THE ANZAAS MERCURY

ANZAAS: Empowering the Community with Science

Issue No. 12, December 2001

Editor's Edict

In this issue we bring you our first report on science in the media from our brand new media reporter Victor Bien, see the back page. Find out how to bridge the university-industry gap in developing new technology in ANZAAS Debate. Look at 'Genes in Your Mouth' to get the latest on the GM food controversy and 'Victoria -Unashamedly a Knowledge Economy' to see what one State is doing about the knowledge revolution. More morsels for your science palette include our youth newsletter ANTENNA. -*Duncan Rouch*

Adam's Airing

Comment From The Chair

By Paul ADAM

Plus ça la change, plus ça la même chose? Lessons From Eric Ashby*

A colleague recently unearthed a remarkable photograph of the 1945 Sydney University botany students on an excursion to Doyles River (in northern NSW). The leader of this valuable expedition, resplendent in plus-fours, was the then Professor of Botany at Sydney, Eric Ashby (ultimately to become Lord Ashby of Brandon and Chairman of the Standing Royal Commission on Pollution in the UK).

This led me to refer to some of the published occasional lectures of Professor Ashby from the war time years. They reflect a time when university professors saw themselves as public intellectuals, contributing to national debate on a range of issues and not just their speciality.

Ashby had a number of major themes, the adequacy of the school system, the nature and role of universities in Australian society and the public understanding of science. In all of these areas some of his utterances of more than half a century ago still seem surprisingly relevant today - in respect to these at least perhaps nothing has changed.

School Education Standards

In regard to secondary schools Ashby's target was the Board of Secondary School Studies in NSW. His charge was that the design and delivery of curriculum was driven by ease of examination and that the requirements of examinations took precedence over real understanding of concepts. Despite several rounds of curriculum reform since the 1940s there are many who would lay the same charge today. In several lectures Ashby provided considerable detail on his ideas for improvement, but while he influenced many individual teachers he was unable to effect lasting change in the system.

What's a University For?

Ashby's observations on the state of universities are pertinent at a time when there is national debate about standards and objectives of the tertiary sector. The particular battle that Ashby wished to fight in the 1940s has long since been lost,

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and to many his ideas would seem quaint and irrelevant (particularly to those who devise the funding models which determine the shape of the modern university), or excessively elitist. Ashby stressed the importance of universities as places of education and research, and hoped they would resist the pressures to become training institutions. Contrasting the mid-nineteenth century university with that of the mid-twentieth century he wrote 'Not so many poets and philosophers now, but more economists, engineers, dentists and veterinary scientists flow from the university. In a few more decades, will the stream include masseurs, journalists, technical salesmen, pharmacists and surveyors? Here is the first practical problem. Universities are being pressed all the time to divert more and more of their resources to professional training, to satisfy the desires of modern society. But universities are concerned first of all with the *needs* of society, which are not the same as its desires. On the grounds of tradition and of expediency it is well that some professional techniques (e.g., surgery) should remain university subjects; but in responding to the popular demand for more technical training, where should the line be drawn?"

Education Versus Training

Ashby was confident that universities would draw what he considered an appropriate line. '...universities will not introduce lectures in journalism, advertising, typewriting and salesmanship. Journalism, advertising and the rest are important. No one denies it. They are more immediately appropriate to a business career than are Latin and philosophy. No one denies that. If universities consented to teach these subjects, a real public demand would be satisfied. This, too, no one denies. But satisfying public demands is not the university's business: it is not a state - subsidized intellectual department, to satisfy this or that demand for skilled labour.'

Ashby recognized that disciplines evolved and did not wish to lock universities into medieval curricula. He proposed criteria by which to determine whether or not a subject belongs in a university. 'If the subject lends itself to disinterested thinking; if generalization can be extracted from it; if it can be advanced by research; if, in brief, it breeds ideas in the mind, then the subject is appropriate for a university. If, on the other hand, the subject borrows all its principles from an older study (as journalism does from literature, or salesmanship from psychology, or massage from anatomy and physiology), and does not lead to generalization, then the subject is not a proper one for a university. Let it be taught somewhere by all means. It is important that there be opportunities for training in it. But it is a technique, not an exercise for maintaining intellectual health; and the place for technique is a technical college.'

No government in recent years would have found such sentiments acceptable, and no vice- chancellor anxious to preserve funding could entertain such thoughts. Several subjects of concern to Ashby have developed a research base and arguably now satisfy his criteria for acceptability. Nevertheless, as we contemplate the role of universities into the future it seems to me that separating the notions of education from technical training may be appropriate. The rate of change in science and technology is such that permanent careers will become rarer and rarer. Retraining ('reskilling') and what is called in current jargon 'life long learning' will be essential, but much of this life long learning will be in technical skills. Perhaps at the first degree stage we need a broader less specialised education, seeking generalisations and establishing a context for subsequent training.

Striving to Be Ephemeral!

Ashby, writing in 1938, felt that Australian universities were better placed to resist some of the changes to which others had succumbed, for what now seems a strange reason. The current pressures to accumulate publications were beginning to be apparent. 'Now just as the schoolboy works sometimes in order to pass the examination rather than to know, so in some research schools there is a temptation to work in order to publish rather than to advance science. An ephemeral reputation may be made from sheer weight of published papers, and one wishes sometimes, as Samuel Butler wished, that there could be as much credit given for "covery" as for discovery.' However, this temptation could be resisted as the University of Sydney did 'not possess that stimulant to hasty publication - the Ph.D degree'! Given the weight now attached to both publication and Ph.D completions this again is not an argument that would find favour today. If the purpose of research is to advance knowledge then there is an obligation to make new knowledge available, although I would tend to have sympathy with Ashby's concern about hasty publication.

Empowering the Community with Science

The third recurrent theme in Ashby's lectures is the need to improve scientific literacy amongst the community. Ashby was concerned by the misuse of science by governments and industry (and quotes striking examples from then contemporary advertisements), and felt that popular science articles and broadcasts of the time did not convey appropriate messages. 'Just as the medieval peasant was kept in awe of the Church by hearing a lot about miracles and very little about its struggle with sin, so the metropolitan commuter is subjected to propaganda about the possibilities of penicillin and rocket planes, but is kept in ignorance of the scientists struggle to find natural laws'.

Science's Acceptability to The Public

'... owing to public ignorance of the scientific method and its consequences, there is no check on the way governments and industry use, or abuse, science. To assert that a policy, or a toothpaste, has a scientific basis is to gain acceptance for it in the public mind, so unquestioning is our respect for science. When we read that an antiseptic gives a Rideal-Walker test at a dilution of one in a thousand we are inclined to bow before the statement as our forefathers bowed before the stigmata of a medieval saint.'

In this arena we may have gone backwards since the 1940s. The lack of understanding of the scientific method is still widespread but today there is no automatic trust of scientists. Rather there is now a large constituency which is distrustful of science. This is seen in the blanket opposition to genetic engineering and perhaps also in the increasing popularity of 'alternative' medicine.

Many things have changed over the last sixty years, but while some of the arguments advanced by Ashby would no longer be acceptable, I find it striking (and somewhat depressing) that the issues identified by him are still unresolved and remain relevant.

**The various quotations in this piece come from Ashby, E. 1946 'Challenge to education'. Angus & Robertson, Sydney, - the individual lectures span a period from the late 1930s.*

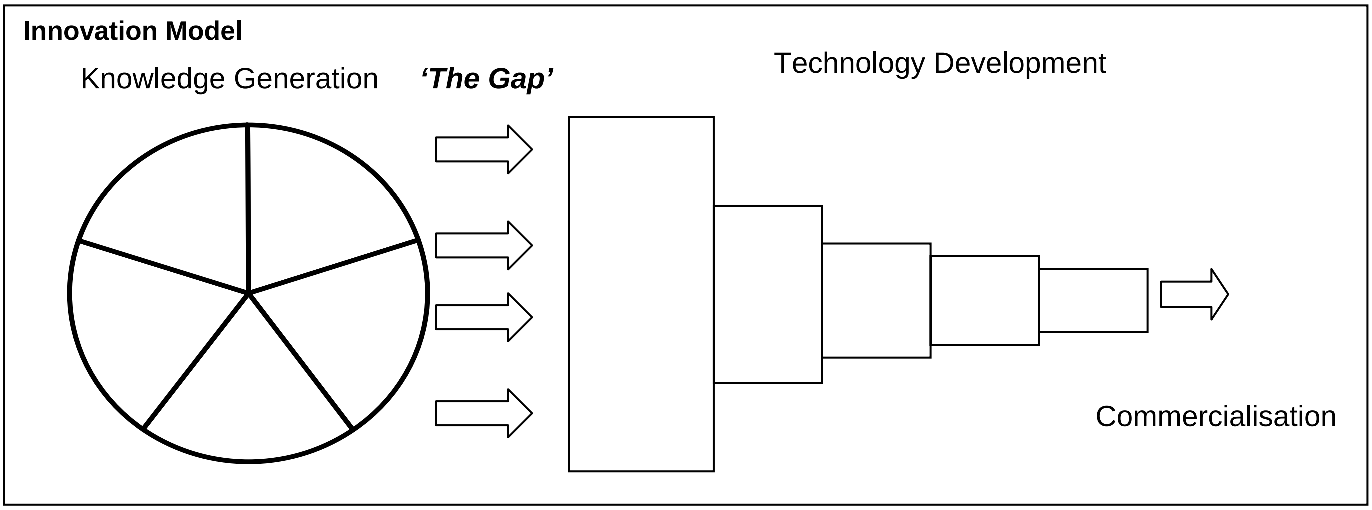
I would welcome any comments and suggestions for issues that could be addressed -e-mail: chair@anzaas.org.au, Tel: (W) 02 9385 2076, (H) 02 9314 2453, FAX: 02 9385 1635

The ANZAAS Debate - Bridging the Gap Between Knowledge Generation and Technology Development

**If Australia is to punch at its weight in the global future it must improve its performance for innovative industry products and services. It is well recognised that a major issue for better industry innovation is improved communication between university research and industry science application. Here Ian Lawrence addresses this crucial topic. Ian is at the STEM Partnership, Suite 603 434 St Kilda Road, Melbourne Vic 3004; Ph (03)9820 0400; e-mail, ilawrence@stempartnership.com.au*

Introduction

The links between scientific discovery and the delivery of practical results - what we call technology - is vital to the wealth of individuals, businesses and the nation. Yet the link between scientific discovery and the development of new technology is poorly understood.[1]



The lack of linkage or gap has a process dimension and a cultural dimension. This article will explore the gaps in understanding and present a new approach that provides the link and bridges the gap with a language that enables, science and technology development to be identified and managed in a value creating way.

Process Gap

There is a fundamental difference between the process of scientific discovery (knowledge generation) and the process of technology development. If we accept that science is first and foremost a process of discovery and that technology development is about the application of knowledge to useful objectives we can see that philosophically we have very different value expectations from science and technology development activities.

Cultural Gap

The gap increases when the cultural differences between stakeholders are considered. The lack of understanding of the process of transforming science into technology is shaped by technical understanding, community needs and business forces and brings together scientific, business and government people whose outlooks, specialized knowledge, and professional languages are very different.

Innovation Model

The process and cultural issues can be further explored by referencing the following generic 'Innovation Model'[2], outlined in the figure. Knowledge generation is an interactive non-linear process, and technology development is focussed to the delivery of specific outcomes.

Process Issues

This model highlights the process differences between projects in Knowledge Generation and those in Technology Development and innovation.

The key process features of Knowledge Generation are:

- Quality of research is a key management issue
- The primary focus is on developing new information and learning
- The identification of quantifiable commercial benefits may be difficult.
- The knowledge generation process can be a cyclical process
- The elements in the cycle are driven by the research need.
- The technical merit of the project is regularly reviewed and decisions made whether to continue in the cycle.
- Reviews of progress are required nodal points to allow commercialisable opportunities to be harvested

The key process features of Technology Development are:

- The fundamental science is generally proven.
- The project is staged with identified outcomes.
- The primary focus is on delivery of the outcomes relative to the stages.

- The drivers of the projects are the commercialisation benefits delivered at implementation.
- Projects can be more easily stopped if outcomes are not delivered.
- Commercial outcomes can be valued and readily adjusted to take account of risk.
- Commercial outcomes are typically the key for advancement to the next stage.
- New knowledge may be created at each stage but this on its own will not necessarily drive the project to the next stage.
- Valuations are typically based around Benefit Assessment, Decision Tree Analysis, Monte Carlo Simulation and risk and uncertainty assessment.

Cultural Issues

From the previous discussion it is clear that different management approaches are required for projects in either phase. These different management responses will develop quite different organisational cultures.

For the Knowledge Generation Projects the key drivers of the management response:

- The option value of the concept or idea.
- The reputation of the researcher or inventor.
- The quality of the research program.
  - Clarity of technical objectives.
  - The experimental program.
  - The quality of the infrastructure.
  - The quality of the support services
- Knowledge growth and peer review.

In the case of the Technology Development projects the key drivers of the management response are:

- The potential commercial value of the project
- The potential market for the technology
  - The size of the market
  - Entry barriers
  - The need for commercialisation partners
  - Potential for competing technologies
- The value growth in technology development
- The risk and uncertainties in commercialisation.
- Risk minimisation and value optimisation
- The critical success factors relative to project stages.
- The deliverables at each stage.

The Consequence of Mismatch

Given the very different management responses needed for the two types of project and the very different management plans that emerge, what are the consequence of a mismatch? Let us consider the consequence of a knowledge growth project managed as if it were a technology development project:

1. It would be difficult to identify clear technical and commercial outcomes and the project would consume a lot of resources in trying to find it way.
2. The project could be stopped before all learning's were identified.
3. The project could block or starve resources from other projects that have clearly defined outcomes and commercialisable opportunities

Conversely a technology development project managed as knowledge growth project would have the following consequences.

1. The project would be managed to create new knowledge rather than to deliver a commercial out come.
2. It would consume a lot of resources seeking answers to technical questions that have little or no commercial relevance.
3. The project would be difficult to stop.

In our experience a large number of technology development can be described by these consequences. Clearly the gap is real and requires a bridge

Bridging the Gap

The STEM Partnership has developed a unique capability that enables technology development to be classified as a knowledge growth or a technology development.

Our process allows key qualitative information to be collected, collated and analysed relative to a structured set of technical and commercial dimensions. The dimensions focus on the benefits that the project will deliver to the stakeholders upon successful implementation.

For a technology development project it is possible to calculate the current and future value of the project. Decision points identify the critical technical and commercial factors that the project must overcome. This coupled with the ability to compare the value added at each gate to the cost of each stage allows the development of a powerful three-dimensional management plan.

In the case of a knowledge growth project the Option value can be calculated or is intuitively understood.

In order to strike the option there is a need to recognise that the knowledge generating activity does have the potential to move into the commercial technology development. The opportunity for a commercial outcome will be identified in the option to engage in knowledge generating activity. Additional opportunity may be recognised as the new information emerges (an embedded option).

Regular reviews of the project by people who are not directly involved in the test work but rather have an interest in the commercial outcome is critical to moving to a technology development phase The cost of the option is the cost to progress to the next stage of knowledge generation. Provided that the new knowledge generated does not waive or extinguish the option then as knew knowledge emerges there is sufficient drive in the option to progress to the next stage. In this way there is a decision process established that identifies any commercial outcomes and either extinguishes, exercises or defers the option.

This approach allows for the development of a management plan that targets the quality of the research process and calls for the external review of new knowledge at relevant points the cycle.

The process we have described allows a project to be described relative to powerful value metrics that all stakeholders can understand. These metrics coupled a regular project review provides the language to bridge the gap in the technology development process.

References

[1] The Valuation of Technology - Business and Financial issues in R&D. F.Peter Boer. Wiley 1999.

[2] Providing Clarity and a Common Language to the Fuzzy Front End. Koen et al.

Please join the debate,
by sending your response to the members e-mail discussion list: email to members@anzaas.org.au

Feature Article

Victoria - Unashamedly for Knowledge Economy

By Stefanie PEARCE

The Prime Minister announced on 29 January 2001 a number of Federal initiatives to "back Australia's abilities", However, Victoria's Government has been supporting science, technology, and innovation in Victoria with substantial funding measures for some time. In a bipartisan approach to boosting the State's advanced scientific and technological capabilities the Bracks' Government recognised that science, technology and innovation are key drivers of future prosperity and quality of life and decided to invest substantially with a 'Science, Technology and Innovation (STI) Initiative'.

Victoria's "unashamedly business-friendly" Minister for State and Regional Development John Brumby is committed to building Victoria as a location for world class science and technology, taking a whole of Government and whole of State approach. The Victorian STI Initiative of $310 million over five years is directed towards catalysing the development of world class science and technology infrastructure, skills and the commercialisation of innovation in Victoria.

STI policy and programs are designed address Victoria's development needs and priorities. These are identified through an ongoing consultative process that encourages collaboration between education, research and industry sectors.

An important aspect of this process is the advice of the Knowledge, Innovation, Science and Engineering Council (KISE Council). The Victorian Government's KISE Council has been formed to provide high level strategic advice on directions and priorities. The Council is chaired by the Premier and comprises leading members of the, research, business and academic communities, together with senior Government Ministers.

Building on Victoria's reputation as Australia's research capital, with the nation's largest concentration of research institutions and corporate R&D, the STI initiative supported Bio 21, a new biotechnology initiative that will confirm Victoria as an international centre for health research, by providing $50 million towards the $400 million Parkville phase. Australia's first synchroton will be based at Monash University in Victoria. The Victorian Government will join with Monash University and other project partners to enable the construction of the $157 million facility, starting in 2001/02. "*It will provide a massive boost to Victoria's position as a global leader of biotechnology and scientific research,*" said Minister for State and Regional Development, John Brumby.

A further $54 million in grants will support fourteen innovative infrastructure projects worth $225 million, including health precincts, microtechnology, plant sciences, neuroscience, food technologies and manufacturing research facilities.

Another recent example of building the State's 'clever' infrastructure is $6 million over three years to establish Victoria's own super-computer, as part of the Victorian Partnership for Advanced Computing (www.vicpac.org). Examples of intended applications include advanced research and modelling on computational nanotechnology, astronomy and the human genome project but also many industrial applications in the automotive and aerospace industries.

Taking the idea to market is the focus on the $20 million Technology Commercialisation Program, which bridges the gap between great ideas and commercialisation, Inventors and innovators can gain improved access to professional business support and development services critical to startup and early stage growth technology firms. There is practical Government support provided for technology parks, and business incubation and acceleration programs.

At the other end of the development pipeline, Victoria is also focusing on its young people, with education and careers support to build a skilled workforce ready to take the State forward and to encourage community support for science and technology as opportunities for jobs and wealth creation.

The Commonwealth Government may have finally heeded the call of universities and the research community to invest in Australia's science and technology base once again, but the Victorian Government sees the need to take this further, by developing the State's capacity to capitalise on its traditional talent for innovation. For Minister Brumby, it's the vision of a partnership between industry, academe and the research and finance sectors, collaboratively developing a creative economy --- a knowledge economy based on education, innovation, science and technology, with Victoria as its knowledge capital.

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News Stories From ANZAAS

Public Responsibility and the Public Perception Of Risk

Life has been described as a sexually transmitted fatal disease. We all know it is ultimately terminal, says Dr Bob Hunter* - internationally distinguished Australian colloid and surface chemist, but how do we assess the risks we are prepared to take along the way? Hunter provided some clear options to this question in this year's ANZAAS Liversidge Lecture, which he delivered at the opening session of CONASTA 50, the Annual General Meeting of the Australian Science Teachers' Association, in Sydney, July 2001.

From bungey jumping to jay walking, from playing golf to playing rugby and from cradle to grave we are surrounded by risk. Our assessments of relative risk are often hopelessly inadequate but our willingness to take on even high risk is an important aspect of the human condition. Good science is the only sure way to properly assess risk, but the record in the chemical and nuclear industries in the last fifty years shows that the final figure often takes a long time to surface. The lesson for any new technologies, such as gene engineering should be obvious: whatever the short term gains, the public will not treat kindly a technology which involves potential long term risk, no matter how small, unless the benefits are very real and very significant.

The scientific evaluation of risk, otherwise known as **Hazard**, is very different to the public's perception of risk. A related term is **Dread**, which may be defined as fear of hidden threats. The public perception of risk has been measured by Paul Slovic on the **Dread Scale**, which is not related to the objective assessment of risk but correlates with lack of familiarity. Risk is measured by the Loss of Life Expectancy (LLE) in days. For example, being a male compared to a female has an LLE of 280 days, smoking cigarettes has an LLE of 2399 days (6.6 years), and generating all electricity by nuclear power has an LLE of only 1.5 days.

The cost of risk reduction can be assessed as the cost of a year of life saved by intervention and expressed in US dollars. Nowadays companies need to consider the triple bottom line of Profit, Environment, and Sociology, all of which involve the concept of risk. The chemical industry is developing a new face as it comes to terms with this. Risks may be divided into two types, based on how they affect people, namely; voluntary risk -such as mountain climbing and smoking, and imposed risk from pollution, food additives, and artificial radiation. Public risk can be classified by the industry involved. For example, the nuclear, pharmaceutical and chemical industries each have their own particular risks to public safety.

Some pesticides and herbicides have risks of acute toxicity, which farmers must be aware of in minimising both the personal and public risk. These are known risks, but sometimes risks may not be apparent until a catastrophe occurs, like that in Union Carbide's pesticide plant in Bhopal, India in 1984. Accidental release of over 40 tons of highly toxic methyl isocyanate into the atmosphere had tragic consequences for the local population, causing an estimated 2000 deaths, 100,000 injuries, with up to 50,000 people still partially or totally disabled a decade after the initial event. The USA, home of the parent Union Carbide company, got the message and set up improved industry standards and environmental regulations.

After World War II it became possible to contemplate world-wide catastrophes resulting from human activities such as: nuclear war, misuse of chemical pesticides -as described in Rachel Carlson's book 'Silent Spring', worldwide pollution - including the greenhouse effect, and overpopulation.

A further issue is Genetically Modified Food, which might change the biosphere in unintended ways. Gene modification brings new risks. There may be differences between plans and results in unforeseen hazards. The aims of genetic modification include crop protection from pests and weeds, and frost and drought resistance, as well as altered properties of the food product.

Distinctions must be made between cases in which the producer benefits and those where the consumer benefits, as consumers need to see direct benefits to accept new products of technology. Both voluntary risk and involuntary risk are incurred when the general population is targeted. Risks are different between consuming the whole organism or separated components, and whether the product is a food or pharmaceutical. For example, human insulin produced by bacteria as a pharmaceutical is voluntarily consumed whereas soybean meal produced from gene engineered 'Roundup Ready' crops may be unknowingly eaten, due to higher information and purity standards in the pharmaceutical industry compared to the food industry.

Other potential issues that should be addressed with GM crops to minimise risks are, Hunter asserts, transfer of antibiotic resistance, transfer of genes across the species barrier, that engineered crop organisms might escape into the environment, fear of harm to future generations and the potential for global catastrophe.

** Dr Bob Hunter is an internationally distinguished colloid and surface chemist. He is a Fellow of the Australian Academy of Science and a former Head of the School of Chemistry at the University of Sydney. He is well known for his active concern about the social responsibility of science; as a long-time office-bearer in Scientists for Global Responsibility (formerly Scientists Against Nuclear Arms) and Sydney University's Centre for Human Aspects of Science and Technology.*

Genes in Your Mouth*

By Duncan ROUCH

Genetically modified (GM) crops and foods made from them are still a controversial issue for many people. Focussing on the gene engineering technology used to make GM food components renowned science communicator Dr Andrea Horvath talks about 'bulldogs and tomatoes'. What is the difference between the accepted selective breeding to produce a new type of bulldog and the controversial gene engineering to give us a new type of tomato? Is the transfer of genes between species asking for trouble? Can regulation avert potential disaster? Should we allow GM food on our supermarket shelves? If so, how should they be labelled to give consumers choice?

To approach these and other questions we called on a diverse group of three experts; Dr Ed Newbign -plant geneticist, School of Botany, University of Melbourne, Mr Bob Phelps - Director of the Australian Gene Ethics Network, and Prof Margaret Britz - biotechnology and food regulation expert, School of Agriculture and Food Systems, University of Melbourne. To help understand this complicated subject we have separated the GM story into two parts. In part 1 in this issue we cover the environmental safety of GM crops, (and in part 2 in the next issue the health safety of GM foods made with GM crops or other modified organisms).

Part 1: Genetically Modified Crops

The world is changing at a great rate, says Britz explaining the global context for regulation of GM food production. Trade liberalisation has seen import tariffs fall from a post world war II high of 46% to the current 6% or less. Modern gene technology first developed in the 1970's with mass production of insulin and other simple products, but now we are looking at cloning humans! Tariff reductions and increased competition have created a demand for more efficient food production processes, while modern gene technology has provided potential ways to meet this demand for greater efficiency.

Gene engineering of crops can increase the efficiency of food production, for example, by altering a crop to be resistant to herbicides iy may allow both increased yields of the crop and reduced input costs. Also the physiology of a crop, such as a tomato, can be altered to allow it to have a longer shelf life says Britz. Herbicide tolerance is the engineered property of the vast majority of GM crops, states Newbign. This new property allows reduced chemical spraying, reduced tillage and reduced erosion. How important are GM crops in agriculture? Planting began in 1995, with 0.1 MHa, and reach 45 MHa by 2000. The main GM crops are Soybean, corn, cotton and canola, which have been planted in 13 countries, mainly in the USA (30.3 Mha) with Australia having 0.15 MHa. The time to market for a new GM crop is about 10 years.

Responding to the controversy over gene engineering Newbign says the 'yuck' response is often how people see new technology. Simply look at the public questioning over safety in the introduction of microwave ovens. Also plant geneticists are mysterious unknown entities in the public arena, which allows belief in anti-GM descriptions like 'Frankenstein makes vegetables'.

Gene Engineering versus Traditional Selective Breeding

Returning to Horvath's question about 'bulldogs and tomatoes', Newbign explains the relationship between traditional selective breeding, that gave us bulldogs and modern maize, and gene technology, the technique of today's society, which has given us things like the long-life tomato. In traditional breeding two parents with different genetic make-ups are crossed to give offspring which each have a different combination of the gene differences between the two parents. Among the many gene differences produced a few may give rise to a change in characteristics desired by the breeder, such as more maize kernels from a single maize stalk. The selected offspring are bred together and over many generations gradual improvements can be obtained. Maize plants of today are modern descendents developed by humans from much sparser varieties from pre-Columbian society thousands of years ago. Traditional techniques have also been used to cross different species.

Traditional breeding produces many differences in offspring in sandblasting fashion, to obtain the few special characteristics the breeder is after. This sandblasting effect is the best we could do until recently because for most of our history we have not understood the relationship between genes and the characteristics we are interested in changing. In contrast, modern gene technology has given us both the means to selectively add one or a few genes, and the knowledge to make useful choices of which genes to engineer. We have the ability to choose particular genes to engineer due to the large amount of knowledge that has accumulated in the last half-century about the relationship between genes and the properties they produce.

The genes added to an organism by gene engineering may be from the same species or a different one. How are new genes engineered into crops? One system uses nature's own genetic engineer, the bacterium called Agrobacterium. The bacterium uses a mobile ring of genes, called a plasmid to transfer genes to the plant's DNA. Usually the bacterium transfers its own genes, which help the bacterium and plant to live in a cooperative way. With gene technology modified genes derived from the same plant or another species can be transferred by the plasmid to the plant. A drawback of this particular system is that it works with only a restricted set of plants.

The peak of controversy over the method of gene engineering corresponds to when the new gene is foreign, coming from a source different to the original organism. This echoes controversy in the 1930s and 1940s over the use of selective breeding to breed different species together.

Agriculture and food companies are using gene engineering simply to improve profits, with little attention to making better environments or stepping to sustainable planet, says Phelps. A widespread issue about using GM Crops is the potential for development of 'super-weeds', weeds that gain the herbicide tolerance from adjacent GM crops. Super-weeds, responds Newbign, are also a problem with traditional chemical systems for control of weeds. In relation to weed control Newbign agrees that use of chemical sprays should be further decreased, for example through crop rotation and other systems used in organic farming.

The issue of chemical sprays also applies to insect pest control. Here there may be environmental benefits of some GM technology agrees Phelps, such as the 10% reduction in chemical spraying on cotton made pest resistant with the bacterial Bt toxin gene. Phelps nevertheless challenges the proponents of modern technology to provide substantially better environmental benefits. Britz echoes this sentiment in predicting the demand for production of plants adapted to wider environmental conditions, such as dryland salinity.

A further problem has arisen with some applications of gene engineering using antibiotic resistance genes from bacteria to mark transfer of new genes to plants. Phelps asks would not this increase the risk of pathogenic bacteria acquiring antibiotic resistance?

There has also been concern that biodiversity of crop plants would decrease as a few GM varieties take over markets, continuing the monopolies of global agricultural seed firms. In these terms gene engineering is perceived as a property of global corporations, and so is partly targeted due to general fears that further globalisation will take away peoples' control over their own lives and increase the wealth disparity between rich and poor countries. Nevertheless, according to Britz, globalisation also means the food industry is continually after new varieties. With its strong consumer focus, if consumers demand choice they will get it. Moreover, intrinsically, gene engineering can make it much easier to put new properties into many varieties, than traditional techniques.

Regulating the Safety of GM Crops

If a foreign gene is used, asks Britz, is the crop with this new gene safe to grow without harming the environment? With this and other serious questions surrounding GM crops clearly proper field trials are needed to assess their environmental impacts. So how effective is government regulation of GM crops? Unauthorized plantings of GM Starlink corn occurred in the US and now the total US corn supply is contaminated with this GM product, says Phelps. In Australia, states Britz, a number of companies performing trials with GM crops have breached the regulations, in the face of the powerless Gene Technology Regulator during 2000. Moreover, one major crop, canola, has the propensity to spread genes from GM canola plantings to non-GM canola stands, perhaps located a number of kilometres away, says Phelp. Newbign added that this was an exception as most crops did not persist if not cultivated, and most crop varieties have relatively short market lives, a variety usually being replaced about 10 years after its introduction.

No doubt the gene technology regulator needs teeth to keep GM companies within the rules. In June this year the new Gene Technology Act came into force. Companies that breach license agreements will face fines of up to $1.1 million per breach per day, and 5 years jail. Health and Aged Care Minister, Michael Woolridge, claims it is easily world's best practice. Donald Anton, Director of the Centre for Environmental law, claims, however, that the act does not go far enough to protect farmers. GM companies should be required to take out insurance, so people can be compensated in the event of an accident. Moreover, the Government has appointed a former biotechnology stalwart, Dr Sue Meek, to the post of Gene Technology Regulator. Critics argue Dr Meek may have difficulty being impartial, with potential bias towards industry. Nevertheless, the job requires a level of technical expertise that most likely could be found only in those trained in biotechnology. The work of the Gene Technology Regulator will no doubt be scrutinised by community groups like Phelps's Gene Ethics Network.

**This article is based on the successful forum, 'Genes in Your Mouth', in the May 2001 national science week, by ANZAAS Victoria and the Faculty of Science, University of Melbourne. New information has also been added to bring this feature up to date.*

Media Report

TV Science Programs Reinvented?

By Victor BIEN

The upheaval of the ABC science programs, amongst other things, created by Jonathan Shier resulting in the death of Quantum ironically has led to a creative renewal in the form of the new TV program Catalyst. Is this a case of Schumpeter's "creative destruction"?

Catalyst is similar to Quantum in avoiding as far as possible the "talking head" syndrome which is easy to slip into in conveying essentially conceptual matter - the stuff of much of science. I think it achieves a better or more contemporary balance than Quantum did in depth of coverage while taking account of the limited attention span of most TV viewers. After all under Shier the ABC is now supposed to pursue ratings. That so far it has failed to do so, in fact quite the contrary, is another matter.

For topics that cannot be covered properly in short grabs the approach of presenting the topic over a series works well. Amongst the topics covering our human nature the one starting in 18 October reporting Australian research about the crucial requirements of parenting babies in their first three years of life probably has the most large scale societal impact over the longer term. It should be made compulsory viewing for all politicians and people in social policy and services sectors. It now appears that the absence of this knowledge for the current generation of upcoming youth has resulted in their states of mind what can be only described as a "disaster". We have an epidemic of youth suicides, drug taking and violence in schools.

Catalyst is doing a good job of providing some science education to the general public. It shows that scientific pursuit is not all cut and dried. It provides some human interest perspectives to some scientific work where the outcomes sought are not at all guaranteed.

Before Catalyst started Aftershock filled in the slot vacated by Quantum. This was a low cost program which unavoidably had talking heads filled in by clever graphics and some scenes which was probably the best that could be done in the circumstances. It was an outsourced program. The compere was Richard Fidler. It is now available on tape from ABC shops. Some of the discussion was quite important and this indicates that perhaps programs should be made now and then to cover this type of activity. This type of discussion is covered by Robyn Williams on ABC Radio but I wonder whether pouring some money into such programs for scene making to take the focus off the talking head could be done thus making these suitable for TV.

It is interesting to note that commercial station Channel 10 now has a science program thus showing that there is money to be made in showing science.

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