What Ought We to Know About Science and Technology? Or: Philosophy of Science and Science Studies as Science Literacy

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Abstract. Although the concept of scientific literacy was developed in the nineteen fifties as a goal for science education, it was put on the agenda again in the nineteen nineties. The proponents of scientific literacy argued that the most important problem today is that the level of knowledge of science and technology is far too low in the population at large, and among school children and students in particular. Although some of the alarming reports may be questioned, it is widely accepted that the situation is disturbing. If the general public lacks the knowledge needed to have reasonably well-founded opinions about important scientific and technological issues, it will be a problem for democracy. The paper will argue that promoting scientific literacy is an important aim of philosophy of science. However, philosophers of science should not be just public relations agents for the sciences. On the contrary, it is imperative that they take a critical look at modern science. It will further be argued that a historical perspective is important in pursuing this goal, and that philosophy of science can learn some important lessons from science studies.

1. Introduction: scientific literacy

The term "scientific literacy" was introduced in the 1950s, and is regarded as a timeless goal for science education. One description of scientific literacy was given by the American Association for the Advancement of Science in the document *Science for All Americans*. In this document a scientifically literate person is described as one who is aware that science and technology are human enterprises with strengths and limitations, un-

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derstand key concepts and principles of science, is familiar with the natural world and recognizes both its diversity and unity, and applies scientific knowledge and skills for individual and social purposes (AAAS, 1990).

Scientific literacy was again put on the public agenda in the 1990s, partly related to the conflict that has come to be known as "the Science Wars". It started when the biologist Paul R. Gross and the mathematician Norman Levitt published the book: *Higher Superstition. The Academic Left and Its Quarrels with Science* (1994). The book was a fierce attack on certain quarters within the history of science, philosophy of science and sociology of science, such as existentialism, phenomenology, postmodernism, feminism, multiculturalism and so on. The next year, 1995, the book was followed up with a conference in New York given by the New York Academy of Sciences titled *The Flight from Science and Reason.* The conflict gained momentum when the physicist Alan Sokal published the article "Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity" (1996) in a journal for cultural studies, *Social Text.* Soon after the article was published, Sokal revealed that the entire thing had been a hoax. He had intentionally written an article that contained a lot of nonsense, however it was written using fashionably correct terminology with references to a range of "postmodern" thinkers. The hoax gained worldwide publicity, and many of the participants in the debate have claimed that this debate shows that C. P. Snow's "two cultures" still exist.

The proceedings of the conference *The Flight from Science and Reason* were published in an anthology with the same title as the conference. In his introduction Paul R. Gross sums up the main concerns of the organizers:

> We believe that there is today in the West, among professors and others who are paid, in principle, to think and teach, a new and most systemic flight from science and reason. It is given endless and contradictory justifications; but its imperialism — for example under the banner of "science studies" — and the high esteem in which it holds the trendiest irrationalisms, are undeniable. This has brought with it, from that unexpected academic quarter, a truculent defense in the name of "democracy" of New Age and traditional forms of sophistry and charlatanism. Younger programs of anti-logic and anti-science are both diffuse (oppositional

> movements being by their nature fractious) and angrier than the siege, already a few decades old, of “objectivity” in the social sciences and humanities (Gross, Levitt, Lewis 1997, p. 2).

This concern was not without foundation, and it is still a cause for concern. Sometimes we receive alarming reports on the low level of scientific literacy in the population at large. “Anti-science” and “alternative science” movements, like creationism, astrology and healing, to take a few examples, are so widespread that they cannot be neglected. Some of the most alarming reports are probably exaggerated, but according to a conservative assessment of the situation there is no doubt that the knowledge of and interest in science and technology do not increase at the same rate as the significance of science and technology in society.

This must be a cause for concern for the authorities, and therefore, “scientific and technological literacy” (STL) and “public understanding of science and technology” (PUST) have been put at the top of the political agenda. In USA president Bill Clinton made it one of the main political issues in his second term in office.[1] Although there is sometimes a considerable discrepancy between word and action, all politicians in industrialized countries (and most other countries as well) maintain that scientific and technological literacy has the highest priority. However, the motivations may be different. Most people can agree that scientific and technological literacy in the population is a prerequisite for keeping up productivity and as a guarantee for a democratic development. If the population by and large lacks the knowledge required for making well-founded decisions on important issues related to science and technology, it will undermine the democratic control of the development.

Some of the advocates of scientific and technological literacy go further, though. They maintain that all public scepticism and resistance against controversial science and technology, like nuclear power and genetically modified food, is based on superstition and ignorance. Therefore, more information and better knowledge will change the negative public opinion. *The Flight from Science and Reason* is one example. The articles follow up the introduction quoted previously with attacks on disciplines that are perceived as representing irrational tendencies in academic life, such as existentialism, phenomenology, feminist epistemology and deep-ecology. The authors probe deeply and also find targets to attack deep

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[1] Needless to say, the priorities of his successor have been different.

within the established sciences. That Ilya Prigogine would be criticized might be expected, but Werner Heisenberg and Niels Bohr also come under criticism. It is difficult to avoid having the impression that the proponents maintain a rigid and orthodox notion of science, where everything that does not fit into a narrow framework is considered to be "anti-science" and "irrational".

2. Ronald Giere on scientific literacy

If we look at the American Association for the Advancement of Science's description of scientific literacy, the interesting thing is that it does not concentrate so much on scientific facts, but rather emphasizes higher levels of cognition, such as critical thinking.

When scientific literacy is taken in this sense, no doubt philosophers of science have promoted scientific literacy. Obvious examples are the logical positivists and Karl Popper. An important goal for their activity was the dissemination of the scientific attitude to all areas of society.

At least one introductory textbook in philosophy of science has the explicit aim of promoting scientific literacy. The book is Ronald Giere, *Understanding Scientific Reasoning*. This is a widely used introductory text at the undergraduate level. The book is supposed to give the basics of scientific reasoning:

> The primary answer to the question, "why study scientific reasoning?" is that it will help you to be better able to understand and evaluate scientific information in both your personal life and your work (Giere 1991, p. 4).

It will not enable the reader to do science in the laboratory, but to evaluate scientific information in a more critical way:

> For the purposes of this text, then, learning to understand scientific reasoning is a matter of learning how to understand and evaluate reports of scientific findings of the type one would find in a popular magazine, a national newspaper, or a news magazine. This requires only a very general idea of what goes on in laboratories. And it does not require the skills that are necessary to do laboratory research (ibid., p. 5).

The book consists of three parts, dealing with models, statistics and theory of decisions respectively.

The virtue of the book is that it is closer to real science than many other introductory textbooks in the philosophy of science. For example, it deals with randomized, prospective and retrospective trials, and the notion of cause as used in epidemiology. The reader is supposed to learn what it means that, say, smoking causes cancer. It uses examples from real-life science, and has many good examples. There are no theoretical discussions, though.

I said that the explicit aim of the book is to promote scientific literacy. And one aspect of the book places it firmly in this tradition: sources of error, ignorance and irrationality are all placed outside science. The two last editions of the book have a chapter with the title “Marginal science”. In this chapter psychoanalysis, astrology, clairvoyance, von Däniken and New Age phenomena are dealt with. There is nothing wrong with this. But it is a striking fact that the book does not address the problem of errors within science, or the abuse of science. If the aim of the book is to promote scientific literacy, this is a serious omission. It is a much more serious possibility that the students who read the book will one day be in the position to abuse science than that they will be the victims of, say, astrology.

It is interesting to notice that in the description given by the American Association of the Advancement of Science quoted previously, it is emphasized that the scientifically literate person is aware that science and technology are human enterprises with strengths and limitations. Learning about the limitations of science is as much a part of scientific literacy as is learning about the strengths of science. Two books which might serve this purpose are Stephen Jay Gould’s *The Mismeasure of Man* and Kristin Shrader-Frechette’s *Risk and Rationality.*

3. A different approach to scientific literacy

A quite different book, which also has the explicit aim of promoting scientific literacy, is Harry Collins and Trevor Pinch: *The Golem: what everyone should know about science*:

> The point is that, for citizens who want to take part in the democratic process of a technological society, all the science they need to know about is controversial ... (Collins and Pinch 1993, p. 3).

Therefore, the main task of the book is to remove science from its “Platonic heaven”. The main strategy is to show that scientific results are the product of disagreement, uncertainty, compromise, power struggle and decisions. In other words: it is a social construction. The problem of traditional history of science (and here they follow Kuhn) is that this is mostly left out, leaving the false impression that scientific “truths” prevail with the inevitable force of logical necessity.

In the book seven historical cases are examined. One is the theories of relativity. Another is cold fusion. After having dealt with the cases the authors draw the following conclusion:

> ... we have shown that scientists at the research front cannot settle their disagreements through better experimentation, more knowledge, more advanced theories, or clearer thinking. It is ridiculous to expect the general public to do better.
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> We agree with the public understanders that the citizen needs to be informed enough to vote on technical issues, but the information needed is not about the content of science; it is about the relationship of experts to politicians, to the media, and to the rest of us (Collins and Pinch 1993, p. 145).

However, Collins and Pinch go further:

> We have no reason to think that relativity is anything but the truth — and a very beautiful, delightful and astonishing truth it is — but it is a truth which came into being as a result of decisions. [...] ... it was a truth brought about by agreement to agree about new things. It was not a truth forced on us by the inexorable logic of a set of crucial experiments (ibid., p. 54).

I have already mentioned that two of the cases in the book are the theories of relativity (the special as well as the general) and cold fusion: one success story and one failure. However, according to the book it looks as if the only difference between the success of the theory of relativity and cold fusion was that the first was accepted whereas the second was rejected by the scientific community.

Collins and Pinch need not go that far, though. The important thing is to show that the results of science are not inevitable, they might have been different. I think that Ian Hacking is right when he gives the following characterization of social constructivists. Social constructivists about X tend to hold that:

(1) X need not have existed, or need not be at all as it is. X, or X as it is at present, is not determined by the nature of things; it is not inevitable.

Very often they go further, and urge that

(2) X is quite bad as it is.
(3) We would be much better off if X were done away with, or at least radically transformed (Hacking 1999, p. 6).

For X we substitute “science” (or “science and technology”).

4. The importance of idealization

Collins and Pinch have later modified their position. However, I shall use their original position to show why I cannot follow them all the way, and I shall start with an example from their book.

The example is an exercise to teach elementary school pupils to measure the boiling point of water. The pupils are told to put their thermometers into a beaker of water and read the temperature when the water boils. Hardly any of the pupils obtain the result 100 ℃ if they do not already know the answer. In the example used in the book the results are like this: Skip gets 102 ℃, Tania gets 105 ℃, Johnny gets 99,5 ℃, Mary gets 100,2 ℃, Zonker gets 54 ℃, whereas Brian does not obtain any result. Smudger boils his beaker dry, and bursts his thermometer. Ten minutes before the end of the lesson the teacher gathers all the pupils and starts the “social engineering” process: Skip held his thermometer in a bubble of superheated steam when he made his reading, Tania had impurities in her water, Johnny did not wait until the water boiled, Mary’s result demonstrates the effect of slightly higher air pressure, and Zonker, Brian and Smudger have not yet acquired the required competence. After this lesson all the pupils are convinced that they have demonstrated that the boiling point of water is 100 ℃, or they would have demonstrated it if there had not been a few local problems. According to Collins and Pinch this simple exercise demonstrates the essence of science:

> In the end, however, it is the scientific community (the head teacher?) who brings order to this chaos, transmuting the clumsy antics of the collective Golem Science into a neat and tidy scientific myth. There is nothing wrong with this; the only sin is not knowing that it is always thus (Collins and Pinch 1993, p. 151).

However, if we look closer at the example, it is worth noticing that something is missing: In each case a specific explanation is given for why the pupil did not obtain the exact value 100 °C. For example, it is said that Skip got 102 °C because he put the thermometer in a bubble of superheated vapor. But the crucial question is: Are these explanations correct? Would all the pupils have obtained 100 °C if they had carried out their measurements correctly under ideal conditions, or is this something that their teacher tries to make them believe? We know that the answer to that question is yes, that the pupils would indeed have obtained the result 100 °C.

The lesson of this example is not that science is a social construction, but that the result can only be obtained under special, idealized conditions. To understand an important aspect of modern science we have to understand the importance of idealization. In fact, we learned this from Alexandre Koyré, who pointed to what he called the Platonism of modern science. In his *Galileo Studies* he draws a line from Pythagoras and Plato, via Archimedes and to Galileo. We might extend this line to Einstein and Hawking.

The basic problem which Platonism tries to solve, is the question if and how certain knowledge can be obtained. The Platonist answer is: through mathematics. Plato's theory of knowledge was inspired by geometry as the paradigm of knowledge, and according to Galileo "the book of nature" is written in the language of mathematics. However, there is an important difference between Plato on the one side and Galileo and modern science on the other. Whereas Plato's reality was immaterial, Galileo's reality was material. Galileo called objective reality "primary sense qualities". The essential property of matter is that it can be described mathematically.

Galileo recognized that a mathematical description requires measurements, and that measurements require controlled laboratory experiments.

The aim of the controlled laboratory experiment is to keep all or most factors constant. Only one or a few factors are varied at a time. These ideal conditions increase *certainty.* According to the traditional view, controlled experiments are merely simplification and purification of natural situations. We have to leave out some factors to make the problems manageable. Afterwards we "add back" the factors that were left out, and in this way we come closer to natural situations.

However, we do not only remove complicating factors. We *impose* artificial conditions on the object as well, because the ideal conditions are normally not realized in everyday life. Therefore, "adding back" may not be an easy task. There is an alternative, though. We may realize the ideal conditions through technology. From this point of view technology is a way of reducing uncertainty. It is interesting to note that Galileo was aware of the intimate relationship between the ideal conditions required to carry out experiments, and technology. In *Dialogue Concerning Two New Sciences* he pointed out that his own results had been proved in the abstract, and when applied to concrete cases they would yield false results. The horizontal motion would not be uniform, a freely falling body would not move according to the law, and the path of a projectile would not be a parabola. However, speaking of the difficulties arising by these limitations, he immediately adds:

> . . . in order to handle this matter in a scientific way, it is necessary to cut loose from these difficulties; and having discovered and demonstrated the theorems, in the case of no resistance, to use them and apply them with such limitations as experience will teach. And the advantage of this method will not be small; for the material and shape of the projectile may be chosen, as dense and round as possible, so that it will encounter the least resistance in the medium (Galileo 1638/1954, p. 251).

To put it simply: technology to a large extent realizes the ideal conditions of the laboratory at a larger scale. We can see how this works in biotechnology by looking at the so-called "green revolution" of the 1960s as an example. It involved the development and introduction of new plant species that gave larger yields per acre than did the traditional species. This first happened with wheat in Mexico, and later with wheat and rice in Asia. The new "high-yielding varieties" could make better use of fertilizer with far higher concentrations than traditional varieties, and they had noticeably faster maturation rates. One crucial factor was that the plants receive the correct amount of watering at the correct time. They were also less resistant against a number of diseases and parasites. To summarize: if the new variants were to give higher yields, a "*technological package*", in the form of the correct amounts of fertilizer, water, pesticides and plant protection products was needed. If these things are not in place, the process can go wrong. The desired effects can in other words only be achieved if one also has control over the environment. What was needed to carry out the "green revolution", was to realize *controlled laboratory conditions in agriculture.*[2]

5. Recognizing uncertainty

Although we can control parts of nature in this way, the inescapable problem is, however, that there will always be something outside the system we control. A factory is a typical example of a controlled system. However, the control is normally far from perfect. First, the production process itself is full of risks, for example the risk of explosions and chemical hazards. Second, there is the area around the factory. Traditionally this was heavily polluted. Although regulations have reduced local pollution, the problem is often moved to other places. In particular, heavily polluting production is often moved from the rich countries to third world countries, where regulations are absent or less strict. Third, we have the uses of the products and the disposal of the worn-out products, and so on. Therefore, when an area is subject to technical control, there is always a large area which escapes control.

In what follows I shall use the term "natural conditions" in contrast to the simplified and idealized conditions of the laboratory and the factory. However, the word "natural" does not imply that the conditions are prior to human intervention.

Then we return to the problem of "adding back" from the simplified and idealized conditions of the laboratory to natural conditions. This

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[2] Cf. the following quotation from Ian Hacking: "In fact, few things that work in the laboratory work very well in a thoroughly unmodified world — in a world which has not been bent toward the laboratory" (Hacking 1992, p. 59). Hacking refers to Latour 1987.

problem has been recognized by ecologists. Therefore, laboratory experiments have limited value in ecology because the artificial conditions sometimes prevent important natural effects from appearing and may magnify incidental and trivial effects. To quote an ecologist:

> Laboratory studies are effective in isolating a response to a factor but the response may not be ecologically relevant and the number of potential factors that could be investigated is so large that the study of any isolated factors may be futile (Peters 1991, p. 138).

If laboratory experiments fail, field experiments might do the job. They are something between a laboratory experiment and the natural system. Because they are closer to the natural systems, they are popular in ecology. However, it looks as if we get nothing for free. There is a trade-off between control of the conditions on the one hand and relevance to natural situations on the other: The better the field experiments, the less relevant they are.

The problem of uncertainty may also be formulated in the language of risk assessment. We must (at least) distinguish between two different situations: uncertainty and ignorance. When we have uncertainty, it means that we know what can go wrong. (When we also know the probabilities, we are talking about risk.) However, there are often situations where we have no idea of what can go wrong. These situations are characterized by *ignorance*. In risk assessment it is desirable to reduce uncertainty to risk, because it enables the application of the mathematical methods of risk analysis (probability theory, statistics and the like). This requires simplification and idealization, either in the form of experiments as described earlier or by applying mathematical models. However, we have a similar problem as in the case of ecology: the reduction of uncertainty may increase ignorance (Wynne 1992, p. 114).

Mathematically speaking the problem is nonlinearity. The mathematical sciences have since the time of Galileo largely concentrated on linear or approximately linear systems. One reason is that the analytical tools of mathematics can be used. However, when the interactions between the parts of a system or the factors determining a process are nonlinear, the situation is changed. This was first observed in chaos. Chaos is characterized by *sensitive dependence on initial conditions* (the “Butterfly effect”): small uncertainties in the determination of the initial conditions of a system may increase exponentially until they are the same magnitude as the parameters of the system. In that case “adding back” does not work, and predictions are limited.

However, organic nature is in general not chaotic, but complex. Complexity and chaos are not the same. It is sometimes said that complexity arises at “the edge of chaos”. But they do have nonlinearity in common, rendering impossible both “adding back” and exact predictions.

Is uncertainty genuinely new in science? The answer is simply “no”. From the very beginning of philosophy and science there were alternative schools of thought that emphasized uncertainty. The contemporaries of Plato, the Sophists, and even Plato’s own teacher, Socrates, stressed both uncertainty and ignorance. Therefore, we can draw an alternative line, from Socrates, via the Renaissance Humanism of Erasmus and Montaigne, to the present situation (cf. Toulmin 1990).

In a certain sense the two aspects, certainty and uncertainty, are combined in the theories of probability and statistics. Furthermore, the recognition of uncertainty is the very foundation of one of the most basic and influential theories of contemporary science, quantum mechanics.

However, what is genuinely new today is the recognition that uncertainty cannot be tamed or ignored. Previously, unintended side-effects of industrial production that were outside our control could to a large extent be ignored. However, the global character of some environmental problems has shown that there is no “outside”: the biosphere is finite. Therefore, scientists and technologists have in many ways come into a new situation. The Chernobyl accident is a dramatic example, however problems such as a possible global warming, a possible reduction of the ozone layer, and so on are all of the same type. These encompass totally different problems than scientists and technologists are traditionally trained to deal with (Funtowicz and Ravetz 1991, p. 85).

6. Some consequences for scientific literacy

Recognizing the importance of idealization in science, the complexity of nature and the irreducibility of uncertainty has consequences for scientific literacy. I shall restrict myself to dealing with one problem, the uses of idealized models.

Experts trained in a field have a tendency to apply the kinds of models that conform with their field. The following example has been taken from

Brian Wynne's "Uncertainty and Environmental Learning": In May of 1986 a cloud of radioactive material from the Chernobyl accident passed over Cumbria in North Wales. Heavy rains caused a large amount of radioactive cesium to fall over an area used to raise sheep. The authorities in charge assured everyone that there was no cause for concern, but in spite of this, six weeks after the rains a ban against selling meat from sheep that had grazed in the area was imposed because of the high levels of radioactivity found in the meat. Experts claimed however that the radioactivity would rapidly decrease, and that the ban would be lifted in a few weeks. Yet, even after six years the level of radioactivity was so high in some of the affected areas that restrictions had to be upheld.

How could the experts be so wrong? Their predictions were based on extrapolations from the behavior of cesium in alkaline clay soil to the acid peat soil of Cumbria. Measurements showed that the dispersion of cesium in these types of soil was fairly similar, and on that basis they assumed that cesium would sink so far down into the ground that after a short period of time there would be no problem. This was based on the assumption that the radiation would come from the cesium in the soil and would be absorbed by people or animals who happened to be in the area. Under this assumption it was the physical transport of cesium in the soil that was important. However, this assumption was wrong. The sheep got cesium in their bodies through the grass they ate. The important question was therefore not how the cesium was dispersed throughout the soil but if it was absorbed into the vegetation. Here there proved to be a significant difference between alkaline clay soil and acid peat. In alkaline clay soil cesium adsorbs onto aluminum silicate molecules so that it does not get absorbed into the vegetation, whereas in peat it remains chemically mobile and can therefore be taken up into the vegetation. The experts did not consider these possibilities, and that was the cause of their mistaken predictions (Wynne 1992, p. 121).

Should not a model that took into consideration for example chemical properties, have been used at the onset? The answer is, of course, yes. But to understand why the experts made such an apparently elementary error we have to take into consideration that they had been trained as physicists. Physicists are used to think in terms of physical transportation and radiation. Chemists are trained to think in terms of chemical reactions and chemical mobility. The problem is that it is not a part of professional training to learn about the limits of the models and methods of a field. This is the neglected part of scientific literacy.

In particular, situations involving complex systems are new to most researchers. In the mathematical sciences one is trained to deal with idealized situations and use simple models. The physicist Per Bak tells a story to demonstrate how inadequate this way of thinking may be:

> The obsession among physicists to construct simplified models is well illustrated by the story about the theoretical physicist asked to help a farmer raise cows that would produce more milk. For a long time, nobody heard from him, but eventually he emerged from hiding, in a very excited state. "I now have figured it all out," he says, and proceeds to the blackboard with a piece of chalk and draws a circle. "Consider a spherical cow . . ." Here, unfortunately, it appears that universality does not apply. We have to deal with the real cow (Bak 1997, p. 45).

"Extended peer communities" implies an extension of the traditional scientific community to include non-experts as well. However, this does not mean that non-experts should invade the research laboratories and carry out research. It does mean, though, that non-experts should take part in discussions of priorities, evaluation of results and policy debates.

The arguments in favor of extended peer communities are similar to Paul Feyerabend's arguments for a democratization of science.[3] I regard it as a continuation of an important element in the Socratic tradition. We know that it was part of Socrates' strategy to pretend that he was more ignorant than he actually was. By asking apparently naive questions to an expert one may reveal tacit assumptions which the expert himself is not aware of. Many scientists are sceptical of public debates about controversial scientific and technological questions, like nuclear power and genetically modified food, and allege that public opinion is often based on prejudices and lack of information. No doubt this is sometimes the case. But there are at least two reasons for not keeping these kinds of questions away from the public. First, non-experts may be wrong because they are prejudiced or lack the required information. But experts may also be wrong. Some of their errors may be corrected by bringing in non-experts. To put it simply: The public may be wrong because it is too far away from

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[3] Cf. "Laymen can and must supervise Science" (Feyerabend 1978, p. 96).

the technical problems, whereas experts may be wrong because they are too close. The "tunnel" vision of experts is at least as great a problem as the ignorance of non-experts. The second reason is that common people are affected by the decisions which are made. The questions of global warming, the ozone layer, radioactive waste and genetically modified food concerns everybody, experts as well as non-experts. These questions are too important to be left only to the experts.

It can be argued that these consequences do not influence science and "the scientific method", but only science policy. In a certain sense this is true, but it depends on what is meant by "the scientific method". What is affected, is not science per se, but a dominating ideal of what science should be, emphasizing measurements, mathematics, idealized models, laboratory experiments, exact predictions and reductionism. When it is recognized that this scientific ideal is too narrow even for the mathematical (or "exact") sciences, the toxicologist or ecologist should have few reservations against doing the same.

However, one might take one step further and argue that the root of uncertainty is complexity. Therefore, to come to terms with the new situation, a new science of complexity is required. An increasing number of authors argue in this way (for a small selection, see Nicolis and Prigogine 1989, Bak 1997 and Auyang 1998). This is an important question, but it goes beyond the scope of this paper.

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