Revealing the big picture

Professor Chris Rapley CBE MAE (1955-1966) discusses his experience of using multi-disciplinary and inter-disciplinary approaches in his scientific career, and the value these bring to both research and understanding. He is Professor of Climate Science at University College London and holds additional roles such as Chair of the European Science Foundation's European Space Sciences Committee. His previous posts include Directorships of the International Geosphere-Biosphere Programme, British Antarctic Survey and the Science Museum.

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IPY Planning Committee at HQ of International Council of Science, Paris.

When I was little, I discovered that I was good at jigsaw puzzles. I recall the satisfaction of seeing the image gradually emerge as the pieces were assembled. It's not a talent I mention on my CV. But it has turned out to be very helpful in my career.

A problem with science today is that its domain is so vast that no-one can be expert in all fields. A common quip is that the career path of a researcher is "to learn more and more about less and less until they know everything about nothing". Joking aside, the silo-ing of knowledge and expertise, and the tendency not to link the parts, is a widespread problem in the modern world, and not just in science.

The US space agency NASA addressed the matter years ago by introducing the concept of the T-shaped employee. This is an individual who combines expert specialist skills with a broad overview and generalist capabilities. Their 'helicopter view' allows them to apply their talents to greatest effect, and to create meaningful knowledge rather than isolated facts. When studying complex systems, such as the Earth's climate system, this also allows the discovery of 'emergent behaviours' not derivable from the individual parts.

My first practical experience of the research advantage of multi-disciplinary awareness was as a PhD student at UCL's Mullard Space Science Laboratory. My task was to determine the origin of the cosmic soft X-ray glow that had been discovered using sounding rockets to loft instruments above the atmosphere. Familiarity with features of the optical sky learned at the Oxford University Observatory during my undergraduate physics studies, and of the radio sky acquired from an MSc course at Jodrell Bank, allowed me to devise a sounding rocket experiment. Following a successful flight (flown from Woomera, Australia), the combination of the radio, optical and X-ray data revealed the source to be Galactic.

Some years later I led an international initiative – the International Geosphere-Biosphere Programme (IGBP) – which provided a community-agreed research plan for thousands of scientists from 75 nations to investigate the Earth's bio-geochemical cycles. To make progress, we had to overcome academic disciplinary boundaries (between physicists, chemists, biologists, ecologists, mathematicians, etc) as well as national, institutional, language and cultural barriers. The aim was to establish a framework guiding the investigation of multiple individual scientific 'jigsaw pieces', and then to assemble the fragments so that the 'big picture' emerged. The IGBP was itself 'nested' within a high-level arrangement of the World Climate Research Programme (studying the physical aspects of the climate system) and International Human Dimensions Programme (studying the role and response of humans within the Earth system). The success of the programme generated new and important insights into how the planet functions.

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Presenting on climate action at the 2023 European Space Agency, Living Planet Symposium in the old German Parliament Chamber, Bonn.

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Later, as Chair of the Planning Committee for the International Polar Year 2007-2008, I applied the same principles, ending up with an integrated programme of observations, research and analysis carried out by an estimated 50,000 researchers from more than 60 countries. It was the largest, most comprehensive campaign ever mounted to explore and characterise the Earth's Polar Regions, including 228 international projects, of which 171 were scientific, the remainder addressing education and outreach. Since then, interdisciplinary synthesis has been a hallmark of the research programme that I led at British Antarctic Survey, and of the galleries (especially the 'atmosphere' climate science gallery) that were installed when I was Director of the Science Museum.

More recently I have been working with colleagues from the field of neuroscience and psychology to understand better why the world is not responding to the climate and environmental crises at the scale and pace that the science shows is necessary. As an experimentalist, I have been rather taken aback to find how little I had previously understood of the behaviours – strengths and shortcomings – of my primary observing instrument – my Mk1 palaeolithic brain! As a 'Child of the Enlightenment' I had presumed that reasoned thinking – followed by rational action – would be the automatic response to overwhelming evidence. But my 'mind science' colleagues were amused at such naivety.

Daniel Kahneman, the Nobel prize-winning economist, and expert on human behaviour, described our mind as "a machine for jumping to conclusions" and noted that "thinking to humans is as swimming to cats – we can do it, but prefer not to". In practice we filter information according to our predilections, and behave in ways that are all too often against our best interests. As social beings we are strongly influenced by our peers. The use of story-telling and example offer powerful ways to overcome psychological and institutional barriers to create the 'agency to act'. These are insights and skills not commonly taught to natural scientists, who have much to learn from the world of social and behavioural research.

The upshot is that I find myself still discovering and assembling new and unexpected jigsaw pieces – and being astonished and inspired by the pictures that emerge!