Professor Graeme Clark and the cochlear implant (bionic ear)

Highlights

- A focused, well managed Australian research team prospered in the face of better-resourced, international competition.
- The physical proximity of experts from different disciplines and sound project management provided an environment conducive to innovation.
- Recruitment of talented and enthusiastic people willing to share the vision is critical.
- Further work on management models that streamline administration and keep the focus on the research, would help other Australian teams take on the challenge of competing with the world's best.

The Australian development of the cochlear implant ear is significant because its development and ongoing success has been achieved in the face of fierce, well-resourced international competition.

When Prof Graeme Clark first embarked on this quest 33 years ago, others, particularly in the US and Europe, had also conceived of the possibility of such a device.

While Prof Clark and his team gained a head start by successfully predicting the technology which would prove appropriate, they still had to compete against immeasurably better resourced international rivals based in some of the world's most famous universities. Given that this project required breakthroughs in a range of disciplines, each requiring considerable resources, this was a massive challenge

There were those in the academic and scientific community who argued against public funding for the project on the grounds that its very concept was overly ambitious. It required not just the biochemical and engineering skills to replicate the function of one of the body's more complex organs, but an understanding of the very process by which the human brain turns external stimuli into cognitive information. If such a breakthrough were possible, it was argued, it would not be made by a small, under-resourced department in an Australian university.

The fact that it did succeed – and continues to be a pacesetter in ongoing development – makes it worthy of study. There are clearly lessons for other potential Australian innovators in the way this project was structured.

The background

Graeme Clark's interest in deafness can be traced back to an awareness of the problems that a severe hearing impairment caused his father. This, along with an ambition to tackle some truly major piece of research, caused him to abandon a successful career as an ENT surgeon, and

undertake a doctorate study in the field. That led to his appointment in 1970 to the chair of Otolaryngology at the University of Melbourne where he was able to further the research.

The complexity of the challenge was enormous, requiring neurological, physiological and engineering advances. In essence it required a device which could capture the complex sounds of running speech and instantly encode them in a series of chemical and electrical impulses which could be transmitted to the brain in a form which allowed them to be decoded into cognitive information. All this in a package small enough to fit into the bone behind the ear. The idea was conceived at a time when silicon chip processors were still in their infancy.

Significantly, Graeme Clark concluded early in his studies that a single electrode would not replicate the complex message patterns collected and transmitted by the nerves of a properly functioning ear. It would take at least 20 such wires, he calculated, and that produced a major engineering challenge in itself. The 20 wires had to be pushed along a tiny – approximately 1mm – channel to the inner ear which itself was in the form of a tightening spiral.

As if these challenges were not sufficient, Graeme Clark faced the additional demand of having to personally raise funds for the project.

Initially he did this by addressing multitudinous luncheons for service clubs and putting the speaker's fee toward research. Given that the fee was usually only a few hundred dollars, this was a hugely time consuming process with a limited revenue stream.

However, it paid off in an unexpected way. After one of his addresses, Melbourne Apex decided to donate $2,000 to the project. Although not itself sufficient to provide any financial security, the gesture made ABC-TV news, where it was seen by Sir Reginald Ansett, then owner of the television station Channel 0, later to become the Ten network. Sir Reginald was sufficiently interested to make further inquiries and eventually to offer to hold a Telethon appeal to fund the project.

Ironically, after three years the telethon was dropped, largely because of pressure from elements of the deaf community, who felt that this emphasis on restoring hearing denigrated their impressive accomplishment in communicating through signs. Fortunately by then, the project had made sufficient progress to gather Government support.

Despite the horrendous pressures and long working days that flowed from having to simultaneously be fund raiser, researcher, academic, administrator and surgeon, Graeme Clark made a conscious decision to keep, wherever possible, a large part of weekends free for family life.

It is a course he recommends to other innovators. It is not only necessary to maintain a stable and supportive family relationship, but also helps refresh the mind and allows you time to think.

He recalls that he solved one critical problem sitting on a beach with his children.
The problem had been to develop threadlike electrodes with the contradictory characteristics of being both rigid enough to be pushed along the channel of the ear, yet flexible enough to thread through its tightening spiral path. On the beach, pondering this issue, he pushed a blade of grass through a spiral seashell and realised the solution. Like a blade of grass, his electrodes had to be more rigid at the base and more flexible at the tip.

As these problems were progressively solved, he was able to conduct the first patient implant in 1978. The results, although limited by today's standards, were hugely exciting because they demonstrated that it was possible to create artificially the coding by which speech signals were transmitted to the brain. He says that the decoding system by which the brain interprets the messages is even today very imperfectly understood.

Even after this success, some scientists were still sceptical of the wisdom of committing Federal research funds to Prof Clark's program, for about this time the US industrial agglomerate 3M committed its very considerable support to the US bionic ear program. In the face of this effort it was felt that Australia, despite its demonstrated success, could never run more than a distant second in getting an effective product onto the world market.

Fortunately, Prof Clark put his case directly to the then Prime Minister Malcolm Fraser and to other Ministers, and was awarded a Public Interest Research Grant which laid the foundations for the project's escalating success. Subsequently, the Australian company Telectronics, which had experience in manufacturing pacemakers, was appointed to provide industry support.

Clark believes that the Public Interest Grant, though now superseded by other programs, was a good model in the streamlined administration and reporting processes which it demanded. The emphasis was very much on research commitment, not administration, he says. It is an accolade he also offers the University of Melbourne which, over a long period, displayed enormous trust in the way he expended departmental funds on the project and in the research people he hired.

The continuing development of the technologies and their worldwide acceptance has led to the creation of the technology company Cochlear Ltd., and to the establishment of the Bionic Ear Institute and the Cooperative Research Council for Cochlear Implant, Speech and Hearing Research.

These organisations are recognised as world leaders and surgeons worldwide come to Australia to study the product which enjoys an international market.

Lessons from this experience

Graeme Clark says the cochlear implant program holds some lessons for any innovator seeking to step into uncharted areas of technology. Among them:

- Persistence. You have to be in for the long haul, and to be willing to make that sort of long term commitment when you start. It is not something in which you can just dabble.

- Focus. One of the reasons Australia was able to outperform the much better resourced US effort, he believes, is that the effort was centred on the University of Melbourne's Otolaryngology Department. In contrast, he says, much of the US work was contracted out to centres of excellence in each of the disciplines involved. The physical proximity of the various researchers at Melbourne meant there was much greater cross-disciplinary interaction and a focus on the end result. Sometimes it transpired there was a biological solution to what

appeared an engineering problem – or vice versa. Also in contrast, the diversification of effort in the US meant reduced communication and great potential for rivalry.

- Team management. World-leading research requires you to gather a team of exceptional people – people with high intelligence and a passion for their own field of interest. However, in such a group, you need strong leadership to maintain a single minded focus on the end result, and not allow a project to become diverted or distracted by developments in areas of individual interest.

Graeme Clark believes there may be scope for further work on the management of groups of exceptional people, but said that in his experience such scientists are more receptive to intellectual leadership than to administrative dominance. For that reason he suggests team leaders need to – above all – keep abreast of the all science aspects of the projects, offering constructive questions or comments and keeping a focus on the end result. Such groups respond best to intellectual stimulus. They respond to a leader who is generous with ideas and input, and is objective in decision making.

This means the team leader must minimise his or her administrative burden. Ideally this can be done through funding programs that recognise this and minimise the reporting demands. Prof Clark says he fully supports the need for accountability of public funds, but urges administrators to limit the number of meetings and reports.

On the other hand, he says that when he began the research program, he needed to get a grasp of project management. This is a skill with which academic researchers are not always equipped. He was able to get guidance from a colleague in the business management faculty and undertake some selective studies.

Can an innovative environment be created?

Graeme Clark is open minded on the question of whether a talent for innovation is inherent in an individual or whether it can be nurtured. However, he notes that in his own case, he was conducting experiments in a garden shed at the age of 9 or 10 and suspects part of his innovative streak may be inherited from his mother. His father was more pragmatic, but Graeme Clark notes that an additional streak of practicality and determination may be equally needed for an innovator to translate an idea into a reality.

He also acknowledges the impact of a group of ‘quite remarkable’ secondary school teachers at Scots College in Sydney, in imparting concepts of deductive reasoning, in the formation and testing of hypotheses and related areas of inquiry.

While these genetic and environmental factors may shape individuals, he does believe that an organisation can foster innovation. He himself has had a policy of recruiting young people who may not be handicapped by preconceptions, and very bright people with an outstanding academic record.

The challenge he sees is to then harness this talent. Research, he suggests, is by its nature an inefficient process, requiring exploration of various paths and ideas, only a minority of which will prove useful. It takes a ‘benign dictator’ with considerable judgement to prevent this process

leading to a fragmentation of effort. At times individual goals and interests need to be curbed, and one line of inquiry abandoned for another more promising one. A clear focus on a single goal (in his case the cochlear implant) also facilitates cross-disciplinary approaches. The task is not an engineering one or a physiological one; it is goal-centred and thus inclusive and enlists any development that is useful.

Prof Clark believes that while vast amounts of study have been conducted into the effective management of business operations, there may be scope for further work in the management of research and research teams. There is, he suggests, a need to ensure that the reporting and operational regimentation needed to ensure accountability does not in the end compromise the intense focus on research that is necessary to motivate teams of exceptional individuals.

Now as a member of several boards, and operating under several boards, he is in a better position to evaluate various management practices.

Graeme Clark also believes that we need at times to allow groups to focus on developing exceptional specialisation in one area, and not be forced to diversify to meet other agendas. "It is important to be leaders in some field, rather than to spread resources too thinly."

He is hopeful however, that the success of his team may serve as a role model for other researchers, demonstrating that focussed and motivated Australian teams can compete and succeed at probing the frontiers of science. "We should never again assume, as some did at the beginnings of this project, that some task is too great for an Australian institution to tackle. We must instead consider how to create an environment in which we can encourage people to accept and meet such challenges."