Honorary Fellow
A Citation

Professor Cheng Chuen-hon Arthur

One of the most mordant criticisms that one academic can make of another is to describe their work as shallow. When we look beyond mere surface appearance we should find underlying structure. How gratifying, then, to honour today someone whose work no-one could describe as shallow: indeed, depth is of its essence, yet his work has also been concerned with reflection.

We perceive ourselves to stand on solid ground and most of us know little about what lies beneath the ground beneath our feet. Yet some do. The deep oceans are sometimes described as 'inner space' and while it is true that their depths remain relatively inaccessible and unexplored, the seemingly solid mass of our planet that lies below us itself is harder by far to explore—however simple Jules Verne may have made it sound. This is Professor Cheng's domain. He is a leading exploration geophysicist—a rock star. But how does one explore these subterranean depths?

One way is, quite literally, to drill down—a metaphor for most of us, but the real thing for a select few. The deepest hole ever to have been made stopped at 12,262 meters—less than 2% of the way to the centre, but still quite a bit further down than Mount Everest goes up. With shallower holes, it's possible to retrieve a core from the drill, so that one can actually see—and touch, measure, and analyse—orderly samples of the rock that is down there. With some forms of rock, however, like the multilayered shales in which (or on occasion beneath which) oil and gas can sometimes be found, the core samples tend to break up. Think of it as rather like taking a bite of puff pastry: those flakes take on lives of their own. Moreover, each core is just a few centimeters across. Repeated sampling of this kind cannot meaningfully represent the structures of an underground feature that can extend for great distances.

An alternative for exploration geophysicists is seismic surveying. They send shock waves through the soil, by setting off explosive charges (or nowadays more typically compressed air blasts) and then using a spatial array of distant sensors to detect the vibrations propagated through the soil. The pattern of waves you pick up depends on the boundaries between different layers (that's the reflection part), and on what those layers are actually made of. This gives you the opposite of core sampling—wide coverage but low resolution—letting you draw more general inferences about what's down there.

Drawing those inferences from remote imaging of this kind has clear parallels with some other forms of indirect imaging. If the sedimentary layers in a shale are all neatly lined up, then shock waves travel differently when they're going along the layers compared to travelling across the layers. This is called anisotropic propagation. In present-day magnetic resonance imaging of the brain, we detect anisotropic properties of water diffusion and use them to map the structures of fibre bundles of axons—the connecting highways of the brain. In seismic exploration, Professor Cheng actually refers back to the brain, by using neural network models. These are computer simulations of the way that groups of neurons in the brain operate together. His neural network models are trained on synthetic data but learn to extract signals from large, natural datasets with great sensitivity and specificity. They let him build better models of

shale anisotropy—making sense of what might otherwise simply be noise, both in the perceptual and in the informational sense.

Work of this kind is both deep and highly technical: it is also much in demand, from charting aquifers and underground oil or gas reservoirs to planning tunnels for high-speed trains. Small wonder, then, that Professor Cheng straddles both academia and the commercial world. He is a true international presence: he was born and raised in Happy Valley and schooled here in Hong Kong but in 1969, when some of his distinguished contemporaries turned their minds to medicine, he followed a mathematical calling. It took him to Cornell for a BSc in Engineering Physics (with Distinction) following which, in 1973, he moved again, to MIT, to become a Geophysicist.

'What should they know of England who only England know', asked Kipling? In that spirit, how might an ambitious explorer of the Earth start their career? Off-world, of course: his first project with his MIT advisor was a study of moonquakes, using Apollo 11 seismometer data (I won't be the only person here who still remembers watching them land). With a Doctorate of Science in Geophysics he subsequently became a Principal Research Scientist in MIT's Department of Earth, Atmospheric and Planetary Sciences where he headed a research consortium until 1996. He then moved into the commercial world, where he spent almost twenty years working with different companies in a variety of roles before returning to academic life with an appointment at the National University of Singapore. His return to the region made an adjunct Professorship here at CUHK into a practical proposition, and he joined the Earth System Science Programme that had been started by Professor Teng-fong Wong whom he had first met in his original MIT days. They are now reunited in the city where they both grew up. This richly mixed career structure is reflected in his publication of over 100 technical papers, two co-authored books, and 29 patents in which he is listed as an inventor.

He has a particularly noteworthy, long-standing relationship with the Society of Exploration Geophysicists, which awarded him Life Membership in 2013, and an Honorary Membership Award in 2021. This latter recognized not only his advancement of his profession, both inside and outside the Society, but also his work with, and his support for, students. It also cited his deeply appreciated volunteer work within the SEG. As those few lines have made clear, he is not only a thinker and a doer: he is also a giver whose notable generosity encompasses CUHK amongst other beneficiaries.

Mr Chairman, it is my great pleasure to present to you Professor Cheng Chuen-hon Arthur for the Honorary Fellowship. Welcome home. It's very good to have you back.

This citation is written by Professor Nick Rawlins