Space+: Pathways for All Abilities

MAKING SENSE OF THE UNIVERSE

IMPROVED ACCESSIBILITY HELPS EVERYBODY

An interview with Garry Foran
Adjunct Research Fellow at
Swinburne University of Technology, Australia

Garry Foran seems to have lived three lives in one. After earning a Ph.D. in Inorganic Chemistry from the University of Sydney, he took up a position in 1992 as Beamline Scientist at the Australian National Beamline facility at the Photon Factory synchrotron light source in Japan.

As a foundation member of the Australian Synchrotron Research Program, Garry supported the experimental activities of research teams Wishing to exploit powerful synchrotron-generated X-rays to study the composition and atomic-scale structure of a wide variety of materials. However, over the years that Garry worked in this role, his eyesight was declining due to the progression of Retinitis Pigmentosa (RP) – a genetic degenerative disorder of the retina that Garry had been diagnosed with in late childhood. RP is characterized by a progressive narrowing of visual field, with rapid periods of decline interspersed with years of stability. It manifests firstly as 'night-blindness' and later as 'tunnel vision', and eventually complete blindness as in Garry's case.

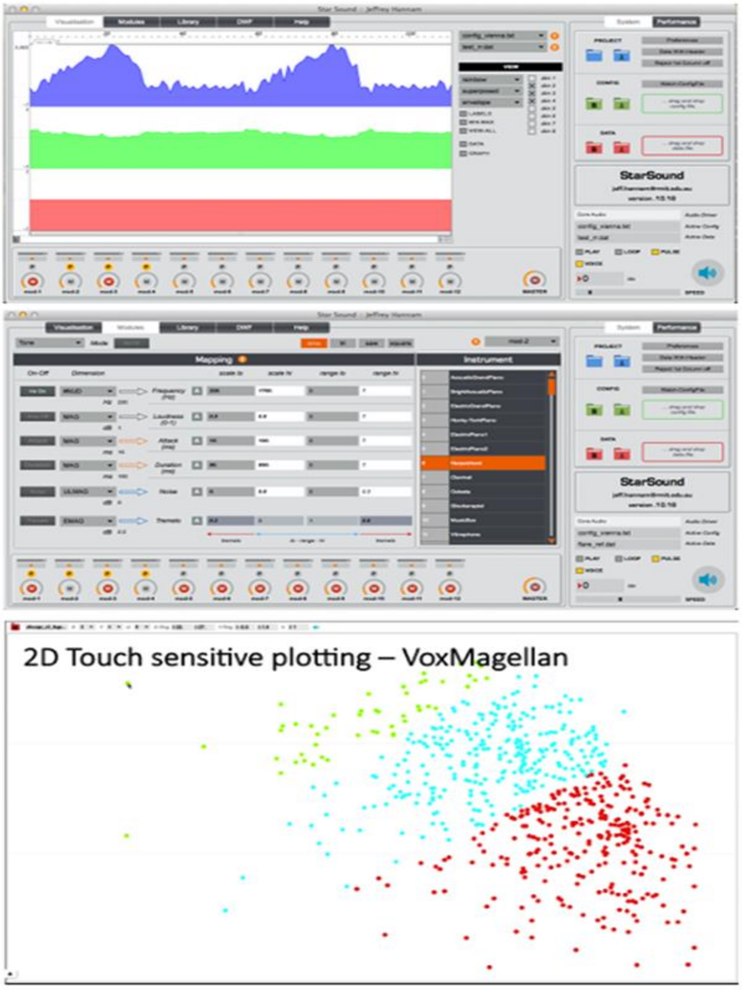
Around 2002 as Garry entered his late-30s, his eyesight reached the point where he could no longer drive. He began having difficulties with work activities such as the handling and alignment of precision instrumentation and the visual interpretation of imaging data. It was around this time that Garry gave up on his ambition to pursue a career in academia. Choosing what he deemed to be the more secure path, he decided to stick with his government employer who had a strong worker support scheme. From then up until now, his visual impairment has been a constant feature in his decision-making.

"Accessible features aren't just about making things easier for people with disabilities, but often they can improve the lives of everyone... " - Sarah Herrlinger, Head of Global Accessibility, Apple

By about 2009, the progression of his RP had left Garry functionally blind. He moved back to Melbourne to work on the first synchrotron light source built in Australia and even returned to Japan for a few years to work at the J-PARC neutron facility, but this period of his life was riddled with frustrations, trials, and uncertainties.

In a burst of perseverance, Garry changed the course of his life and decided to pursue a long-standing interest of his: astronomy and astrophysics. He contacted the Swinburne's Centre for Astrophysics and Supercomputing after hearing a radio interview, and ultimately enrolled in a Ph.D. in galaxy formation and evolution. As they explore new ways to make sense of the Universe, Garry and his colleagues are developing powerful sonification tools aimed at expanding the data experience of scientists of all abilities. Garry completed his PhD in 2022 and has now returned to Swinburne as an Adjunct Research Fellow to continue his invaluable work.

In this article, Garry shares his experience as a blind scientist, the challenges he has faced, the techniques he has used to overcome them, the beautiful discoveries he made along the way, and his advice for other scientists with disabilities. We will also be discussing his current research and what he hopes to accomplish in the future. Through this interview, we hope to shed light on the capabilities of individuals with disabilities and inspire others to pursue their passions, regardless of any obstacles they may face.



Interface of StarSound and VoxMagellan
(Upper) The StarSound visualisation page showing the first of the five tool tabs. This tab includes a data visualisation window, here showing three discrete data channels being sonified (blue, green and red traces), controls for modifying visual features of the plot and project administration (to the right), and 12 channels (with panning stereo) and controls for starting, stopping and moving back and forth through the data (along the bottom).
(Centre) The second tab replaces the data visualisation window with controls to modify the properties of the sound.
(Bottom) VoxMagellan rendering of a 2-D multidimensional data set showing a plot of galaxy colours (y-axis) vs. brightness (x-axis) based on certain selection criteria (green, cyan, and red). Here, the colours are assigned to distinct sounds to easily identify each population, which has different properties. For each data point a second sound is overlaid to provide additional information (here, the strength of a certain spectroscopic feature).

UNOOSA: Thinking of the different stages of your life, how do you think your disability influenced your choices in terms of education or career?

Foran: I was very lucky that throughout high school and my first two degrees, and in my first job at an Australian research facility in Japan, my eye condition didn't affect my choices. It was about ten years later, around 2002, that things got more difficult. My eyesight reached the point where I could no longer drive. I was struggling with some work activities, especially those requiring the handling and alignment of precision instrumentation or the visual interpretation of imaging data. As an early-career researcher, my main ambition had been to go into academia and teach. I decided to give up on that idea. I thought it would be too difficult to work in such an environment with my declining vision, so I took the safe path, which was to stick with my government employer who had always supported me and had a strong worker support scheme and disability safety net. From about that stage on, my visual impairment started to affect my life choices, and I guess since then up until now, it's been a constant feature in my decision-making.

Garry and his Guide Dog Trooper at the Mitaka Campus of the National Astronomical Observatory of Japan on the occasion of "IAU Symposium 358: Astronomy for Equity, Diversity and Inclusion — A Roadmap to Action Within the Framework of IAU Centennial Anniversary", November 2019. Credit: Garry Foran.

You lost your ability to see at the age of 40 and had to give up on your career in synchrotron radiation. Could you share your experience of this period of transition and how you got into astronomy and astrophysics? What made you realize that going back to research was something you could do?

When I moved to Melbourne after 17 years in Japan to work at the Australian Synchrotron, it was a rather difficult period for lots of reasons. There was great political uncertainty around the future of synchrotron science in Australia and my career path in the field. While the opportunity at the Australian Synchrotron was created for me with my physical limitations in mind, my vision loss was affecting much more than just my professional life. In particular, I was starting to have serious difficulties with mobility. That's when I started white-cane training just to be able to get around. I was engaged with organizations who provided software and assistive technology to help me do my computer-based work. But it was very traumatic, and I was not in a good headspace for much of that time, not knowing where my career or my eyesight were going, having to make changes in my lifestyle, and having to absorb all that new information. The project I was working on came to a natural end after a couple of years, and I decided to leave my employer and the field.

My life turned around in early 2011 when I got my Guide Dog, Trooper. With him, I was once again able to move around at a normal speed and in a normal way, which I was never able to do with the cane. I regained a sense of independence and personal dignity that I felt I had lost. I took an interesting job back in Japan for three years at a neutron facility, but again, it was a desk job remote from the science, and my desire to return to research grew stronger. As a result, I started to look around again.

I had always had a keen interest in astronomy and astrophysics, but had thought them to be beyond my ability. But as I got to a point of frustration with where I was and what was happening, I stumbled upon interviews with members of the Swinburne team while listening to the radio. We had just bought an apartment in Melbourne, and I knew Swinburne was very close by. My eyesight was barely functional, and it wasn't obvious at all that I would be able to do the work, but I thought I should just try and pursue something that I had always loved and see what would happen.

I Started looking into the astrophysics program at Swinburne, and one day, really on a fancy, on a whim, I contacted them. I didn't admit straight away that I was a) old or b) blind, I just made a general inquiry. But when I spoke to them for the first time on the phone, they'd already read between the lines, and from that instant, they were right behind me to try and make it happen. There was never even a suggestion that I should think of doing something else or that this might be too hard for me.

While I prepared my application for the graduate program, I undertook a five-month internship with Prof. Jeff Cooke – who later became my Ph.D. advisor – for both of us to test if it was going to be feasible. I had a background in physics, chemistry, optics, spectroscopy, and other experience relevant to observational astrophysics, but I was an amateur in the field, so I was starting quite behind the eight ball in that sense. The internship was excellent because it was a low-pressure environment, without any degree hanging on it or milestones to be achieved, where I could start to get familiar with the tools, the language, and the daily routine of research activities in the field. It also allowed Swinburne to see how I was doing. If they had thought it was beyond me, they may have given me different advice, but the internship went very well, and I enrolled in the Ph.D. program at the start of 2016.

How did this experience modify your perspective on the field of astrophysics?

Astronomy and astrophysics are often perceived as very visual fields of research. We often see in the media awe-inspiring images of the cosmos observed using the latest space- and ground-based telescopes. But while there is a high concentration of visual content, the fact of the matter is that like many other areas of research, all astrophysical data these days is digitally collected; it's entirely signals that are invisible to the naked eye. One doesn’t necessarily have to use visual tools to process and analyze the data, understand the physics, and probe into current problems in the field. In terms of analyzing the data, I developed my own set of techniques, all based on just looking at numbers, text-based systems, and the sound readout that I rely on now for all my work.

Garry outside the Cahill Center for Astronomy and Astrophysics, California Institute of Technology, on the occasion of the 3rd Swinburne-Caltech Science Workshop: Galaxies and their Halos, September 2017. Credit: Garry Foran.

It wasn’t obvious that astronomy and astrophysics would have been possible for me, but with the support of my colleagues and the staff at Swinburne, we found a way to make it feasible for someone with my level of vision to undertake a program of high-level research.

You're involved in the development of new sonification tools. Could you tell us more about the projects you've been working on?

Sonification in astronomy and astrophysics has come a long way in the last ten years or so. My Ph.D. supervisor Jeff Cooke and I started thinking about sonification projects in the early days of my degree. We were able to link up with Jeff Hannam – a sound architect from RMIT University in Melbourne -- who I met via a network in Australia that brings together researchers who are vision impaired and people doing research on visual impairment. Since then, the three of us have been collaborating on sonification software tools that were designed from the start with me as the conceptual designer and end user. I would say "this is what I want to be able to do" and Jeff Hannam would work out how to do that through software, under Jeff Cooke's oversight and direction.

> *"No two people are the same and visual impairment entails different levels and combinations of loss of color, depth, or perception. The main difficulty in designing sonification software as an accessibility tool is determining the scope."*

We now have two tools. The first one, StarSound, is a tool for interrogating and analyzing one-dimensional data such as spectra or time series data streams. It is publicly available and is used by others around the world. It was a topic of testing at the Audible Universe Conference workshop in Leiden last December. The other, Vox Magellan, is a 2D image sonification tool currently in the prototype phase. The principal aim was accessibility and enabling analyses that I wanted to do, but they've both since grown to a much broader scope, investigating the application of sonification to a wider

> *"Limiting the range is therefore probably one of the biggest challenges so that you pick a scope and do that well rather than trying to do a whole lot of things not very well."*

mainstream audience. Jeff Cooke's leadership on that was important because he identified that if sonification is to be sustainable, it's got to have applications beyond my accessibility needs.

What are the main difficulties in developing sonification technologies and making them appeal to a wider audience?

No two people are the same, and visual impairment can manifest in a variety of ways, e.g., as a reduction in visual acuity or field, loss of color and contrast perception, or a combination of these with other disruptive phenomena. The main difficulty in designing sonification software as an accessibility tool is determining the scope because it's impossible to produce a single, universal tool. You must define what it is you're trying to achieve, for what sort of people, and how you're going to achieve it.

What I do, and what I think a lot of people who have sensory needs for assistive technology do, is to have a suite of tools and techniques that can be applied depending on the problem at hand. That might range from just optical character recognition software to contrast enhancement. Some would need zoom-in or zoom-out capabilities, some would need full sonification.

I need everything to be turned into a sound or turned into a format, usually numbers, that I can then interrogate as text. When I create a histogram plot, for instance, I don't put a histogram plot on the screen. I print out the numbers of the histogram on my screen and I read the line of numbers from left to right.

That way I can create a mental image of the shape of the histogram and the relative size of the histogram bars. Limiting the range of any tool is therefore probably one of the biggest challenges so that you pick a scope and do that well rather than trying to do a whole lot of things not very well.

For mainstream research and for people with sight, are there things that sound can do better than sight? What are the advantages of listening to data, in your field but also research in general?

There are at least four areas in which audition is superior to visual perception: temporal resolution, reaction time, spatial localization, and attentional selectivity. This last point relates to the so -called 'cocktail party' effect. Imagine you're in a restaurant full of people speaking a foreign language. If there's a table in the corner where your native language is being spoken, you will be able to hear that discussion amid the ambient noise because your brain is highly attuned to your native language. This ability to pick a signal of interest out of a noisy environment has already been applied in astrophysics.

> *"Audition has its strengths and visual perception has its weaknesses. If we intelligently combine the two so that they complement each other, there's no reason sonification shouldn't be an additive tool to the data analysis experience."*

Spatial localization is another area where audition has strong potential. Our ears can locate a sound around us in three dimensions (forward, back, left, right, up, and down) while our eyes only work well straight ahead. Audition has its strengths and visual perception has its weaknesses. If we intelligently combine the two so that they complement each other, there's no reason sonification shouldn't be an additive tool to the data analysis experience.

We've heard talks about a multi-sensory approach to data analysis. How do you envision the future of this multi-sensory approach to data analysis? Which new tools do you think are most likely to change work environments in the future for researchers with disabilities?

I'm very much in the camp of using a multi-modal sensory approach that is not limited to sonification but also incorporates haptic and tactile feedback. For instance, our Vox Magellan package that analyzes 2D plots and images, works by mapping the image onto the trackpad of the computer, allowing the user to navigate around the image or plot relative to the edges of the trackpad which correspond to the edges of the image.

Multi-sensory modalities make perfect sense because that's how we interact with the real world already. We have ears and eyes and fingers and other senses because that's how we're designed to interact with our environment. The advantages of such an approach are obvious in computer gaming, the metaverse and virtual reality applications where immersive environments are already widely used. There's no reason why data analysis, not only in astrophysics but also in many other fields, shouldn't go down the same path of combining sensory modalities intelligently to enhance the experience beyond what has up 'til now been limited to looking at plots or images on a screen.

It's something we've been talking about at Swinburne. Jeff Cooke leads the Deeper, Wider, Faster programme, a multi-telescope international search for what we call transient phenomena. They're attempting to do a multi-wavelength real-time analysis of very short-lived events, looking at everything from fast radio bursts on the millisecond time scale up to things on the minutes to hours time scale like Flare Stars or Novae. That involves managing very large volumes of data and triaging very rapidly in a search for transient candidates which can then be followed up using expensive space- and ground-based assets. One of Jeff's visions for that project would involve something like a virtual reality headset, in which the sky is projected.

When candidate transient phenomena are identified in the pipeline from the supercomputer, they will appear somewhere in the field; there'll then be a sound and a visual signal that can draw the attention of the user and be matched to a particular image or a particular timestamp. Then, the follow-up researchers can go to that and confirm whether it's bogus or a real transient event. It's easy to see how a multi-modal approach could find application there.

Could you share any specific challenges you faced as a scientist with a disability, and how did you overcome them?

I guess a major difficulty of doing research when you rely on sound alone, especially at a graduate level, is access to the literature. Journals have come a long way, even in recent years, in terms of improving the accessibility of their text and even some of their graphs, images, and mathematical symbols.

There is an initiative called MathJax, which has made some good progress in turning equations and expressions into a form that can be interpreted by someone using a screen reader.

Some journals are moving towards improving the accessibility of the material and incorporating sound into their publications. The Nature group, for instance, hosts the material from the Audible Universe workshops.

The accessibility of general articles, however, especially legacy journal material, is a major hurdle. It's an area that could benefit from a more concentrated effort.

Your experience is that of a gradual loss of vision. How could we improve accessibility for scientists with disabilities, including those who develop a disability at a later stage in life? What should we be mindful of when considering these different experiences?

I was lucky enough to go through my early education as a sighted person. I learned how to do calculus, how to read plots and spectra, how to align optics, and how to tune lasers. I had the research framework already built, so even when I lost my sight, I could still imagine what things were supposed to look like.

For someone like myself, the requirements are going to be quite different compared to those for someone who has never had use of their vision. I don't say that's better or worse, because someone who's never had vision usually has a more developed skill set, and far better use of their other senses than I do.

For example, I think someone who's never had sight would learn Braille at an early age. I never learned Braille because I was very fortunate to lose my eyesight in the digital age when screen reading, optical character recognition, and electronic voice synthesis really came into their own, but Braille is an enormously powerful tool. It comes back to this idea that no two people are quite the same; they'll have different skills and different needs, and it's important to be aware of that.

What steps can research institutions and other organizations take to be more inclusive of researchers with disabilities? What would be good practices from your experience?

Perhaps I've just gotten a bit older and wiser, but I think it's just about being good people. I know that sometimes policy is required, and sometimes rules need to be made and guidelines set out, but that's the easy part. In terms of creating the right environment, my experience at Swinburne was that as long as people acted generously and decently, nothing was too big of a hassle.

> *"Perhaps I've just got a bit older and wiser, but I think making things easier for people with disabilities is not too hard. It's just about being good people."*

From the student body to the head of the center, I never had an experience with somebody who wasn't helpful and supportive. There was never a "Not that guy with the dog again"; there was never any sense that I wasn't contributing to the center. I know that if I felt that I wasn't getting that support or that I was not welcomed or that I was causing problems, my enthusiasm would have dropped off very quickly.

I've been really blessed to have the opportunity to travel during my degree. I attended a Winter School in Switzerland, travelled to the IAU Congress in 2017 in Vienna where I gave a talk during the Inspiring Stars exhibition, went to conferences in South Africa and Japan and twice to the Keck telescope, and undertook a speaking tour around the US. This was all at Jeff's encouragement, and everywhere I went I was welcomed and supported.

How can persons without disabilities, notably those at the top of institutions, help create an inclusive environment that embraces those with disabilities?

I was very lucky to have institutional support from the top down, but I was also lucky to have colleagues who created an environment in which I felt comfortable asking for help without making me feel stupid or needy.

> *"Having an environment like that, where people are genuinely supportive and helpful without an ounce of condescension or pity, is what I would like to see for everyone. "*

My colleague Sara, for instance, was always ready to help without making a big deal of it: simple things, like "I'll be in tomorrow; if there's anything you need, let me know". Nothing was too much trouble at all. If she couldn't do it right away, she'd always come back to me later. She would check in with me regularly, and if I said something was a bit of a struggle, she would offer help and I'd take it.

Sometimes the most trivial things would be roadblocks to me if I insisted on doing them myself, such as University administration tasks. Sara would just say "I'll do that for you. Just tell me what you need to fill out" and it made life so much easier when those stupid little things that I would agonize over became no problem.

> *"My first piece of advice would be to talk to people… my second piece of advice for people with a disability is to get over yourself, ask for help, and be gracious in accepting it."*

Having an environment like that, where people are genuinely supportive and helpful without an ounce of condescension or pity, is what I would like to see for everyone.

If you have someone around you who does occasionally need a little bit of extra help, try to create an environment where it's easy for them to ask for help, and you'll both benefit from that.

Do you have advice for people with disabilities who may want to study or work in the field of astronomy? What they should look for in a job or in a company, for instance?

I think people with special needs like me are very sensitive to what others are thinking. There's an internalized stigma, and I think people are very perceptive if they think something's not quite right or that they're not quite welcome.

My first piece of advice would be to talk to people. Find out where they're coming from and what their attitudes are before you choose a job or program. Before I went to Swinburne, I met with several professors about potential projects, and I told them."

This is what I can do and what I can't do" and asked how they would approach that. They were always very accommodating. In research today, almost nobody works alone on a project, so the message I got from the Swinburne staff was that if I reached a point where I physically can't do a task, then I should ask someone to help.

I guess my second piece of advice for people with a disability is to get over yourself, ask for help, and be gracious in accepting it. For many years I have suffered from that same pathological independent streak. I wanted to be self-sufficient. I wanted to do it on my own. I wanted to prove to the world that I wasn't disabled.

A very good lesson for me when I went back to research was learning how to be realistic about what I can and can't do, ask for help, and accept it when it's offered. You will find that most people are just happy to help in any way they can. Reluctance often comes from the fact that people don't know how to help, so they stand back. If you're specific in what you ask, most people will be relieved to know what they could do. You'll be amazed at how smooth things get when you give up the fight.

And finally, do you have an inspirational quote, an anecdote, a book, a movie, or a project related to disability inclusion in science that you would like to share?

There is a quote by - Sarah Herrlinger, the Head of Global Accessibility at Apple Corporation, that I use at the end of my talks:

"Accessible features aren't just about making things easier for people with disabilities, but often they can improve the lives of everyone...Things in assistive technology have applicability for a broader audience so it's always fun when we find things that were originally built for one community that have such great applicability for so many."

This is an inspiring quote because it encourages people to envision accessibility not just as something to help people with a disability, but as something that has the potential to help everyone.■

Garry speaking at "Inspiring Stars — the IAU inclusive world exhibition" held in Vienna, Austria, August 2018. Credit: Garry Foran.

BIO

Garry received his first PhD from the University of Sydney in 1994, where he studied inorganic chemistry. From there, he moved into a 20-year career in X-ray physics and synchrotron radiation technology. He went on to become Scientific Manager of the Australian Synchrotron Research Program and a Principal Research Scientist at the Australian Nuclear Science and Technology Organisation. After losing his sight to a degenerative retinal condition, Garry retired from these roles and embarked on a new career path by enrolling in 2016 in a PhD in the Centre for Astrophysics and Supercomputing at Swinburne University of Technology. In his doctoral thesis, Garry demonstrated new relationships between the observed ultraviolet light from early galaxies and their structural, kinematic, and environmental properties. After graduating in 2022, Garry took up a position as Adjunct Research Fellow at Swinburne where, in addition to his galaxy evolution research, he continues to be active in a collaboration that is developing sonification tools that facilitate the management and analysis of astrophysical data using sound.

RESOURCES

- StarSound website
- Talk on StarSound and Vox Magellan by Jeff Cooke (2021) via Sonification World YouTube channel
- Astreos Space podcast episode 3: we discuss galaxy types, kinematics and the Linman Alpha line which Gary uses with sound, as a blind astronomer, to further unveil one of the mysteries of the universe: [Link]
- Swinburne University of Technology YouTube. "Swinburne Story: Garry Foran": [Link]
- Foran, G., Cooke, J., & Hannam, J. (2022) Proceedings of the 2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion (Eds. Santiago Vargas, Beatríz García, Gary Hemming, Sonia Duffau, Nicolás Vázquez, & Angela Pérez), Revista Mexicana de Astronomia y Astrofisica Conference Series 54, 1-8

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REDUCED INEQUALITIES

ABOUT

This article is part of the "Space+: Pathways for All Abilities" interview series under the United Nations Office for Outer Space Affairs Space for Persons with Disabilities project. The aim of this interview series is to raise awareness of the importance of disability inclusion and to advance inclusive and equitable development in the space sector through sharing the experiences of and lessons from disability advocates and persons with disabilities in space.

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