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Artists and Engineers[1]

D. H. MELLOR

Abstract
I dispute a widespread contrast between the sciences and the humanities that undervalues the latter compared to the former. This contrast assumes that science is more valuable than the humanities because it is more useful, an assumption I reject on the grounds that (a) science is not more useful than the humanities and (b) the value of usefulness, being instrumental, depends on the non-instrumental value of what it's usefulness for. I conclude that science is not made more valuable than the humanities either by its instrumental or by its non-instrumental value.

1. Introduction

In 1959 the scientist and novelist C. P. Snow gave a public lecture in Cambridge on 'The Two Cultures'.[2] His two cultures were those of the humanities and the sciences, which he thought the British cultural establishment of the day falsely opposed, undervaluing science and overvaluing the humanities. Today the cultural boot is more often on the other foot, largely because science is widely but mistakenly thought to be more useful than the humanities. To correct that mistake we need to consider a culture Snow overlooked, that of engineering or technology, whose job is not to find things out, as science does, but to show us how to do things: in short, to give us know-how.

2. Knowing that and knowing how

What makes sciences useful is the know-how they give us: medical science shows us how to cure illness; aeronautics how to fly; and so on. But there is more to know-how than knowledge of the facts that

[1] Ancestors of this paper were presented and discussed at the Cambridge University Moral Sciences club on 9th October 2012, the Massachusetts Institute of Technology on 1st May 2013, Dalhousie University on 3rd May 2013, and King's College London on 28th February 2014. My revisions of them owe much to helpful comments made on those and later occasions.

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

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enable it, as our inability to build nuclear fusion power stations shows: we have known all the relevant facts for decades; what we lack is the engineering know-how needed to apply them.

This distinction between factual knowledge and know-how comes from Gilbert Ryle's 'Knowing How and Knowing That'.[3] How these kinds of knowledge are related remains a contentious question, but it will beg no present question to assume that neither reduces to the other. This is not just because it takes more than know-how to be able to do things: knowing how to ride a bike won't enable me to ride one if I've broken my leg or have no bike. That's irrelevant, because by 'know-how' we mean the *extra* abilities that enable normally fit and relevantly equipped people to do specific things, abilities that usually require more than factual knowledge. You can be fit as a fiddle, and know all about how bicycles are ridden, and still be unable to ride one, because you lack the reflexes by which cyclists keep their balance.

If there is generally more to knowing how than knowing that, the converse is also true: having a cyclist's reflexes will not tell you what those reflexes are. But even when neither kind of knowledge entails the other, they may, and usually do, depend on each other. The know-how of physicians requires them to know facts about their patients, just as that of pilots requires them to know facts about their aircraft, which is why so much technology depends on science. But equally, science depends on technology, because knowing facts depends on knowing how to find them out, a kind of know-how that is rarely if ever exhausted by factual knowledge. Take optical microscopes:[4] as anyone who has learned how to use one knows, good eyesight, and knowing all the relevant facts about what you are seeing, is not enough: it still takes practice to acquire the ability to see what a microscope can show you.

This interdependence of know-how and factual knowledge is not confined to the sciences. On the one hand, knowing how to paint depends on knowing facts about pigments and the effects of mixing them; on the other, a landscape or portrait painter's factual knowledge of what to paint depends on hard-won perceptual know-how, just as a microscopist's does. In his *Art and Illusion* Ernst Gombrich quotes John Constable, the 19th century landscape painter, as saying that 'the art of seeing nature is a thing almost as

[3] Gilbert Ryle, *The Concept of Mind* (London: Hutchinson, 1949), ch. 2.
[4] Ian Hacking, *Representing and Intervening* (Cambridge: Cambridge University Press, 1983), ch. 11.

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much to be acquired as the art of reading Egyptian hieroglyphs'.[5] Here too, factual knowledge and keen eyesight is not enough: in painting, as in microscopy, it takes practice to acquire the ability to see what your eyes can show you.

That the knowing-how/knowing-that distinction applies as much to the humanities as to the sciences is obscured by such modern definitions of 'technology' as the 2007 *Shorter Oxford English Dictionary* (*SOED*)'s 'the mechanical arts or applied sciences collectively'. But the concept was not always so limited, for as Martin Heidegger says in 'The Question Concerning Technology', the Greek word '*techne* is the name not only for the activities and skills of the craftsman but also for the arts of the mind and the fine arts', adding that *techne* was 'from earliest times until Plato linked with the word *episteme*. Both words are terms for knowing in the broadest sense',[6] the former being knowing how and the latter knowing that.

Fortunately the 2007 *SOED* also includes a sense of 'engineering' – 'the action of working artfully to bring something about' – that does fit Heidegger's *techne*. In this sense painters, composers, actors and novelists are engineers, just as builders of power stations are, as are mathematicians and practitioners of Heidegger's other 'arts of the mind': in his sense, Euclid's 'working artfully to bring … about' the proof that there is no greatest prime number was engineering too.

Suppose we now extend the sense of 'science' to match this *techne* sense of 'engineering', by applying it to any 'action [or result] of working artfully', not to bring something about, but to find something out. That gives each of our kinds of *techne* a corresponding *episteme*. It makes theorists, assessors and historians of painting, composing, acting and novel-writing, scientists, just like those whose factual knowledge informs civil, mechanical, electrical and chemical engineering. Similarly, if the makers of mathematics are its engineers, its theorists, assessors and historians are its scientists. Similarly with history: if those who make it are its engineers, those who write it are its scientists. And even when those who make it also write it, as Winston Churchill did in his history of the Second World War, those are distinct if interdependent activities.

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

[6] Martin Heidegger (1954), 'The Question Concerning Technology', trans. W. Levitt, in his *Basic Writings*, ed. D. F. Krell, revised edn (London: Routledge 1993), 318.

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3. Means and Ends

If know-how is not confined to science and engineering in their narrow modern senses (to which I now revert), it must take more than know-how to make science more useful than the humanities. And so it does, since to be useful is to be a means to an end, which know-how need not be, because it can be valued for its own sake. Constable, for example, could look at nature, not to paint it, but simply to enjoy the view his painterly know-how showed him, just as we can take exercise, not to keep fit, but because we enjoy taking it.

Yet know-how can, of course, also 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 is when know-how is useful: when it is used as a means to an end. In particular, it is when science is useful: when its factual discoveries enable, i.e. provide means to, engineering know-how that in turn provides means to other ends. The science of nuclear fission, unlike that of nuclear fusion, is useful because it enables the know-how that builds nuclear power stations.

That many sciences are useful in this sense is undeniable. But so are the humanities. Novels and poems are written to be read, i.e. as means to that end, which makes writing them not only enjoyable, when it is, but useful. Similarly with painting and sculpture, which is created to be seen. Similarly with music, dance, theatre, radio and television: those who create works for these media, whether or not they enjoy doing it, do it also as means to ends: namely of having their work presented and thereby, usually, of making a living.

What then 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; 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 scientists, and computers for everyone. Unfortunately this answer is too simple, as two objections show.

Objection 1. The distinction the answer relies on, between work done as a means to an end, and work done 'for its own sake', is spurious. For the above examples of the latter are also done as means to an end, namely that of enjoying doing them, or at least of avoiding the pain or dissatisfaction of not doing them. That is why we take exercise, meditate, sunbathe, drink, dance, play music, watch TV, go to theatres, cinemas or concerts, or converse or indulge in other forms

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of intercourse 'for their own sake'; just as – to lower the hedonic tone – people scratch itches, take addictive drugs, confess under torture, and so on. It is also a large part of why most academics work: not only for a living, or as a means to other ends, but for the satisfaction of working well, and in the hope of thereby making or enabling some worthwhile additions to their subject. Take G. H. Hardy's *A Mathematician's Apology*:

> I have never done anything 'useful'. No discovery of mine has made, or is likely to make, directly or indirectly, for good or ill, the least difference to the amenity of the world. … 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.[7]

Reply to 1. Even if all our actions are ultimately means to personal ends, we can still distinguish proximal from distal means to those ends. The former include those we say we do 'for their own sake'; the latter we call 'useful' because they are means – or means to means – to the former. It is in this perfectly legitimate if derivative sense that science is more useful than the humanities.

Objection 2. What makes science useful, when it is, is the useful know-how that its factual discoveries enable, not all of which can presuppose factual knowledge. For a start, our most basic perceptual abilities – to recognise food, mates and predators – cannot, because the senses that embody them are what give us all the factual knowledge we have. Nor, more pertinently, can the linguistic ability needed to apply, express and communicate factual knowledge be reduced to factual knowledge. Take Robert Brandom's account, in *Articulating Reasons*, of 'knowing (or believing, or saying) *that* such and such is the case in terms of knowing *how* (being able) to do something'.[8] In particular, the know-how Brandom says our use of language requires includes not only the inferential abilities he uses to define our concepts, but also the perceptual ability to apply those concepts. For, as he says,

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

[8] Robert Brandom, *Articulating Reasons: An Introduction to Inferentialism* (Cambridge, Mass.: Harvard University Press, 2000), 4.

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> part of the practical skill that forms the implicit background of knowing how against which alone a broadly inferentialist semantic theory can explain the practice of explicitly claiming that something is red … is the capacity non-inferentially to respond appropriately and differentially to red things.[9]

In short, we language users, like painters and microscopists, need a perceptual know-how that no amount of factual knowledge can give us.

Reply to 2. Objection 2 also fails to put the humanities on a utilitarian par with science. For given the linguistic know-how we all need, science may still give us more useful know-how than the humanities. As it appears to have done, for example, in the increased life-expectancy and useful technology that its discoveries have enabled in the last two centuries. That the humanities have ever been as valuably useful in these respects as science has been is far from obvious; if they have, that remains to be shown.

4. The Value of Usefulness

Since to be useful is to be a means to an end, the means we find useful depend on our ends, i.e. on what we need or want. Some of our needs and wants, such as having enough food and water to survive, and being free from pain and disease, are practically universal. But many others are not: access to contraception, for example, is more useful to some people than to others. Calling means to these less than universal ends 'useful' therefore implies an aggregation of their usefulness to members of a given or understood set of people: everyone, men, women, children, the gay, the straight, the elderly, the ill, the deaf, Europeans, Asians, Jews, Muslims, Buddhists, etc. etc. Fortunately the obvious difficulty of doing this is immaterial to the argument of section 3, that whatever makes science useful in this sense generally makes the humanities useful in the same sense too.

What *is* material to the argument is the fact that the value of usefulness depends on what it's usefulness *for*: being useful for curing ill babies is valuable; being useful for torturing them is not. In other words, the value of usefulness is instrumental: it's determined by the *non*-instrumental value, positive or negative, of the end to which it's a means. So science's instrumental value is fixed by the

[9] Op. cit. note 8, 21.

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non-instrumental value of the ends to which the know-how it enables provides means. And although no one disputes the value of the universal ends listed above – our needs and wants for food, water and freedom from pain and disease – the value of other and more variable ends is more debatable.

To simplify what follows, I shall follow the practice of calling non-instrumental value 'intrinsic' even when, as Christine Korsgaard says,[10] and as noted in objection 1 above, it is of ends that are also means, or means to means, to more personal ends. Here, however, as the reply to objection 1 shows, we may treat the non-scientific ends that make science useful as 'ends in themselves' in this relative sense. Thus, in taking the instrumental value of a printing press to be fixed by the value of what it's used to print, we may ignore the fact that this value too is instrumental, being fixed in the end by how what's printed affects its readers. Similarly, in taking the instrumental value of the machinery that made our printing press to be fixed by the press's value, we may ignore that value's instrumental nature and treat it as intrinsic. And so on.

This relational distinction between instrumental and intrinsic value doesn't make it 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 as content to read them on an e-book reader as in print. But not always. Sometimes for me, and more often for others, a well-made book is valuable in its own right, over and above its value as a means to the end of making its content perceptible.

Books are not alone in having intrinsic as well as instrumental value: most and perhaps all means 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. In general, the *net* value of a means is a function – which for simplicity we may model here by addition – of its intrinsic and instrumental values. And as these are logically independent, and may be positive or negative, so may the net value of a means. Thus a positive intrinsic value can offset a reduction in instrumental value, as that of the Sydney Opera House roof does: its intrinsic merit as a beautiful and brilliantly engineered sculpture offsets some of its instrumental defects as a cramping canopy of the opera house and concert hall it covers.

[10] Christine Korsgaard, 'Two Distinctions in Goodness', *Philosophical Review* **92** (1983), 170.

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More often, however, offsetting goes the other way, as it does whenever we buy something. For then we take the benefit (intrinsic value) of the end (what we pay for) to outweigh the cost (intrinsic disvalue) of the means (paying for it). If this fails to be engineering in the *SOED*'s '*techne*' sense, that is only because it is too easy and too routine: paying for a package holiday is hardly 'working artfully' to bring it about, even if using the internet to find the best deal is. Other less quotidian cases are more serious and clearcut: warfare, for example, is only worthwhile if its instrumental value, in making a post-war world better than it would otherwise be, outweighs the intrinsic disvalue of the death and destruction warfare entails.

More to the present point, even intrinsically valuable things may still need instrumental value to make their net value positive. Houses must be habitable, cars safely drivable, meals nutritious, medicines curative, etc. to be worth having, however intrinsically attractive they may be. Hence the value of the structural, automotive, culinary, medical (etc.) know-how that gives these things their instrumental value; and hence the value of the sciences which enable that know-how.

5. Instrumental and Intrinsic Value

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 fine and performing arts is valued not as a means to an end but for its own sake, which makes its value purely 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 generally independent of that or any other instrumental value. Similarly in academia, and not only in the humanities, as cosmology, much microphysics, and G. H. Hardy's apologia for his mathematics, show. And if that work can be valuable without being useful, so can work in the arts and humanities.

Second, 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 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 so beautiful that it survives the loss of their

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instrumental value as light sources when their candles are unlit. So if useful things can remain valuable after ceasing to be useful, their net value cannot depend entirely on their usefulness.

Thirdly, and most importantly, a thing's instrumental value itself depends by definition on the intrinsic value of the end to which it's a means. 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 is not intrinsic depends on value that is*.

So 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 examples at the end of section 3: 'the increased life-expectancy and useful technology [that science's] discoveries have enabled'. The instrumental value of those discoveries depends on the intrinsic value of their effects, which may be positive or negative. The value of greater longevity, for example, depends on whether longer lives go well, which not all do, since, for more and more of us, a growing proportion of our lengthening lives, 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 (Jaques, *As You Like It*, Act 2, Scene 7).

This, plus the earth's becoming ever less able to support its growing human population, means the net value of more people living longer may well have passed its peak.

Against this, though, we must set the vast increase in human health, and consequent reduction in human suffering, caused in the last two centuries by the use of scientific discoveries to improve agriculture, public health and medicine. Our ability to meet these undeniably valuable universal needs and wants was certainly enabled by those scientific discoveries. But that these benefits, while still far from universal, are as widespread as they are, is due not to science but to social developments, like the end of slavery, the protection of children, the spread of education, democracy and the rule of law, respect for human rights, fair and honest trade, and so on. These are products of developments not in science but in the humanities: in ethics, economics, social, political and legal theory – and in the arts, as in novels, like Charles Dickens' *Nicholas*

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Nickleby, whose public impact destroyed schools like its dreadful Dotheboys Hall. Where the humanities go wrong, so do the applications of science: to war instead of peace; to poverty instead of plenty; to the curtailment of liberty; to increased sexual, racial and religious discrimination; and so on.

So if a reduction in human suffering adds instrumental value to the medical and other sciences that cause it, it must also add instrumental value to the humane attitudes which apply the sciences to that good end: because each needs the other to achieve that end. In other words, the relevant sciences and humanities are what John Mackie called 'INUS conditions' of their valuable effects, i.e. conditions that are only necessary and sufficient for those effects given all the effects' other INUS conditions.[11] That's what makes the humanities as valuably useful as the sciences whose applications they guide.

In any case, as we have seen, not all net value requires instrumental value. If it did, many pure sciences – from Hardy's mathematics to cosmology – would be on a valueless par with most fine and performing arts and other such 'useless' humanities subjects. That in turn would destroy the instrumental value not only of galleries, theatres and concert halls, but also of institutions like CERN and its Large Hadron Collider, which are valuable only as a means of gaining intrinsically valuable but practically inapplicable theoretical knowledge of the universe.

In short, 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 is 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 intrinsic value of Darwin's and Einstein's work exceeds that of Shakespeare's and Mozart's, or (b) the instrumental value of theories of physics exceeds that of theories of ethics; questions as silly as they are unanswerable.

D. H. MELLOR (dhm11@cam.ac.uk) *is Emeritus Professor of Philosophy at the University of Cambridge. Most of his work has been on topics in metaphysics, the philosophy of science and the philosophy of mind. His recent publications include* Mind, Meaning, and Reality *(Oxford University Press, 2012).*

[11] '… an *insufficient* but *necessary* part of a condition which is itself *unnecessary* but *sufficient* for the result', J. L. Mackie, 'Causes and Conditions', in *Causation*, ed. E. Sosa and M. Tooley (Oxford: Oxford University Press 1993), 34.

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