What does Bachelard mean by *rationalisme appliqué*?

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While Bachelard's *Rationalisme appliqué* can readily be translated as *Applied Rationalism*, neither the French nor the English are very revealing of the position being advocated. In particular one would be led very far astray if one were to think of rationalism as a philosophical position which suggests that knowledge can be logically deduced from first principles that are either immediate and self-evident, or reached by analysis, and then to think that Bachelard is talking about how to apply such rationally grounded theoretical knowledge. This is not at all the perspective from which he approaches scientific knowledge.

First, as the beginning of the translated passage indicates, Bachelard is concerned with the *processes by which scientific knowledge is acquired*. His position is a form of rationalism in the sense that reason has a dominant role here; scientific knowledge is both rationally organized and rationally grounded in experience, and both of these features emerge from the way in which it is acquired. It is not first proposed as theory and then tested empirically (as a Popperian would suggest); the role Bachelard assigns to reason is one of empirical engagement. Applied rationalism is thus an account of empirically (materially) engaged reasoning, not of theoretical reasoning subsequently applied. His position can be hard to grasp because it represents a quite radical departure from philosophical norms, particularly those that analytic philosophy inherited from the logical positivists. He transgresses divisions that others have taken as absolute givens, such as that between abstract and concrete when he talks of the concrete universal.

He is already talking about what Latour would later call the world of hybrids, the material world informed by modern science and technology. This is both the world of industrial mass production and its products and the world of the scientific laboratory where the study of phenomena is heavily mediated by instruments. As Bachelard says, modern science has passed from the phenomenology of nature studies to the phenomeno-technique of the laboratory.[1]

Second, Bachelard equates reason, reasoning or deduction not with logic but with the development and deployment of mathematics in organizing both thought and experimental practices. It goes without saying that he rejects logicist and formalist views of mathematics. So in a sense he is talking about science as applied mathematics. In this respect he is as guilty as other philosophers of science in taking physics as his paradigm science (although unlike others of his period he does go on to look at chemistry). At the beginning of *Rationalisme appliqué* he says:

> Physics thus has two philosophical poles. It is a veritable *field of thought* which is expressed mathematically and experimentally and which is at its most lively in the conjunction of mathematics with experiment. Prominent in physics is a synthesis which determines an *abstract-concrete* mentality. (*RA* 1)

Bachelard is seeking to characterize this unitary 'mentality' in its double action of abstraction and concretization. We find more evidence that this marks a fairly radical departure from other philosophies of science, when he says:

> The time for an epistemology which considers mathematics as simply a means of expressing physical laws are over. The mathematics of physics are more 'engaged' … There can be no empty rationality, and no disconnected empiricism. (*RA* 3)

Later on he says:

> People have been too quick to say that mathematics is simply a language which records, in its way, the facts of observation. This language is, more than any other, inseparable from thought. One cannot *speak* mathematics without *understanding* mathematically. (*RA* 180)

He goes on to note that

> The necessary dialogue is so tightly knit that one can hardly recognize here the old dualism of the philosophers. It is no longer a question of confronting a solitary mind with an indifferent universe. It is necessary henceforth to place oneself at the centre where the knowing mind is determined by the precise object of its knowledge and where, in exchange, it determines its experience [or experiments] with greater precision. It is precisely in this *central* position that the dialectic between reason and technique finds it efficacy. We will try to put ourselves in this central position where an *applied rationalism* is as much manifest as is *an instructed materialism*. *(RA* 4)

Here Bachelard signals that there are in fact two chasms established as a result of philosophy in the Cartesian tradition whose erasure he insists has been essential to the project of modern science. One is between abstract thought (the realm of ideas and hence of knowledge) and concrete objects (the world of empirical reality, the object of scientific knowledge), the other is between the individual as knowing subject (the self) and others (other minds). Unlike other philosophers (whether analytic or continental) Bachelard does not try to ground the objectivity of scientific knowledge in a removal of the role of the knowing subject. He self-consciously swims against the anti-psychologistic tide by insisting that any epistemology must include the role of the knower and her/his thought processes. Instead he works to ground the normativity, objectivity and security of scientific knowledge in the essentially social and materially engaged processes of its acquisition. Reason here is not something innate in an individual subject; it is a social, cultural product of the practices through which we simultaneously order and regulate our world and our understanding of it. He writes:

> We thus have as our task to show that rationalism is in no way linked with imperialism of the subject, that it cannot be formed in an isolated consciousness. We have also to prove that *the materialism of technique* is in no way a philosophical realism. Technological materialism corresponds essentially to a transformed reality, a reality rectified, a reality which precisely has received the human mark par excellence, the mark of rationalization. (*RA* 8)

Here Bachelard wants to emphasize the mark of *reason* inherent in technical materialism and the mark of *concrete reality* inherent in applied rationalism. These are really two sides of the same coin. As such, he wants to insist that his position can also escape the charge of pyschologism; it is neither psychologism of the individual subject nor the anti-psychologism of its erasure, but alive to the dialectical process by which the individual is socialized as a member of a group with a common culture. Knowledge, scientific knowledge in particular, is a cultural not an individual product. But it is also, according to Bachelard, always a second culture, a culture that defines itself in its distinction from the biases, interests and errors of 'common sense' everyday culture. Here again, far from saying with Popperians that science is common sense writ large, Bachelard insists that the scientific attitude requires a constant critical review of assumptions that may have been made uncritically as a matter of habit conditioned by past socialization. Such a review is integral to the process of rationalization, of enumerating and putting in order, consciousness of which is, he insists, part and parcel of genuine scientific understanding, an understanding which is quite distinct from knowledge of a disparate bundle of facts.

It is perhaps easy to see what Bachelard is driving at if one takes one of his own examples: that of measurement. Without some measurement practices scientific knowledge of either the natural or the social world cannot get off the ground. No individual can establish a system of measurement that has a function beyond her own purposes; to be of use in commerce, in architecture, map-making, navigation, and so on, it has to be communicated to others, and others have to be persuaded that it is a good system – that it is accurate and robust enough for the intended purposes. Measurement practices then need to be agreed and established by convention, including standards and ways of checking that procedures are being followed correctly. Once established one cannot depart from agreed practices without risk of penalty (whether practical – things don't fit or don't work – or legal – being sued for selling short weight, and so on). Uniform standards of measurement bring order to our lives, and the more widely uniform the wider the power and control that go with practices dependent on them. One

can think here of arguments about currencies as an example: uniformity has one kind of benefit but also has some downsides in terms of lack of independence and autonomy for countries with their own individual currencies. The use of uniform and uniformly agreed units of measurement and standards behind those units is an essential part of the (rational) infrastructure of modern science. The definitions of these units are not, however, immune from critical review, and the history of measurement shows that repeated changes in standards and units have been required, by the demands of new science and engineering, to meet ever more strict levels of accuracy and precision. This is a rather basic but important example of the way in which practices that bring rational order to the material and mental world are at the same time cultural ('corrational') not individual and have both abstract and concrete lives. The double character of scientific thought, on which Bachelard repeatedly insists, is that it is a requirement of scientific understanding that one have a critical consciousness of the measurement practices one uses, such that one can, should the need arise, put some of the assumptions behind aspects of those practices in question and be able to argue the case for a change. That critical consciousness will be informed by knowledge of the history of a measurement practice and of the reasons why current standards are as they are, as well as of the problems that were overcome as successive refinements (rectifications) were made.

In light of the example of currencies one can perhaps begin to understand why Bachelard talks of rationalism not in the singular, as would most philosophers, but in the plural. He talks of regional rationalisms, just as one might have regional currencies. At least some of the practices and techniques used to bring (rational) order to a particular domain of scientific study are likely to be specific to the object of the investigation (the object of knowledge). This is particularly true of the instrumentation used to conduct experiments and make and record measurements. This disunity of science, and the communication challenges it presents, have become more apparent since Bachelard wrote, as scientific research has become increasingly specialized and academically compartmentalized. It is noteworthy that at a time when others were writing about the unity of science and of *the* scientific method, Bachelard was talking about the plurality of regional rationalisms.

In *RA* he gives the examples of electrical rationalism and mechanical rationalism. Each of these he treats at some length and in detail that it is not possible to convey here. But it is worth just remarking that electricity provides a particularly striking example of the technical basis of the phenomena studied. Experiments to study electricity and electrical phenomena have to be rationally organized and planned in the light of theory realized in apparatuses since there are few natural occurrences of electrical phenomena (lightning, static electricity, but not an apparently continuous electrical current). Moreover, the ability to manipulate electrical and electronic phenomena has quite literally changed, and continues to change, the world in which we live.

The case of mechanics, a science with a long history and a very early mathematization, is rather different. In his chapter on this Bachelard seeks to illustrate the continued utility of the framework of rational mechanics, and to separate this from any philosophical (metaphysical) endorsement of mechanism. He is particularly dismissive of philosophers who try to reject science by rejecting mechanism. He says 'Mechanism is a philosophy that misunderstands the profound and specific interests of scientific research' (*RA* 175). Towards the end of the chapter he discusses wave mechanics in order to show that its organizing 'rationality' has the same algebraic structure as that of the 'rationality' of electricity – the algebra associated with wave equations and Fourier analysis. This commonality invites further questions about the possible future relationship between the domains.

Throughout this work Bachelard is trying to find a language to convey his conviction, based in his experience as a science teacher, that mathematics is integral to the thought processes of scientists. This is not just a language of convenience; to think about a subject matter in mathematical terms is to think in such a way that the thought processes are carried by mathematical procedures which are already not merely mathematical but have physical embodiment. At its core it is something that is hard to convey because it needs to be experienced, which is why he is so insistent that the knowing subject cannot be removed from an epistemology dealing with the acquisition of scientific knowledge. The formalism does not speak for itself and cannot run on automatic. In this at least Bachelard sides with Descartes rather than Leibniz. It would be really fascinating to know what Bachelard would have to say, were he alive now, about the rise in the use of computer modelling in the sciences.

Note

1. For more on this theme, see Mary Tiles, 'Technology, Science and Inexact Knowledge: Bachelard's Non-Cartesian Epistemology', in Gary Gutting, ed., *Continental Philosophy of Science*, Blackwell, Oxford, 2005, pp. 157–75; Mary Tiles, 'Is Historical Epistemology Part of the Modernist Settlement?', *Erkenntnis*, vol. 75, no. 3, 2011, pp. 525–43.