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SPECIAL SPEECH

SCIENCE AND LAW: CONTRASTS AND COOPERATION

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It is a great honor and a great pleasure to be asked to speak here at the famous Renmin University, which is not only one of China's great universities, but one of the world's leading universities. Renmin University has many distinguished faculties and maintains collaborative relationships with many well-known universities around the world, including our King's College in London. As President of the Supreme Court of the UK, I am of course a lawyer, and have spent over forty years in the law, the first half as a practicing advocate, the second half as a judge. So, when I address you on the topic of contrasts and cooperation between science and law I am more at home when talking about the law. Nonetheless, I know a little about science.

At school and at University I studied chemistry; I even carried out research into the artificial synthesis of insulin. I was not very good at it, and in due course I turned to law, which suited me better. I have nonetheless maintained an educated if amateur interest in science throughout my career in the law. This interest has led me to think about the contrasts, similarities, and overlaps between science and law. I would like to talk to you about two aspects of this today. The first is somewhat philosophical and it concerns the differences and similarities between scientific thought and legal thought. The second is rather more practical and it concerns the relationship between science and law in practice.

So far as the thought processes are concerned, most scientific problems seem to have objectively verifiable, binary, solutions. The answer to a question involving Newton's laws of motion or the laws of thermodynamics is universal and timeless: It is the same whether you are in Beijing today or you were on the moon 2,000 years ago. So, at least for students taking exams, there is an independently verifiable right answer for the great majority of scientific problems and questions.

Legal issues are very different. A student's answers may seem right or wrong to an examiner, but law does not have the discipline of objectively verifiable answers. And unlike the laws of thermodynamics or of motion in science, legal rules are far from timeless. Fundamental legal rights which are taken for granted in England today would have seemed alien, or at the very least controversial, to an Englishman 400 years ago, let

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alone at the time of Magna Carta 800 years ago. And even today, acceptable opinions about fundamental legal rights are very different in different countries.

Having said that appropriate legal laws may vary enormously with time and place, I hope there would be acceptance that the law incorporates some fundamental and timeless principles, such as the importance of impartial justice, the need for enforceable and enforced laws and certainty in the law, and the nature of legal reasoning. And science is not quite as timeless as it appears. At the end of the 19th century, classical physics, which was thought to be incontrovertible, was virtually turned on its head by Max Planck's discoveries and Albert Einstein's equations. And this year marks the centenary of the first publication of the tectonic plate theory of continental drift. 90 years ago, a geology student who supported that hypothesis in the 1930's would have failed his exams, whereas today it is received wisdom. And, 500 years ago, in a world of alchemy, lots of people in Europe were trying to convert lead to gold involving mystery and charlatanism; 150 years ago, in the early days of the periodic table, it was thought to be nonsense; and in today's nuclear age it is an expensive reality.

If one turns to the cutting edge of science, there are many areas where there are currently no right answers. Many of you will have heard of string theory, which is seen by some scientists to have "the potential to show that all of the wondrous happenings in the universe…are reflections of one, grand physical principle, one master equation," and by others as nonsense.

If one digs a little deeper, there are some fundamental similarities between scientific and legal thinking — not surprisingly as their aims are in some ways similar and they are each the product of human intellectual endeavor. On a relatively high level of analysis, science and law are both concerned with imposing order on chaos, and identifying laws which work-in the case of science with the observable universe, and in the case of law with human beings in society. And both scientific thinking and legal thinking rely in general on logical reasoning and on the evaluation of evidence. Scientists and lawyers each search for and assess hard facts from which they can establish the truth, whether of a particular theory or in a particular case, and science and law each use principles and reasoning to enable them to reach what they hope is the right conclusion. A law student, like a science student, learns to assimilate what are seen to be the currently significant facts, theories, and hypotheses, and the currently important issues and principles, as well as how to question and reason, and how to look for and assess evidence.

Nonetheless, there are many significant differences between a professional scientist's approach to a scientific problem and a judge's approach to a legal dispute. Even though the justice system and scientific method are both designed to get to the truth, there are real differences in approach. Scientists observe the facts, form a hypothesis, and then test the hypothesis with experiments to establish whether an unknown law he hoped to prove really exists. On the other hand, a legal dispute appears to proceed on an almost reverse basis; a legal case starts with already established laws, which each party applies to a

series of facts with a view to creating a hypothesis, which then becomes that party's case, and the judge then decides which of the two cases she prefers. The validity of published scientific discoveries can be confirmed or falsified by repeating the published experiments. It is true, peer review is not always a guarantee of accuracy, but it provides a check on hypotheses: one cannot check legal hypotheses except by appeal.

So far as thought processes are concerned, scientific thinking is resolutely rational: there is, for instance, no basis for falling back on morality, let alone religion. Neither of those disciplines has any part to play in scientific thinking. By contrast, many legal principles are based on morality — for instance much of the criminal law. It is true that, in the modern age, judges in the UK do not bring their moral and religious views into play when it comes to deciding particular cases or issues, but that does not alter the fact that legal rules and laws are fundamentally underpinned by moral principles.

Another factor is the role of common sense in scientific and legal thinking. Many well-established scientific principles are positively contrary to common sense. For instance, quantum entanglement, which appears to involve information being passed from one sub-atomic particle to another faster than the speed of light, is contrary to common sense but is an established principle. It is one which even Einstein found hard to take, famously calling it "spooky action at a distance." By contrast, judges frequently rely on common sense to justify their decisions. One has to be careful, as if used too easily it can be a recipe for sloppy thinking, but undoubtedly it is important in strengthening public confidence.

By the same token, logic is absolutely fundamental to all scientific endeavors. A flaw in the logic of any step in a chain of reasoning of any scientific hypothesis will be fatal to the reliability of the hypothesis and to any conclusion it would otherwise appear to justify. By contrast, while logic undoubtedly plays a very important part in legal thinking, the precise extent of its role is uncertain. Indeed, a cynic might say that judges generally invoke logic to support a conclusion, but when they dislike the conclusion which appears to be compelled by logic, they fall back on common sense or human experience.

The ambiguous relationship between law and logic is reflected by comparing what was said by a great 17th century English Judge, Sir Edward Coke, "Reason is the life of the law," with what was said by a great 19th century US Judge, Oliver Wendell Holmes, "The life of the law has not been logic; it has been experience." Both are right: logic and experience have a part to play, and the common law is not strictly logic.

Nonetheless, as I have said, logic does play a vital part in legal, as well as scientific, thinking. But a countervailing feature, which inevitably raises its head in both scientific and legal thinking, is human nature. However much we try and allow for our own prejudices, it is almost inevitable that that insidious and uncontrollable mental feature, unconscious bias, will be hard at work. When a judge has to decide, as the Supreme Court did fairly recently, whether the absolute ban on assisting suicide contravenes human rights, we all did our best to ensure that we discounted our own religious, social, or moral

views on the topic. Most of us found that quite difficult when coming to our conclusions.

Because scientists are human, scientific thought can suffer from similar problems, particularly when it runs into personal self-interest or wider policy issues. I referred earlier to string theory: if you have spent twenty years of your life devoted to string theory, you are going to find it hard to be dispassionate when it comes to the issue of whether or not it is soundly based.

Another feature which scientific and legal thought processes share is the reasoning process. Karl Popper, the 20th century historian of ideas, thought it more likely that a scientist has a bright idea and then tries to rationalize backwards to justify it — and then tries to see whether it works, normally by falsification. In truth, I suspect that the processes of scientific discovery and invention involve a mixture of thought processes — reasoning backwards as well as forwards. Judicial reasoning involves the same exercise. Once she grasps the facts of a case, a judge often has an instinct for the right answer, and then tries to work out logically whether it is the right answer, and if so why. Of course, like a scientist, a judge may often have a change of mind as to the right answer or may decide that what she thought was the right answer cannot be justified as a matter of law. The similarity of thought process in science and law is scarcely surprising, given that they are both fields involving human mental effort in seeking to get to the truth.

The fact that there are no right answers is nonetheless more likely to be true in law than it is in science, but scientists have an enormous advantage over judges. When faced with a problem, a scientist can respectably say, "It's impossible to give an answer"; indeed, it may be the only intellectually respectable answer from the scientific perspective. And a scientist can say, "I need more information before I can reach a conclusion; I will investigate. A judge has to give an answer at the end of a case, and cannot play it safe in this way (although a judge can say that a case is 'not proved' to the requisite standard of proof)."

Science and law not only have the human condition in common; there are many areas where they share an interface. The most obvious area for a UK judge is that of patents. Patents are justified by two principles. First, it is in the public interest to reward research which results in technological advances, as that encourages such research. But it is in the public interest that an inventor discloses his invention to the public: otherwise the invention may be lost to the world or become subject to monopolies. Accordingly, a patent gives the inventor a monopoly of the invention for a fixed period from the date when she formally discloses her invention by making an application for a patent; and at the end of that period, anyone can freely use the invention. If the inventor does not publish her invention by applying for a patent, another inventor may beat her to it, and get the temporary monopoly.

Many patent applications are made every year and patent law in China has developed very fast over the past thirty years. In Europe, over 270,000 were issued in the European Patent Office in 2014 alone. Most patents turn out to have little if any value, but a few are

valuable, and a very few immensely so. It is therefore inevitable that there are arguments about the validity of patents and also as to whether an article infringes a patent — *i.e.* arguments as to whether the monopoly should exist and, if it should, how broad its scope should be. These points can give rise to various issues, including: What does the patent actually claim as the invention? Is the claimed invention novel? Is the claimed invention obvious? Does the patent actually enable one to make the claimed invention? Does the allegedly infringing article actually infringe the patent?

In the UK, all these questions have to be decided by a judge in cases which involve full argument by lawyers, and often quite a lot of evidence. In most such cases, there are issues of science or technology, which a court in our common law system cannot decide without expert evidence. So, the judge will normally hear from expert witnesses, who may give expert evidence on such issues of meaning, novelty, obviousness, enablement, and infringement. This can mean that cases try a long time, and cost a lot of money, if they go to a trial.

Of course, patents are by no means the only area of legal dispute where scientific evidence is called for. On the civil side, sophisticated evidence on engineering, technical, and IT issues is frequently given to judges. And, almost by definition, expert evidence across the scientific and technological range may be needed in professional negligence cases, most commonly in medical negligence cases. Expert scientific evidence is also given at criminal and family law trials. DNA profiling evidence is an obvious example in family cases but also in criminal cases, and it has had a similarly revolutionary effect to fingerprint evidence a century earlier.

The problem with these cases involving expert evidence is that the parties will frequently call equally irreproachably experienced and expert witnesses, who, with equally impressive credentials and confidence, will say precisely the opposite to each other. At trial, the Judge has to decide which of those experts is reliable and which is not.

In some cases this is unsurprising. Many of the scientific issues on which an expert has to give a view are matters of opinion or judgment rather than involving any sort of hard-edged or quantitative assessment. For instance, whether an invention was obvious over what was already known, or whether the relevantly skilled person reading the patent would have sufficient knowledge to understand how to make the invention from reading the patent, are legal-type issues on which, at least in many cases, reasonable scientists could differ. And in a case in which the stakes are high enough, the parties may well each trawl through the scientists in the relevant field until they find one who subscribes to the view which suits their case. The judge will often have little idea which of the two scientific opinions is typical of what scientists in the relevant field think. And, because the question at issue is frequently a matter of individual judgement, the evidence on the issue is often incapable of being weighed in any logically meaningful way; accordingly, human nature being what it is, there is a risk that the judge may decide the issue by reference to who is the more impressive witness, rather than whose evidence is more

impressive.

Some of these problems can be dealt with, to an extent, by enacting strict rules enforcing the independence of expert witnesses, and then enforcing those rules. Steps have been taken in that connection in the English courts over the past sixteen years, in the form of strengthening the rules, and of judges making strong statements about the need for impartiality on the part of expert witnesses. Another partially successful solution involves the experts being ordered to meet with a view to agreeing as much as they can, and at least narrowing the issues. However, as both scientists and lawyers, of all people, should recognize, human nature, and in particular the curse of unconscious bias, cannot be legislated or educated out of existence. We can legislate and educate to ensure that expert witnesses are made as aware as possible of the nature of their duty, and hope that a culture will develop which minimizes the existence of bias.

I can see considerable attraction in the notion of the experts giving their evidence on a somewhat more informal basis, at a hearing which is more like a meeting chaired by the judge. Court rules in England now permit such concurrent evidence to be taken by a judge.

Judges often have to decide cases involving highly technical or scientific issues. In cases involving technical or scientific issues, the parties sometimes produce a primer (or introductory guide) for the judge, which gives her a good explanation of the basic scientific principles and state of knowledge, which is agreed by both parties. In the first big recombinant DNA technology patent case, Kirin-Amgen, which I tried, I would have been in serious difficulties without the benefit of a very clear and helpful primer which had been prepared by the parties. There is no reason why that practice needs to be limited to patent cases. Courts also sometimes sit with an independent expert to advise them on the science during the hearing, but, albeit that my experience is limited, I have found that rather an uncomfortable exercise, as the expert has to be very careful about what he can say. A better alternative may be to have one or two seminars with an independent expert before the hearing, as happened when the Kirin-Amgen case went to the Supreme Court. Primers and seminars can clearly go a long way in enabling judges to understand the technicalities they need to appreciate in order to try a particular case.

The Sally Clark conviction showed up in sharp focus the failings of a system where an expert trespasses into an area (statistics) outside his competence (paediatrics), and the judge, the lawyers, and other expert witnesses fail to identify his error. It has to be said that the error was not particularly sophisticated. A mother was accused of killing one of her babies in 1996 and another in 1998, and her lawyers argued that they had each died from sudden infant death syndrome (SIDS). The evidence suggested the probability of a baby dying of SIDS was 1 in 8,543, and, in his evidence, the renowned Professor Meadow said that, as two babies were involved, "[y]ou have to multiply 1 in 8,543 times 1 in 8,543 and…it's approximately a chance of 1 in 73 million." That went unchallenged by the defence lawyers and the Judge. You do not have to be an expert statistician to

realize that this evidence could only be "valid if each of the deaths is truly independent of the other, that is without, at the very least, the shared genetic and environmental circumstances of the children being members of the same family," as it was put in the Court of Appeal.

This case is one of a number which support the notion that judges, and indeed lawyers, could usefully be instructed in the science appropriate for the particular case more often than they are — at least in the UK. Particularly with the increased specialization we are seeing almost everywhere, cross-fertilization between, and even within, cultures or professions seems to me to be inherently beneficial for members of the cultures and professions individually and for those cultures and professions, indeed for society, as a whole.

Once one starts to think of scientific topics which would be valuable for lawyers and judges to know more about, the list seems to be at risk of almost never ending. The use of DNA and other methods of detection and identification and the use and abuse of statistics are, as I have already implied, two possible topics. Neuroscience is another field, where developments may in due course provide real assistance on important legal issues such as the memory process, the age of legal responsibility, mental capacity, the connection between criminality and brain disease, the risk of re-offending, the extent of pain and suffering actually undergone, and the cause of head injuries.

As studies on the brain develop, no doubt we will start to learn about the way we react to events, to people and to ideas, and how we make decisions. So neuroscience will assist a judge not merely with assessing information and evidence which is coming into her brain through her eyes and ears, but also, and rather unsettlingly I suspect, with an insight as to how she processes that information and evidence once it is in her brain. Her conscious and unconscious biases and assumptions will be factors which she will have to know about and no doubt which she should allow for.

However, what is (currently at least) a rather different area of science may conceivably be starting to outflank the human element in judging and advising on legal issues altogether. I have in mind artificial intelligence. We all know that IT is developing techniques to deal with the more humdrum side of law, such as disclosure of documents. But, no doubt thanks to the effect of Moore's Law, computer programs are being developed which can outplay the human world chess champion and the human world Go champion. The take-over of legal work by IT is very interesting to read and think about and it presents very important medium and long-term strategic issues for the legal profession. However, for the moment at least, I think that there is little point in judges making plans for the possibility of being replaced by AI. We should be concentrating on learning how to be as good at our judicial roles as we can, and that includes making best use of IT and in due course no doubt of AI.

Science thus has a great deal to teach the law, but I like to think that law has something to teach science. One area is dealing with scientific fraud and assessing the

reliability of experimental results. Most judges and lawyers are well versed in dealing with dishonesty and its close relation self-deceit. And we are also well-practiced in assessing the value and effectiveness of evidence, which might be helpful to scientists.

More broadly, law and lawyers can and should help to provide the framework within which science and scientists operate. The rule of law is absolutely fundamental to a civilized society, and particularly in the light of the far-reaching and fast-changing developments which are occurring in so many areas of scientific endeavor, it is essential that scientists know the identity of the legal rules and the location of the legal boundaries appropriate to their work. And it is equally essential that lawyers are kept up to date with scientific developments, because the law needs to keep pace with technological developments and in some cases needs to police them. To give just a few topical examples, the relationship between surveillance techniques and data protection and the right to privacy; in some contexts including the UK, the implications of fracking on property rights; taking a more moral issue, the patentability of inventions produced by stem cell research; and then the interrelationship of search engines and copyright. Finally, and very importantly, there is the environment where the relationship between law and science is key.

So science and law are like two strands of DNA — different, but inextricably linked. They are necessary to each other, and far more productive together than they ever would hope to be separately.