

Artists and Engineers¹

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1. In 1959, when I was a third-year chemical engineering student in Cambridge, I went to a public lecture given by the scientist and novelist C. P. Snow. The lecture was about what he called ‘The Two Cultures’,² those of the sciences and the humanities. In it, he argued that the British cultural establishment of the day drew a false contrast between these cultures, a contrast that undervalued the sciences and overvalued the humanities. Today, while the false contrast is still there, the cultural boot is mostly on the other foot, mainly because science is widely thought to be more useful than the humanities, which for present purposes I’ll take to include all non-science subjects and activities, including the literary, fine and performing arts.
2. The best way to see what’s wrong both with Snow’s pecking order of his two cultures and with today’s, is to take account of a third culture that Snow overlooked: that of engineering, or technology, whose job is not to find things out, as science does, but to enable us to do things: in other words, to give us know-how. For what makes the sciences useful, when they are, is the know-how they give us: medical science tells us how to cure illnesses; aeronautics tells us how to fly; and so on.
3. But there’s more to know-how than knowing the facts it depends on, as our present inability to use nuclear fusion to generate electricity shows. We’ve known all the relevant facts for decades; what we lack is the engineering know-how needed to apply them. This distinction, by the way, between know-how and knowledge of facts, is the one the philosopher Gilbert Ryle drew in the ‘Knowing How and Knowing That’ chapter of his 1949 book *The Concept of Mind*.³
4. The first point to be made about know-how is that being able to do something usually depends on more than knowing how to do it. Knowing how to ride a bike, for example, won’t enable you to ride one if you’ve no access to one, or if you’ve a broken leg.

1 Earlier versions: 9/10/12 MSC; 1/5/13 MIT; 3/5/13 Dalhousie; 28/2/14 KCL; University of Stellenbosch 16/9/15; University of Cape Town 18/9/15

2 C. P. Snow *The Two Cultures and The Scientific Revolution* (Cambridge: Cambridge University Press, 1959).

3 Gilbert Ryle, *The Concept of Mind* (London: Hutchinson, 1949), ch. 2.

Knowing how to do something is the extra ability that relevantly fit, and relevantly equipped, people need in order to be able to do it.

5. The next point to be made about know-how, so understood, is that it rarely if ever reduces to factual knowledge. You can be fit as a fiddle, and know all there is to know about how bicycles are ridden, and still be unable to ride one, because you lack the reflexes that cyclists need in order to keep their balance. Conversely, you can, and we often do, know how to do something without knowing the facts on which that know-how depends: I doubt, for example, if many cyclists know what the reflexes are that enable them to cycle.
6. But if neither of these two kinds of knowledge reduces to the other, they can still depend on each other, and they usually do. The know-how of doctors requires them to know many facts about medicines and their patients; the know-how of pilots requires them to know many facts about their aircraft; and so on. That's why so much modern technology depends on science.
7. But equally, science depends on technology, partly because knowledge of facts depends on knowing how to find them out, a kind of know-how that's rarely if ever exhausted by factual knowledge. Take optical microscopes. As anyone who's ever learned how to use them knows, it's not enough to have good eyesight, and to know what you're looking at: it still takes a lot of practice to acquire the ability to see what a microscope can show you.
8. This interdependence of know-how and factual knowledge isn't confined to the sciences. Painters, for example, not only need to know many facts, about pigments and the effects of mixing them; like microscopists, they also need a perceptual know-how that factual knowledge alone can't give them. As John Constable, the 19th century landscape painter, put it, 'the art of seeing nature is a thing almost as much to be acquired as the art of reading Egyptian hieroglyphs'.⁴
9. And as for painting and microscopy, so for our linguistic ability. Suppose you know no English, and want to learn it without being, or having ever been, exposed to it, either in real life or on stage or screen, or in illustrated books, or even in strip-cartoons, and with no way of translating it into your own language. All you have are three unillustrated

4 E. H. Gombrich, *Art and Illusion* (London: Phaidon, 1977), 14.

books in English: a grammar, a thesaurus and a dictionary: could they be enough to enable you to learn English?

10. The answer, of course, is that they couldn't. You must already know what some English words mean before these books can teach you anything. Suppose your dictionary says that water is a transparent colourless liquid. That tells you nothing if you don't already know how to recognise what in English is called a 'liquid'; and similarly for 'transparent' and 'colourless'. Our linguistic ability, without which we could state nothing about anything, including science, depends as on our already having an irreducible kind of know-how, just as our ability to paint or use a microscope does.
11. So what makes science more useful than the humanities, if it is, can't be that it's what provides all the know-how we need: it doesn't. On the contrary, we couldn't do science, or any other discursive subject, without a basic perceptual and linguistic know-how that none of those subjects gives us. Science must get whatever peculiar usefulness it has from something else.
12. And maybe it can, because, after all, to be useful is to be a means to an end, which know-how needn't be, since it can be, and often is, valued for its own sake. Constable, for example, could look at nature, not only when he wanted to paint it, but when he simply wanted to enjoy the view that his painterly know-how showed him; just as people can take exercise, not only to keep fit, but because they enjoy taking it.
13. But know-how, of course, does provide means to ends: taking exercise is a way of keeping fit; knowing how to see nature did enable Constable to paint it better; and so on. That's when know-how is useful: when it's a means to an end. And that's when science is useful: when its factual discoveries enable engineering know-how that provides means to ends. It's what, for example, makes the science of nuclear fission, unlike that of nuclear fusion, useful in peacetime: it enables the know-how we needed in order to build nuclear power stations.
14. That many sciences are useful in this sense is undeniable. But then so are the humanities. Novels and poems are written to be read, i.e. as a necessary means to that end, which is what makes writing them useful. Similarly with paintings and sculptures, which are created to be seen. Similarly again with music, dance, theatre, radio and

television: those who create works for these media, whether or not they enjoy doing it, also do it as a means to an end: namely, of having their work performed and thereby, often, of making a living.

15. So what, if anything, does makes science more useful than the humanities? The simple answer is that the engineering know-how it enables provides means to all our ends: paint, brushes, canvas, paper, iPads and cameras for paintings and photographs; musical instruments, studios and concert halls for music; theatres, cinemas, TV and video-recording equipment for drama, dance and musicals; printers, e-readers and online technology for books and journals; laboratory equipment for the experimental sciences; and computers and smartphones for everyone who wants and can afford them.
16. But this simple answer is too simple, because the distinction it relies on, between things done as means to ends, and things done ‘for their own sake’, is itself too simple. Anything we say we do ‘for its own sake’ is really also done as a means to an end: the end being the pleasure, or at least the avoidance of pain, dissatisfaction or boredom, that doing it gives us. That’s why people take exercise, meditate, sunbathe, drink, dance, make or play music, watch TV, go to theatres, cinemas or concerts, or converse or indulge in other forms of intercourse ‘for its own sake’; just as – to lower the tone – people scratch itches, take addictive drugs, confess under torture, and so on.
17. It’s also a large part of why – I hope – most of us academics work: not only to make a living, but also for the satisfaction of making, or enabling people we teach or work with to make, valuable contributions to our subjects. It’s why G. H. Hardy said, in his 1942 book *A Mathematician’s Apology*, that

The case for my life ... is this: that I have added something to knowledge, and helped others to add more; and that these somethings have a value which differs in degree only, and not in kind, from that of the creations of the great mathematicians, or of any of the other artists, great or small, who have left some kind of memorial behind them.⁵

18.

⁵ G. H. Hardy (1942), *A Mathematician's Apology*, Canto edn (Cambridge: Cambridge University Press, 1992), 150–1.

19. But this isn't enough to show that the humanities are as useful as the sciences. For even if all our actions are means to our ultimate personal ends, we can still distinguish proximal means to those ends – the ones nearest to them – from distal ones, ones that are means to the proximal ones.
20. Then the proximal means to our personal ends are the things we say we do 'for their own sake'; the distal ones are those we call 'useful' – because they're means – or means to means – to the proximal ones. And science could certainly claim to be more useful than the humanities in that derivative but perfectly legitimate sense, of providing more necessary distal means to our personal ends than the humanities do.
21. Let's grant then, for the time being, and for the sake of argument, that science is more useful than the humanities in that sense. This still doesn't show that it's more valuable, because whether usefulness is valuable depends on what its usefulness is for. Being useful for curing ill babies is valuable; being useful for torturing them isn't. In other words, the value of usefulness is instrumental: it's determined by the non-instrumental value, positive or negative, of whatever it's a means to.
22. So science gets its instrumental value from the non-instrumental value of the human ends to which the know-how it enables provides means. And while many of our human ends vary from culture to culture, and person to person, the most basic ones don't. The non-instrumental value to everyone of having enough food, water, and freedom from pain and disease, is undeniable; and so therefore is the instrumental value of the sciences that provide the know-how needed to achieve those ends.
23. But even this doesn't settle the question of whether the sciences really are more valuable than the humanities. There's more to be said, and to simplify the saying of it, I'm going to follow the philosophical practice of calling non-instrumental value 'intrinsic' even when, as we've seen, it's the value of ends that are themselves means, or means to means, to more personal ends.
24. This lets me say, for example, that the instrumental value of a printing press is fixed by the intrinsic value of what it's used to print, ignoring the fact that that value is also instrumental, being fixed in the end by how what's printed affects its readers. We can then take the instrumental value of the machinery used to make the printing press to be

fixed by the press's value, by treating that as intrinsic and ignoring its instrumental dependence on the value of what it's used to print. And so on. The instrumental-intrinsic distinction, as I'm going to draw it, is a relative one, which can be drawn at different levels as required.

25. Then the first thing I need to say about this distinction, so understood, is that it's not a dichotomy. It's true that when I buy a bottle of wine, what I value isn't the bottle but what's in it: for me, the bottle's value, as a container of the wine, is purely instrumental. Similarly for most books, which is why I'm usually as content to read them on an e-book reader as in print. But not always. Sometimes for me, and more often, I know, for others, a well-made printed book isn't just an instrumentally valuable means to the end of making its content perceptible: its construction and appearance give it an intrinsic value of its own.
26. Printed books, of course, aren't alone in having intrinsic as well as instrumental value: most, and perhaps all, means to ends do. That's why, other – instrumental – things being equal, people will pay more for elegantly-served meals, good-looking buildings, and stylish cars, computers and other consumer goods.
27. In general, then, the net value of a means is a function – which for some purposes we can model by addition – of its intrinsic and instrumental values. And as these are independent, and may be positive or negative, so the net value of a means may also be positive or negative. A positive intrinsic value can sometimes offset a consequent reduction in instrumental value, as in the case of the Sydney Opera House roof. Its intrinsic value, as a beautiful and brilliantly engineered sculpture, offsets some of its consequent instrumental defects as a seriously cramping canopy of the opera house and concert hall that it covers.
28. More often, though, offsetting goes the other way, as it does whenever we buy something. For then we're taking the benefit (the intrinsic value) of the end (what we're paying for) to outweigh the cost (the intrinsic disvalue) of the means (having to pay for it). Similarly, and rather more seriously, a war is only worth fighting if its instrumental value, in making the post-war world better than it would otherwise be, outweighs the intrinsic disvalue of the death and destruction the war will cause.

29. But net value isn't always a simple sum of intrinsic and instrumental values. Many things with positive intrinsic value also need positive instrumental value to make their net value positive. Houses must be habitable, cars safely drivable, and medicines curative, to be worth having, however intrinsically attractive they may be. Hence the value of the structural, automotive and medical know-how that gives these things their instrumental value; and hence the value of the sciences which enable that know-how.
30. So far, then, so good for the claim that science's usefulness makes it more valuable than the humanities. But not far enough, for three reasons. First, most work in the literary, fine and performing arts is valued not as a means to an end but for its own sake, and that makes its value intrinsic. For while most painters and sculptors, composers, playwrights, poets and novelists do their work at least partly to make a living, the value of their work, once done, is largely independent of that or any other instrumental value. Similarly in academia, and not only in the humanities, as cosmology, a lot of microphysics, and G. H. Hardy's apologia for his mathematics, show. And if that scientific and mathematical work can be valuable without being useful, so can work in the humanities.
31. Secondly, even when a work is useful, its net value may still depend more on its intrinsic than on its instrumental value. Not always, of course: for while the intrinsic value of the Sydney Opera House roof may outweigh some of its instrumental defects, it could hardly outweigh failing to keep the interior dry. But intrinsic value does sometimes outweigh instrumental value. Take light fittings, whose net value ranges from the purely instrumental value of concealed lighting to that of chandeliers whose beauty makes them valuable even when they have no instrumental value as light sources, because they're unlit. And if useful things can remain valuable after ceasing to be useful, their net value can't depend entirely on their usefulness.
32. Thirdly, and most importantly, a thing's instrumental value itself depends – by definition – on the intrinsic value of whatever end it's a means to. The instrumental value of buildings, cars, meals, medicines, etc., depends on the intrinsic value of what they're used for. Hospitals are more valuable than torture chambers, ambulances than get-away cars, meals for the starving than meals for the obese, medicines used to cure diseases than medicines used to feed addictions, and so on. In the end, all value that isn't intrinsic depends on value that is.

33. This means that science's usefulness will only make it more valuable than the humanities if the intrinsic value of its applications exceeds that of the humanities and their applications. Take the increased life-expectancy of people that's been enabled by scientific discoveries made in the last two hundred years. The instrumental value of those discoveries depends on the intrinsic value of that increased longevity. But for many people that value may soon become negative, as the earth becomes increasingly unable to support its growing human population, and as a growing proportion of our lives, the old age that Jaques, in Shakespeare's *As You like It*, calls the

... Last scene of all,
That ends this strange eventful history,
Is second childishness and mere oblivion,
Sans teeth, sans eyes, sans taste, sans everything.

34. Still, against this, of course, we must set the increases in human health, and the reductions in human suffering, caused in the last two centuries by the use of scientific discoveries to improve agriculture, public health and medicine. Our increased ability to achieve these undeniably valuable human ends has certainly been enabled by scientific discoveries.
35. But that these benefits, if still far from widespread enough, are as widespread as they are, is due not to science but to social developments, like the outlawing of slavery, the spread of education, democracy and the rule of law, respect for human rights, fair and honest trade, and so on. These are developments not in science but in the humanities: in ethics, economics, social, political and legal practice – and in the arts, as in novels, like Charles Dickens' *Nicholas Nickleby*, that led to the closing of many nineteenth century British schools that were all too similar to its dreadful Dotheboys Hall.
36. And when, on the other hand, the humanities go wrong, so do the applications of science: to war instead of peace; to maintaining poverty when there could be plenty, and corruption where there should be justice; to the curtailment of liberty; to increased sexual, racial and religious discrimination; and so on.
37. So if such reductions in human suffering, and increases in human well-being, as have occurred in the last two centuries, add instrumental value to the applications of science

- that caused them, they must also add instrumental value to the humane attitudes that applied science to those good ends: because each needs the other to achieve those ends.
38. In other words, sciences that have valuable social effects can only have them given the relevant humanities, just as those humanities can only have them given the relevant sciences. That's why whatever instrumental value those effects give those sciences they must also give those humanities.
39. And finally, as we've seen, not all net value requires instrumental value. If it did, many pure sciences – from G. H. Hardy's mathematics to cosmology – would be on a valueless par with most fine and performing arts and other 'useless' humanities subjects. That in turn would destroy the instrumental value not only of libraries, art galleries, theatres and concert halls, but also of institutions like CERN and its Large Hadron Collider, which are after all only valuable as a means of gaining intrinsically valuable but practically useless theoretical knowledge of the universe.
40. In short, and in conclusion, science is not made more valuable than the humanities by being more useful. The view that it is rests on two false premises: that instrumental value is independent of intrinsic value; and that it's confined to the sciences. Whether science is really more or less valuable than the humanities depends in the end on which of them (a) has, or (b) has applications that have, greater intrinsic value: i.e. on whether, for example, (a) the positive intrinsic value of Darwin's and Einstein's work exceeds that of Shakespeare's and Mozart's, or (b) the positive instrumental value of physics exceeds that of ethics. And those are questions that seems to me as silly as they are unanswerable.