry is the Periodic Table. In it, the more than 100 different elements so far discovered are arranged so that those that react in a similar manner are grouped together, one under the other.

The Periodic Table is one of the first things any student of chemistry notices. There is a chart of it in almost every chemistry classroom.

But two groups of elements — the lanthanoids (commonly known as the rare earths) and the actinoids — do not fit in to the main table. They contain elements with strange names like Praseodymium, Gadolinium and Ytterbium and radioactive elements like Uranium and Plutonium.

These groups are almost always banished to the bottom of the table. And the next thing the chemistry student notices about them is that teachers of chemistry almost never mention them.

But, according to Dr Glen Deacon of Chemistry, who has been studying the rare earths for more than 13 years, that is about to change in Australia.

The reason is that the rare earths recently have been found to be useful in a wide variety of industrial applications. And Australia is one of the world's largest producers of rare earth minerals.

By far the biggest potential use for rare earths is in the production of the new generation of high temperature superconductors which look set to revolutionise the electric and electronic world.

Superconductors are materials which offer no resistance to the passage of electric current.

They hold vast promise. Not only could they make possible the transmission of electricity without loss of power over great distances, but also they allow the development of powerful magnets for fusion reactors and magnetically suspended trains, as well as heat-free electronics to produce even smaller and faster computers.

Until last year physicists thought superconductors could not exist at temperatures above about -230 degrees Celsius, a temperature which demands cooling with liquid Helium which is bulky, complicated and expensive.

Since last year, however, the physics world has been left reeling by a spate of announcements about new materials which become superconductors at temperatures above -180 degrees Celsius. There are even unconfirmed reports that the threshold temperature has risen above -35 degrees Celsius.

Even at -180 degrees Celsius the new superconductors already are in the realm of the usable, because they could be cooled by liquid nitrogen, which is relatively easy to produce and store, and is comparatively inexpensive.

The new superconducting materials, central to what is at present the world's hottest research topic, are ceramics which combine rare earths with copper and barium oxides.

So Deacon has found himself with an important role to play in the university's superconductor research effort, which has been established quietly in the past two months within the departments of Chemistry, Physics and Materials Engineering.

"The rare earths are actually misnamed - they are not rare at all. They are found in significant amounts in beach sands, for instance, and also are heavily associated with uranium minerals. They occur at 100 to 200 parts per million in a wide range of soils," he said.

One of the reasons their chemistry has been neglected until recently is that all the different rare earths show similar physical and chemical characteristics, which makes them difficult to separate and purify. Using modern techniques, however, they can be purified routinely, although the cost is high. Some of the free metals - for example, lutetium - cost more than platinum or gold.

Deacon said that among the other uses which have been found for the rare earths are in catalysts for cracking crude oil; in steels; in the polishing and coloring of optical glass; as part of new alloys for storing hydrogen, a potential future fuel; as part of the alloys which form the new 'supermagnets'; and in lasers to produce novel colors.

He said they also showed potential as relatively non-toxic additives to replace the lead in petrol and as surface coatings to prevent corrosion in aeroplanes. The Chinese have had some success in using rare earths to get better agricultural yields in soils with low rare earth levels.

In fact, some Australian scientists are so enthusiastic about the future for rare earths that they are pushing for the establishment of a complete rare earth industry in Australia which would mine and then purify rare earths and finally use them to make products like superconductors.

The Ministry of Industry, Technology and Commerce, which has listed new materials as an area to receive grants for...
generic technology, considers rare earths of special interest.

A conference entitled 'Rare Earth Horizons' took place in April at the National Measurement Laboratory, in Lindfield, New South Wales. It was an attempt to bring industry, the CSIRO and the universities together and focus their attention on the potential of the rare earths, and was sponsored by the Ministry of Science and the CSIRO Division of Applied Physics.

The invited keynote speaker was a prominent rare earth chemist Dr Patricia Watson, an Australian working with the Dupont Corporation in the US. Deacon was invited to give the background lecture on rare earth chemistry.

The research which Deacon has undertaken for more than a decade with his colleagues and students has centred around combining rare earths with organic (carbon-based) compounds.

"When I started looking at such organo-metallic compounds 13 years ago very little was known. In fact, one prominent chemist called it 'the last frontier of organo-metallic chemistry'. Now the field is a lot more popular, there's really great excitement, because it turns out these compounds are very reactive and throw up exciting possibilities for constructing other organic compounds."

In fact, Deacon's interest has been very productive. He has made a complete new class of rare earth organo-metallic compounds and has introduced at least three new methods for producing these compounds.

But these reactive rare earth compounds are particularly sensitive to oxygen and water, either of which causes them to break down so easily and violently that all handling of solid compounds must take place in a dry box. The water vapor and oxygen levels in the dry box are kept extremely low by continuously recycling the atmosphere through an oxygen removal catalyst and water-retaining molecular sieves.

Deacon is trying to see if he can increase the stability in air and water of the rare earth organo-metallic compounds by packing bulky groups of atoms around a central rare earth atom. If they could be stabilised in such a way, they could become very useful petroleum additives.

Another area of productive research is with those rare earth organo-metallic compounds which are volatile. The idea is that they might be useful to coat or impregnate surfaces with rare earth compounds.

Deacon is exploring this potential with Dr Neil Ryan of the Aeronautical Research Laboratory in a collaborative project which is looking at protecting metal surfaces against corrosion with a coat of rare earth metal oxide.

There is also a possibility of producing novel variants of the silicon chip impregnated with rare earth metals.

Dr Deacon's work has been supported by grants from the Australian Research Grants Scheme, the Australian Institute for Nuclear Science and Engineering, the university's Special Research Funds and Rare Earth Products of the UK.

His collaborators and students over the years have included Dr David Vince, Dr Warwick Raveritti, Dr Andrew Koplick, Dr Tran Tuong, Dr Geoff Pan, Dr Peter Mackinnon, Dr John Taylor, Dr Trevor Hanbly, Dr Brian Gathouse, Dr Gary Fallon, Professor Alan Bond, Mr Dallas Wilkinson, Mr Russell Newnham, Mr Craig Forsyth and Mr Simon Platts.
I believe that within three of four years there’ll be a number of new universities in Australia. It also seems unlikely that the total amount of revenue available to higher education will increase. And the evidence indicates that unmet demand for university places is rising.

I would argue this makes a strong case for increasing the size of the existing institutions, rather than establishing new universities. It is far more economical than starting from scratch.

Many of the existing universities are operating at way below the optimum size. Murdoch, Flinders, Deakin, Wollongong, James Cook, Griffith are all very small by American standards and have great capacity for growth.

There is also scope for growth in the larger universities which have the professional schools. But at Monash we have four great problems which could retard overall development and make it difficult for us to take more students on board.

The first is space, accommodation on campus. There is little room to do any more than we are already doing.

The more successful our researchers are in getting research grants from outside the university, the greater is the pressure imposed on its infrastructure to support them. We’re in the dangerous position of having almost to decline research grants because of lack of space or laboratories or equipment and support staff.

When the Victorian Government initially proposed to give us $1 million to establish the Accident Research Centre, part of the deal was that we had to provide accommodation for it. It became an enormous job to find a small bit of space to enable us to take the money.

Australian Labor Party.

So we’ve got to look at alternative ways of funding buildings, such as joint financing arrangements with the private sector for capital works.

The second problem area is the library, the central service institution for the whole university. We’re having real difficulty in handling the huge increases in prices of books and periodicals resulting from the devaluation of the Australian dollar.

Expand unis in size, not number

Third, in the laboratory facilities, equipment costs have gone through the roof. We are now replacing equipment on a cycle of about every 17 years, which puts us out of touch with what’s happening in the real world.

The fourth problem is the Computer Centre where equipment costs are extremely high and rising.

So, financing the fundamental infrastructure of the whole university has become a massive problem, and we’re not unique although we might be having more trouble with accommodation than most.

But there’s no magic pot of gold. There aren’t many alternative sources of money.

We must be prepared to develop relationships with the private sector, but not to allow them to determine the priorities or the future course of the university.

It’s the responsibility of the university community to have a view of what it would like the university to become, and then to be selective in its outside relationships. Universities should not be driven by links to the private sector, but the present situation makes it imperative for us to work with the private sector. Where else are we to find the money?

I am in support of private universities, primarily because of the example of the great American private universities such as Harvard, Stanford, Princeton, Yale, Carnegie-Mellon and Northwestern.

I think what has to be watched in the establishment of the Bond University is academic freedom, and to that end, there should be a form of tenure to safeguard the right of an academic to pursue independent research and to speak his or her mind.

And it should not be just a university of technology, but also cater for the humanities and social sciences. There is continued strong demand for study in the humanities and social sciences, and the Bond University should be prepared to meet that demand, especially if it is governed by market forces.

A university which is not balanced ceases to be a real university.

It doesn’t worry me that private universities may be able to wave a fistful of dollars at academics. If Monash people are attracted, it creates vacancies here, and loosens things up a bit.

And I approve of the sort of salary offers they are making. They might make an impact on the state universities, and even lead to the topping up of the salaries of the most talented people. Overall I see no potential benefits in the advent of private universities than dangers.

The demand for accountability of universities has increased in recent years, with greater pressure from government that money be spent in the most efficient manner. It is a request that is reasonable. Most good people in the university would agree that some form of accountability is appropriate.

Huge amounts of taxpayers’ money go into universities and we have to tighten up our procedures and look very carefully at the research productivity and teaching performance of all staff from tutors to professors.

We have to devise measures to do it, and that is right on the agenda. Research productivity can be measured by the number of publications over time, although I admit that is a very crude measure.

Teaching performance perhaps can be measured by student evaluations, which are widespread in the US and accepted as useful measure. I’m unsure, however, as to whether they could be successfully introduced to Australia.

Part of my longer term strategy is to identify a vision for the future, and I would sweep up in that these questions of accountability and performance of both academic and general staff. We have to lift our performance against the vision of what we want to become.

I don’t feel unduly pressured by government or the community. I think it possible to handle most matters and I’m prepared to take a strong stand on matters not acceptable to the autonomy of the university.
New instrument measures tilt for engineering safety

THE MEASUREMENT of tilt or inclination can be crucial to safety in civil engineering. It provides information about the deformation of structures and also about slope and dam stability.

The CDP Inclinometer, a new instrument designed in the Civil Engineering department for making such measurements, is now available from MONTECH.

Originally made to monitor deflections in concrete beams, the CDP Inclinometer comes in quarter, half and full bridge models. It is housed in a light, high impact thermoplastic and has a range of ±20 degrees.

CDP Inclinometers are designed to be placed close together to allow a complete deformation profile to be recorded at any point of interest.

Measurements can be displayed on standard strain gauge or voltage facilities.

At Monash, companies and institutions can use some of the finest High Performance Liquid Chromatography (HPLC) facilities in Australia, to separate, analyse and test for chemicals and biochemicals.

The Physiology department, for instance, is proposing to use the HPLC unit to isolate and test for the carcinogen Dithiostrepton, the substance responsible for pine needle blight.

Any organisation wanting further information or interested in using the Monash facilities should contact MONTECH.

The overwhelming response earlier this year to the first two Monash short courses in genetic engineering techniques showed that Australian companies are keen to stay at the forefront of biotechnology.

MONTECH and the Microbial Biotechnology and Diagnostic Unit now are collaborating to offer a wide range of biotechnology expertise to industry.

As well as planning further short courses, the unit is available for consulting work and contract research and development in a wide variety of microbiological fields including general diagnostic bacteriology, parasitology and mycology; viral electron microscopy; cell and tissue culture techniques; and the development and evaluation of serodiagnostic tests, especially immunoassays, monoclonal antibodies and diagnostic gene probes for bacterial infections.

For further information, contact MONTECH.

MONTECH, the university's technology, consulting and commercial arm, is available now to help business and industry use Monash resources.

It can arrange consulting work, testing, short courses and contract research and development (which is 150% tax deductible).

MONTECH also helps commercialise university research, and markets any products manufactured on campus.

For further information, contact Paul Hudson at MONTECH on (03) 565 3038.

A line of CDP inclinometers measures the deformation of a concrete beam.
Taking the prickle and itch out of wool

From Page 1

greater than 75 milligrams.

And this can be measured by a method, developed by Dr Bob Mayfield of the CSIRO group, using teflon tape of specific thickness on a glass slide. When wool fabric is laid on top of the teflon tape, those fibres that exert a force greater than 75 milligrams pierce the tape where they contact it. The number of holes in a specific area where this has occurred can then be counted.

Now that the group knows what it is that causes prickle in woollen fabric, and has objective method of measuring it, it can begin to tackle the problem of taking the prickle out of wool.

Kenins said: “Fibre diameter is a very important factor. One way out is to use very fine wool, which never prickles, but that’s expensive. What we found was that fabric makers have, in the past, lowered their costs by blending coarse wool with fine, but even five per cent coarse creates problems.”

Another possibility is to finish the fabric differently so that no hairs are sticking out. The group also is working on a way of increasing the diameter of the ends of the wool hairs — for instance, by sticking on a glob of plastic — so that the area of skin contacted by the hair is increased and the pressure on each individual pain sensor is lowered.

The study has destroyed the myth that most people who are sensitive to wool are allergic to it. There seems to be no chemical basis to wool prickle, which means that the standard chemical dermatological test of skin sensitivity — putting an extract of wool oils on the skin — generally will not give meaningful results.

Having developed the techniques to solve the riddle of what makes wool itch, Kenins has begun to study what people like about wool — in other words, what will sell wool.

“’I’m now in the pleasure game,” he said.

“We are hoping to be able to tell manufacturers which fabrics will be most effective in the marketplace, and perhaps to advise finishers what to change to make a fabric more acceptable.”

“At the moment this sort of work is done at the level simply of an experienced person feeling the fabric and judging whether it is pleasant to touch or not.”

Such sensations are transmitted to the brain by much larger nerves than C-fibres, and Kenins now is monitoring the activity of the medial nerve in the arm, a large and accessible nerve.

The study can be done with fine needles using human subjects. Fabrics are rubbed across their hands and their nervous response recorded. The results will determine what people prefer or find pleasurable.

Although these projects have a direct application in the wool industry, Kenins is quick to point out that work of this nature can be generalised. For instance, he said, testing how people respond to fabrics and other surfaces could help in the development of effective tactile aids for the blind using distinctive surfaces.

At the CSIRO, Paul Kenins is working with Bob Mayfield and Ray Gully in a group led by Dave Phillips.

Dr Paul Kenins tests a subject for response to wool fabric using a fine platinum probe.