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Historical-Critical Dictionary of Marxism

Experiment

A: tağruba. – F: expérience/test. – G: Experiment. – R: eksperiment. – S: experimento. – C: shiyan 实验.

Gramsci wrote that 'the rise of the experimental method separates two historical worlds, two epochs, and initiates [...] the process of development of modern thought whose consummation is in the philosophy of praxis' (*Q*11, §34).

Read in the context of the history of Marxist thought, this is a highly idiosyncratic remark. **Marx** himself had very little to say, directly anyway, on the theme of experiment. This may well be because, though he had a lively interest in the natural sciences, his main work was in the critique of political economy, and he considered that in 'the analysis of economic forms [...] neither microscopes nor chemical reagents are of use' (*MECW* 35, 8; cf. **Brockmeier** & **Rohbeck** 1981). **Engels** studied the natural sciences much more intensively and systematically, as well as epistemological and other questions connected with them, and though the theme of experiment occurs explicitly here and there, a linkage with **Gramsci**'s claims is not immediately apparent. As to later historically significant writers who have located themselves in the tradition founded by **Marx**, the only engagement in any detail with **Engels**'s thinking on experiment is **Lukács**'s criticism in *History and Class Consciousness* (1971, 132) that it shows no real understanding of genuine 'praxis'. An indication of the continued neglect of the theme is that 'experiment' does not rate an entry in either the *Dictionnaire critique du marxisme* or *A Dictionary of Marxist Thought*.

Looking more broadly at the subject of experiment, it seems surprising that, though experiment in fact began assuming an increasingly central role in the sciences from the fifteenth century onwards (cf., e.g., **Crombie** 1994), and was celebrated by Francis **Bacon** among a few others at the time, it received very little recognition in the philosophical mainstream until **Kant**, who wrote in the Preface to the *Critique of Pure Reason* (1787) that with the experiments of **Galileo** and others 'a light broke upon all students of nature' (B xiii). However, this proclamation was not followed up during the nineteenth century, when, with the notable exception of Claude **Bernard** (1865), interest was focussed mainly (e.g., in J.S. **Mill**) on its role in the logic of inductive inference (cf. **Lalande** 1929). During the earlier part of the twentieth century, experiment was attended to here and there (e.g., **Mach** 1917, **Duhem** 1914), but only **Dewey** (1929) – and to a lesser extent **Dingler** (1928) – ascribed exceptional significance to it. After this, the theme virtually disappeared for over fifty years. (Exceptions include **Lewin** 1927; **Fleck** 1980 [1935]; **Holzkamp** 1963, 1968). Thus Ian **Hacking** could truly write in 1983 that 'philosophers of science ... say almost nothing about experiment ...' (149). However, the book from which these words are cited became just the first major contribution to an increasing body of 'mainstream' literature on experiment, much of it of very high quality (cf. e.g., **Batens** & **Bendegem** (eds.) 1988; **Crease** 1993; **Franklin** 1986, 1990; **Fraunberger** & **Teichmann** (eds.) 1984; **Galison** 1987; **Gooding** 1990; **Gooding** *et al.* (eds.) 1989; **Krieger** 1992; **Legrand** (ed.) 1990; **Radder** 1988; **Rheinberger** 1992; **Tetens** 1987).

So it is especially timely to make a start at recovering the main line of the thought of **Marx** and **Engels** on the theme of experiment. This entry attempts to do this in the overall

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form of a spelling-out of the implications of **Gramsci**'s claims. The emphasis here falls on the 'classical physical experiment'. Other types of experiment are only noted in passing (the thought-experiment and ones which investigate artefacts of the experiment itself). These remain to be investigated by Marxist epistemology, as well as, *inter alia*, a very diverse group of types of 'experiment', essentially linked to modern computing devices, which include ones involving number theory and manipulations of simulations of complex systems.

1. *The 'Classical Physical Experiment'.* **Marx** wrote in *Capital*: 'The physicist either observes natural processes where they occur in their most typical form and most free from disturbing influence, or, wherever possible, he makes experiments under conditions that assure the pure occurrence of the process' (*MECW* 35, 8; translation modified). This characterisation may be analysed with the aid of a conceptual apparatus developed by **Aristotle** (whom **Marx** calls 'the great researcher' and whose 'genius' he celebrates in *Capital*; *MECW* 35, 70), namely, his schema of what in Latin translation became familiar as the four *causae* of anything that is produced: (1) the 'material' cause [*causa materialis*]: what it is made from; (2) the 'formal' cause [*causa formalis*]: its nature; (3) the 'efficient' cause [*causa efficiens*]: what brings it about; and (4) the 'final' cause [*causa finalis*]: the end, purpose, goal for the sake of which it was brought about (*Metaph* V, 2).

1.1 The 'material cause' here is 'natural process'. This distinguishes the sort of experiment that is being characterised from, for example, what has been called 'Gedankenexperimente', and also leaves it open that outside the natural sciences other sorts of experiment may be appropriate (cf. 4.2 below).

1.2 The 'formal cause' is determined in the first place by observation of natural processes that 'occur in their most typical form and most free from disturbing influence', observation of 'the pure occurrence of the process'. Conditions of this sort are necessary because, as **Marx** wrote elsewhere: 'The concrete is concrete because it is a synthesis of many determinations, thus a unity of the diverse' (*MECW* 28, 38), so that knowledge of the concrete must begin with knowledge of the 'pure' – that is, isolated – determinations of which it is the unity. Similarly, **Engels** writes: 'The first thing that strikes us in considering matter in motion is the inter-connection of the individual motions of separate bodies, their being determined by one another' (*MECW* 25, 510). But this means that, in general, inquiry into a particular subject-matter is interfered with by phenomena which are, at best, irrelevant to that inquiry. For instance, 'Sadi Carnot [. . .] studied the steam-engine, analysed it, and found that in it the process which mattered does not appear in *pure* form but is concealed by all sorts of subsidiary processes' (*MECW* 25, 509). Where such (relatively) isolated, 'closed' systems are not naturally available, the conditions which 'assure' them, and thus the possibility of observing them, must be artificially produced, that is, the naturally given situation must be altered in certain ways. In the passage quoted above, **Marx** seems to identify experiment with the production of such systems.

However, this characterisation needs to be supplemented in a very important way. For, once such a closed system – that is, one whose *boundary* conditions are optimally *constant* – has been produced, it may and indeed typically is further altered in order to observe the effect on one element of the system of changing another element. The *initial* conditions *within* the system, that is, are deliberately *varied*.

All this contributes to constituting what is called here the 'classical' physical experiment, in distinction, *inter alia*, from those experiments which have become increasingly important, especially in fundamental physics, where the objects studied within the given boundary conditions are artefacts of the experiment itself rather than isolates from what exists already (cf., e.g., **Bachelard** 1949).

In general, if experiment functions in the first place in the process of *analysis*, this having been completed (for the moment), the process of explanatory *synthesis* can begin in earnest, a process which itself typically involves experimentation concerning the modes of combination of what has been

already analysed. It is in this way that we may read **Engels**'s remark that in experimentation there is a 'unification' of 'analysis' and 'synthesis' (*MECW* 25, 505).

1.3 It follows from (1.2) that the 'efficient cause' centrally involves material instrumentation, for natural processes can only be altered by other parts of nature. Furthermore, instrumentation in turn involves an agent who uses it.

1.4 The 'final cause' of experiment is, in one sense, already given in the specification of (1.2), namely, the production of certain sorts of natural systems. But in another sense a request for the 'final cause' may be taken as a request for a specification of the 'point' of producing such systems. In the most general terms this may be said to be its contribution to the general aim of inquiry, namely, the seeking of answers to questions, solutions to problems. But is there any more specific response to the request?

At least until recently, the almost unanimous modern answer to this question has been that the fundamental role of experiment is to *test theories*. In this 'hypothetico-deductive' conception of scientific inquiry, experiment is basically conceived as, to adapt **von Clausewitz**'s famous aphorism about war, the continuation of theory by other means.

Now, experiment certainly does play this role, but it is not its only or even always principal one. For example, experiments have an 'exploratory' role, insofar as they play a part in the project of *description* rather than of explanation, that is, the project of answering questions about what exists and what is true of what exists, and what the facts are concerning that which exists. More specifically, this question may bear on (i) what *objects* exist, (ii) what *properties* (constant or variable) exist, and (iii) what the *relations* are between (i) and (ii) and between items within (ii), particularly regarding the forms and limits of co-variation of properties. In this context experiment is not without theoretical assumptions, but it may be independent of theory in the sense that its role is not to test already-proposed theories. Of course, experimental results may suggest the need for changes in existing theories or the formation of new ones. Indeed, experiments may help to *generate* such developments. (For examples of the interplay between theory and experiment, cf. **Beller** 1988, **Arabatzis** 1992.)

To say simply that the role of experiment is, in the first instance anyway, to produce appropriately isolated systems for the purpose of testing given theories is to *presuppose* that the investigator knows what the 'pure' form of that which is to be studied is, and what the 'disturbing' conditions are. However, one of the main tasks of inquiry in which experiment is a principal factor is precisely to *determine* wherein this distinction consists. Once this distinction has been determined, experiment becomes, in this regard anyway, less a means of genuine investigation than one of demonstrating what is already known.

2. *The Epochal Significance of the Experimental Method*. **Gramsci**'s first claim in the passage cited at the beginning of this entry was that the experimental method marks a dividing line between two epochs.

2.1 Of course, this does not mean that there was no experimentation before early modern times. In Greek antiquity there were experiments in physics (mainly mechanics) as well as medicine (see, e.g., **Lloyd** 1991; von **Staden** 1975; **Wilkie** 1984; **Zoubov** 1959), and in mediaeval times especially in optics (cf., e.g., **Crombie** 1994, I, 313 et sq.). However, the problematic character of experiment during this pre-modern period is reflected in the very language used. In classical Latin both *experientia* and *experimentum* (from the verb *experiri*) meant 'experience' (in the sense of ordinary observation – Greek *empeiria*) and also 'proof', 'test', 'trial', possibly involving contrived manipulation of the world (cf. the French *expérience*) in both a natural-scientific and legal context. Men of experience were *experti* who might obtain their *experimenta* by magical procedures. Again, *probare*/*probatio* had a range of meanings, from 'test' through 'examine' and 'judge' to 'approve', with a connection to *probus*, 'good', 'upright', 'honourable'. In mediaeval literature *experientia* and *experimentum* (whence *experimentalis*, *experimentatio*, *experimentator*) were also linked to the world of natural magic.

Indeed, there were positive constraints on pre-modern experiment. Philosophical ones are laid out in the works of **Aristotle**. These were of two main sorts. (1) On the ontological plane, **Aristotle** held (e.g., *Metaph* 1025b, 20–26) that physical science [*he phusikè episteme*] deals with what has the principle [*he arché*] of its motion and rest within itself, and therefore, since every intellectual activity [*diánoia*] is either practical or productive [*poietiké*] or speculative [*theoretiké*], it must be the latter, since both the first and second have to do with what has the said principle outside itself (on the place of *tékhne* in classical thought, cf. **Isnardi Parente** 1966). Thus science has nothing to do with interference with the objects of inquiry. (2) On the epistemological plane, inquiry into nature has as its subject-matter '*to phainómenon aeì kúrios kàta tèn aísthesin*' (*De Caelo* 306a15–17; cf. *APr.* 46a17–22), that is, the world just as it is presented to us under normal conditions, free of our interference with it.

2.2 The width and depth of the divide which separates the modern epoch from what preceded it is measured by the fact that modern researchers reject both of these principles. As regards (1), the distinction between internal (natural) and external (artificial) sources of motion was dropped. As regards (2), the immediate deliverances of the senses were regarded as being as likely as not misleading; **Galileo** praised those who had done violence [*fatto forza*] to their senses in the cause of reason (VII, 355) – in particular by means of experiment – in order to arrive at the truth. Thus, if for **Aristotle** interference with the object of knowledge is at best irrelevant and at worst an obstacle to the acquisition of scientific knowledge, for the moderns it is always a permissible and often an indispensable means to it.

2.3 The new approach was expressed in a new conception, that of 'maker's knowledge' (cf. **Pérez-Ramos** 1988): the idea that we can understand something to the extent that we can make it. This is rooted in the first instance in the technique of 'hypothetical modelling', which, though it had ancient precursors (e.g., imitation of the celestial motions by means of the armillary sphere and the celestial globes), became a central method from the mid-thirteenth century onwards; insights into the processes of nature offered by their conformity with the demonstrated capacities of human artefacts increased towards the end of the sixteenth century. The method consisted in using the known properties of an artefact (known because it was designed by an artificer) in order to simulate and hence explore and explain the unknown properties of natural phenomena.

The main early types of models used were of two kinds. The first was the *scale* model exemplified by **Theoderic of Freiberg**'s experimental analysis of the formation of the colours of the rainbow by means of a spherical crystal or flask of water constituting an enlarged raindrop and William **Gilbert**'s exploration of terrestrial magnetism by means of a spherical lodestone [*terrella*]. The second was the *analogue* model exemplified by **Kepler**'s use of the 'camera obscura' in relation to the operation of the eye, and **Harvey**'s use of a pumping system in relation to that of the heart and blood.

Both of these sorts of models are real models. But there also grew up, in effect, the idea of *abstract* models (cf. **Galileo**, VIII, 197ff.). Here the starting-point is certain theoretical (in particular, mathematical) principles. These are then interpreted in terms of various abstract objects which are models of them insofar as they are defined or constituted by the principles in question (e.g., the equation of a simple linear oscillator has many such models, a very simple one being a frictionless simple pendulum, moving *in vacuo*). The experimental method is then used to produce, in the real, *as far as possible*, the pure/ideal cases constructed in theory, so that concept and theory on the one hand, and experiment on the other are bound into an indissoluble unity. To the extent that this 'fit' between a real system and an abstract model can be obtained, then, since the latter is understood through the equations which define it, the former is also understood. (On idealisation in relation to experimental testing, cf. **Laymon** 1985.)

This working with 'pure cases'/'idealisations' is a specially central feature of **Marx**'s methodology in political economy (cf. **Nowak** 1980). In political economy, **Marx** writes, 'the force of

abstraction' must replace microscopes and chemical reagents (*MECW* 35, 8). If, on **Marx**'s view, experiment is inapplicable here, the adequacy of 'fit' between the model and the real object of inquiry is judged by the degree of correspondence between the former and information about the latter generated independently, though, of course, in language homogeneous with that in which the former is specified.

The role of abstract models in the physical sciences is pointed out by **Engels** in a passage concerning the work of **Carnot** on thermodynamics. **Carnot** 'did away with these subsidiary circumstances that have no bearing on the essential process, and constructed an ideal steam-engine (or gas engine), which it is true is as little capable of being realised as, for instance, a geometrical line or surface, but in its way performs the same service as these mathematical abstractions: it presents the process in a pure, independent, and unadulterated form' (*MECW* 25, 509).

2.4 The current just described, rooted in the tradition of craftsmen and practical mathematicians, must be clearly distinguished from the tradition originating in **Plato**'s idea of nature as having been divinely created in the likeness of certain immaterial, eternal Ideas, according to the model of the way in which the craftsman produces something in accordance with a pre-existing plan (e.g., *R*x,596B; *Ti* 29A–B). In its Christian version (e.g. **Augustine**, *De Trin*. xv, 13, 22; **Aquinas**, *S.T*. i, 14.8.3), only God could fully know the natural world because he alone designed and made it.

Such is the background to **Vico**'s principle 'verum et factum reciprocantur seu … convertuntur' (*De Antiquissima Italorum Sapientia* … [1710], i.1.1). The latter is often confused with the doctrine of **Hobbes** which he puts in one place thus: 'scientia … est cognitio a causis, sive a generatione subjecti per rectam ratiocinationem derivata' (*De Homine* [1658], X, 4; cf. also *De Corpore* [1655], I and X). But **Vico** rejected experiment, except in medicine and alchemy (see his autobiography), and though **Hobbes** never came completely to terms with the full import of the experimental method (**Shapin** & **Schaffer** 1985), the view of *scientia* occurs within the context of a thoroughly materialist system (the same is true of Spinoza; cf. **Daudin** 1949, **Yakira** 1988).

3. *The Experimental Method and the Origins of Marxism.* **Gramsci**'s second claim was that the rise of the experimental method marks the beginning of the intellectual development which culminated in Marxism.

If the connection is not explicit in **Marx**'s writings, nevertheless there is a profound inner continuity between the experimental method's unique break with the 'spectator' view of knowledge involved in 'anschauende Materialismus' and the practice-based conception, initiated by Marx in the *Theses on Feuerbach*. This continuity is much more visible in **Engels**'s later writings, though the passages in question have to be read with considerable care.

3.1 **Engels** affirms that the demonstrable power of human beings to bring about certain states of affairs in nature is the *origin* of the idea of causality. 'Not only do we find that a particular motion is followed by another', but also that 'we can evoke a particular motion by setting up the conditions in which it takes place in nature, that we can even produce motions which do not occur at all in nature […], at least not in this way, and that we can give these motions a predetermined direction and extent. In this way, by the activity of human beings, the idea of causality becomes established, the idea that one motion is the cause of another' (*MECW* 25, 510).

3.2 Furthermore, this human power to influence the course of nature is the *criterion* of the existence of causal relations. 'True, the regular sequence of certain natural phenomena can by itself give rise to the idea of causality […] but this affords no proof, and to that extent Hume's scepticism was correct in saying that a regular post hoc can never establish a propter hoc. But the activity of human beings forms the test of causality'. If 'the proof of necessity lies in human activity, in experiment, in work: if I am able to *make* the *post hoc*, it becomes identical with the *propter hoc*' (*MECW* 25, 510).

3.2.1 **Engels** then replies to an objection to (3.2): 'Here the sceptic cannot even say that

because of previous experience it does not follow that it will be the same next time. For, as a matter of fact, it does sometimes happen that it is not the same [....] But it is precisely this which proves causality instead of refuting it, because we can find out the cause of each such deviation from the rule by appropriate investigation[.]' (*MECW* 25, 510). This fits smoothly into the tradition of modern experimental science. Thus **Galileo** proceeds by first looking for a fundamental cause (preferably expressed in a quantitative relation), removing small accidental variations by abstraction or by purpose-designed experiments and then investigating the accidents themselves (VIII, 128–30, 136–41, 205–8, 276–8, 293–309). As **Diderot** wrote: 'Toute expérience qui n'étend pas la loi à quelque cas nouveau, ou qui *ne la restreinte pas par quelque exception*, ne signifie rien' (*De l'interprétation de la nature*, §xliv; emphasis added).

3.3 This leads to a more general position. This is that the human power to bring about intended changes in the course of the world is the basis of the decisive refuation of those philosophers, like **Hume** and **Kant**, 'who dispute the possibility of any cognition, or at least of an exhaustive cognition, of the world, [... in] practice, namely, experiment and industry', that is, if 'we are able to prove the correctness of our conception of a natural phenomenon by bringing it about ourselves, producing it out of its conditions and making it serve our own purposes into the bargain, then the ungraspable Kantian "thing-in-itself" is finished' (*MECW* 26, 367). Thus, 'experiment and industry' provides a test of both the *adequacy* of putative knowledge and of its *exhaustiveness*.

Lukács for one has argued (1971, 132) that at this point **Engels** completely misunderstands **Kant**'s epistemology, insofar as, for the latter, experiments take place *within* the domain of phenomena, and so are irrelevant to the question of the existence of the 'Ding an sich', which is in principle *beyond* them. However, **Lukács** misunderstands **Engels**'s fundamental *philosophical strategy* here. For **Engels**, to be a materialist is simply to comprehend 'the real world – nature and history – just as it presents itself to everyone who approaches it free from preconceived idealist quirks. It was decided mercilessly to sacrifice every idealist quirk which could not be brought into harmony with the facts conceived in their own, and not in a fantastic, interconnection' (*MECW* 26, 383). So the thrust of **Engels**'s argument may be put precisely by *reversing* **Lukács**'s objection: insofar as experiment does not bear on the supposition of the 'Ding an sich', so too the latter does not bear on experiment, and therefore counts merely as an 'idealististic quirk'. In other words, **Engels** does not *argue* with **Kant** *on the latter's own ground*, but rather simply *bypasses* him.

4. *Contributions of Marxism to the Study of Experiment.* However, whilst Marxism stands indebted to the rise of the experimental method it can also contribute to understanding it better, both systematically and historically.

4.1 This occurs in the first place by theorising it in terms of the concept of the 'theoretical mode of production'. Experiment is situated, in the first place, in the 'theoretical labour-process' and can then be shown to be more and more concretely 'overdetermined' in successive stages of analysis. Thus Marxism offers a unified framework through which many individually valuable though collectively fragmentary studies of experiment may be brought together (cf. the materials on the economics and 'sociology' of experiment in **James** (ed.) 1989; **Galison** 1987, Chapters 5–6; **Gooding** *et al.* 1989, Part IV, on the 'rhetoric' of experiment in the contribution by **Cantor** to **Gooding** *et al.* (eds.) 1989, as well as other literature listed in **Zuckermann** 1988). The beginnings of an example of the use of such a framework can be reconstructed from elements already present in the classical writings of Marxism.

Earlier, the backwardness of experiment in antiquity was connected with the Aristotelian idea of the primacy of what is self-regulating (free) over what is regulated, constrained from outside itself. This is, most centrally, a cosmological generalisation of the relation of domination and oppression specific to a slaveholding society, the basic structure of the latter 'writ large'. In turn, these relations of production are associated with the ideology of the

inferior nature of manual-productive labour in comparison with mental activity. Finally, such a mode of production offered little stimulus to the development of the means of production, and, in particular, to the instruments of production, and a corresponding paucity of observational material.

By the same token, such a framework permits an explanation of why the experimental method developed when it did. For all the above changed with the development of the capitalist mode of production. As **Engels** wrote: 'If [...] the sciences suddenly arose anew with undreamt-of force, developing at a miraculous rate, once again we owe this miracle to production. In the first place, following the crusades, industry developed enormously and brought to light a quantity of new mechanical [...], chemical [...] and physical [...] facts, and this not only gave enormous material for observation, but also itself provided quite other means for experimenting than previously existed, and allowed the construction of new instruments; it can be said that really systematic experimental science now became possible for the first time' (*MECW* 25, 466; cf. **Van Helden** 1984; **Warner** 1990; **Weigl** 1990). Not only was there this increase, both extensive and intensive, of the 'means of production' of scientific work – 'raw materials' (facts) and instruments – but there was a new evaluation of the labour of the craftsman. Furthermore, the primacy of the free subject as a cosmological model was replaced by that of the machine (particularly the clock) and the teleological ideal of natural order associated with the former was replaced by the idea of order as a resultant of mechanical forces.

4.2 Because of the centrality to Marxist epistemology of the rejection of epistemic 'closures', it is particularly well-placed to make effective criticism of recurrent attempts to characterise an essence of experiment on the basis of how experiment is conducted in a necessarily limited historical-theoretical context, and to decontextualise experimental methods, ignoring the specificity of such methods to particular sorts of subject-matter (cf., on the first point, the remarks on **Maxwell**'s account of experiment in **Galison** 1987, 24–7, and on Claude **Bernard** in **Canguilhem** 1970; on the second point, cf. **Lewin** 1927 and, paradigmatically **Holzkamp**'s critique of the use of the experimental-statistical variable-schema, 1983, Chapter 9, as well as **Gramsci**'s very apposite remarks in *Q*11, §15).

4.3 Marxist epistemology will also be sensitive to metaphysical 'displacements' (**Bachelard**) of experiment, of which classical German idealism offers excellent examples. The decisive clue here lies in the very familiar words of the first of the *Theses on Feuerbach*, where **Marx** wrote that 'the active side' of the cognitive appropriation of nature 'in contradistinction to materialism, was developed abstractly by idealism – which, of course, does not know real, sensuous activity as such' (*MECW* 5, 3).

4.3.1 In the Preface to the *Critique of Pure Reason*, **Kant** wrote that the effect of the introduction of the experimental method was that students of nature now have 'learned that reason has insight only into that which it produces after a plan of its own, and that it must not allow itself to be kept, as it were, in nature's leading-strings, but must itself show the way with principles of judgement based upon fixed laws, constraining nature to give answer to questions of reason's own determining. [...] Reason, holding in one hand its principles [...] and in the other hand the experiment [...] must approach nature in order to be taught by it' (B xiii et sq.). Considered at face value, this is a brilliant characterisation and celebration of what he speaks of in the same place as physics's 'beneficial revolution in its point of view', by which 'the study of nature has entered on the secure path of a science' (B xiv). However, it is *simultaneously* also a 'displacement' of this scientific breakthrough in the direction of idealism, a philosophical *exploitation* of the experimental method. For the lesson to be learnt from that revolution is, according to **Kant**, that 'while reason must seek in nature, not fictitiously ascribe to it, whatever as not being knowable through reason's own resources has to be learnt, if learnt at all, only from nature, it must adopt as its guide, in so seeking, that which it has itself put into nature' (ibid.). From the entirely *sound* position that experiment involves an alteration of *parts or aspects* of the real in accordance with

a 'rational' plan, there is a 'slippage' to the *idealist* position that the *real itself*, as empirical object of knowledge, is (partly) constituted by reason.

4.3.2 In both the *Phenomenology of Spirit* (*W* 3, 194) and the *Science of Logic* (*W* 6, 521 et sq.), **Hegel** gave a clear characterisation of experiment from the point of view of its being a practical change in an objective situation in order to isolate, as far as possible, certain features of it from others. But, ultimately, **Hegel** too 'displaces' experiment philosophically, insofar as the 'drive of knowledge towards truth, cognition properly so-called, the theoretical [. . .] activity of the idea' (*Enz* §225, *W* 8, 378), which includes experiment, is always for him a residue of sheer givenness, which stands in the way of perfect knowledge: theoretical procedures and results are justified only by reference to what is other than it. This is only overcome in 'the drive of the Good to fulfil the same, the practical activity of the idea, or volition' (ibid.): here the objective situation is changed in accordance with a goal freely posited by the subject, which thus sees itself reflected in the object, and to this extent is at one with the object, and in this sense has perfect knowledge of the latter.

In the light of what has already been said about the idea of 'maker's knowledge', this may be seen as a metaphysical rewriting of the idea that we can be said really to know only what we can construct in accordance with a pre-existing plan, what is thus constructed being understandable insofar as we understand the plan which we ourselves have formulated. **Hegel** thus transposes into an ethical key what **Kant** had already written in a (meta) physical-epistemological register.

4.4 Criticism of the objectivist point of view, which Hegel deployed 'idealistically', remained virulent in Marxist social philosophy. **Horkheimer** and **Adorno** regarded the experimental method as the modern paradigm for the transformation of enlightenment into domination. 'What men want to learn from nature is how to use it in order wholly to dominate it and other men' (1972, 8). From the perspective of empirical research, there is the question of whether it is capable of carrying over the experimental order onto the social formation. **Holzkamp** denied this in his critique of experimental psychology. 'It studies people not in the different and non-unitary conditions in which they actually live every day, but rather, it creates artificial conditions in the experiment, in which people are posited as "test subjects" ' (1963, 50). In order to study them as real actors, the experimenter must include his or her own activity in the investigation.

4.5 **Gramsci** gives experimentation a surprising formulation, by seeing in experimental activity itself the possibility of overcoming objectivist observation and its 'idealistic' complements. Experimental activity pushes thought into a new position, depriving it of its illusionary and closed absoluteness and making science possible as 'universal labour' (**Marx**). 'The scientist-experimenter is also a worker, not a pure thinker, and his thought is continually controlled by practice and vice versa, until there is formed the perfect unity of theory and practice' (*Q*11, §34). **Gramsci** can therefore regard experiment itself as 'the first model of the dialectical mediation between man and nature': 'Scientific experiment is the first cell of the new method of production, of the new form of active union of man and nature' (ibid.).

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