The New Dialectics of Nature

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Andrew Pickering, *The Mangle of Practice: Time, Agency and Science* (Chicago, IL: The University of Chicago Press, 1995), xiv + 282pp, $45.00/£35.95 hbk, $17.95/£14.25 pbk. ISBN 0–226–66802–9 hbk; 0–226–66803–7 pbk.

In ***The Mangle of Practice***, Andrew Pickering proposes a general analysis of scientific practice, defined as cultural extension and transformation in time (4), and centred on the dialectic of resistance and accommodation. The presentation of these two concepts in Chapter One is followed by four chapters of 'Instantiations' rehearsing Pickering's preferred case studies translated into the new language of 'resistance' and 'accommodation': quarks (more exactly the now well-known Morpurgo) (Chapter 2) and quaternions (Chapter 3) to which he adds his own reading of Peter Galison's study of the bubble chamber (Chapter 4) and David Noble's analysis of numerically controlled (N/C) machine tools (Chapter 5), in order to show that his 'dialectic of resistance and accommodation' is universally applicable and in fact constitutes a 'theory of everything (TOE)' (246). After having thus suggested that his approach opens a fruitful avenue for historical narratives, Pickering goes on, in the last two chapters, to show that his 'mangle of practice' also gives rise to a new understanding of the old-age problems in philosophy of science, namely: Realism, Incommensurability, Objectivity, Relativism and Historicism, each topic being 'renewed' in less than seven pages. Given all this, one could hardly disagree with the first part of the first sentence of the back cover: this is an ambitious book.

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Faced with the book's tentacular aspects — Pickering has something to say, however briefly, about virtually all aspects of recent writings in STS and even in cultural studies in general — my presentation will be far less encompassing and will focus on what I see as being his central points: his model of scientific practice as a dialectic of resistance and accommodation and its consequences for the writing of history; his metaphysical views on agency and emergence; and his heartfelt condemnation of the notion of constraint as a useless sociological category.

The Dialectic of Resistance and Accommodation: A Piagetian Theme

The term 'mangle' is being taken as synonymous with, and a short hand for, 'dialectic of resistance and accommodation' (23). I prefer to talk about the 'dialectic' itself instead of the 'mangle' in order to circumvent the possibility of misunderstanding that the metaphor of the mangle can raise, and already did (23, note 37).[1] So I leave to others the joy of discussing the various meanings of that term in different countries of Anglo-Saxon tradition, for I am far from sure that it contributes anything positive apart from showing one's erudition in philology and household technology.

For Pickering, 'resistance' is the occurrence of a 'block on the path to some goal [. . .] a practical obstacle' (39), and 'accommodation' is 'an active human strategy of response to resistance' (22). The former is on the side of 'material agency' (though resistance could also come from other humans or organizations), and the latter on the side of 'human agency' (23). The dialectic of resistance and accommodation is thus 'the play' in which the latter seeks to capture the former. To this very simple model, Pickering adds the notion of 'goal', for 'scientific practice is typically organized around *specific plans and goals*' (17). He also uses the notion of modelling developed in his earlier works, but his former notions of 'material procedure', 'instrumental model' and 'phenomenal model', which were central to his model of interactive stabilization in previous treatments of Morpurgo, and his model of 'opportunism in context' developed in *Constructing Quarks* are only occasionally mentioned in notes but not really integrated in his new dialectic of resistance and accommodation. But this does not suggest that it could not be done.[2]

Pickering admits that science has many 'dimensions' — conceptual, social, material (2, 6) — that are heterogeneous and have to be brought together and interactively stabilized through the dialectic of resistance and accommodation in order to produce accepted knowledge about a given aspect of the world (the behaviour of a bubble chamber, the non-existence of a free quark, the existence of quaternions, and so on).

Reading the phrase 'dialectic of resistance and accommodation' reminded me of the times when, nearly twenty years ago, I was eagerly assimilating the works of Jean Piaget. As some readers may know, the core of his conception of the construction of knowledge (Piaget calls his approach 'genetic epistemology') is what he calls the dialectic of assimilation and accommodation that characterizes the interaction between the subject (the child) and the objects s/he manipulates. 'Assimilation', is the act of incorporating into a scheme of action of a subject, the properties of the object with which s/he interacts. 'Accommodation' is the action of adapting the scheme in order to accommodate it to the unexpected resistance of the object to its manipulation. For Piaget, the construction of knowledge is the result of this dialectic of assimilation and accommodation between the subject and the object and it corresponds very much to Pickering's dialectic of resistance and accommodation. The major difference between the two, however, is that Piaget has a *structuralist* conception of action. For him, all actions are related to *schemes* of assimilation, themselves constructed in previous interactions with objects, which are applied on to external objects and which accommodate to them in order to take into account new resistances — that is, properties not compatible with the existing schemes of action. A classical example is the scheme of gripping (*préhension*) by a child that must be modified in order to apply to bigger or heavier objects (taking things with one or two hands, for example). For Piaget, the incorporation of external elements to a given scheme can either be done without modifying the scheme (as when new small objects are assimilated by the baby) or only by modifying it when the characteristics of the objects are too different from those already assimilated. In the latter case we have a disequilibrium between accommodation and assimilation that leads to a structural reorganization of the scheme until a new equilibrium is reached.[3] This structuralist aspect of the concept of 'scheme' makes possible a real integration of different elements of practice like modelling or tacit knowledge. The former can be seen as schemes

(or even as 'habitus', to use a concept of Bourdieu's which is quite compatible with Piaget's works),[4] while the latter is akin to the stage of concrete operations, in which the subject knows how to do operations in practice but has not yet a conceptual grasp of them (obtained only at the stage of formal operations). By comparison, the purely phenomenalist conception offered by Pickering is limited to acknowledging that modelling is an open-ended activity submitted to the dialectic of resistance and accommodation, and that whatever happens simply happens. Piaget's schemes are also open-ended but their transformations are more constrained by their very structure, which limits the possibilities of reaching a new equilibrium.

Resistance . . . to Realism

The point in mentioning Piaget is not to fault Pickering for having ignored an author centrally concerned with questions similar to his, but to show that one can have a constructivist view of knowledge without being afraid of talking about material objects, and without thereby falling into any simplistic 'correspondence realism' — as Pickering likes to call his preferred straw-man. For Piaget, physical knowledge is the result of our interaction with the material world, whereas mathematical knowledge is the result of the operations on the objects.[5] Piaget insists that we cannot have access to the properties of an object without using preexisting schemes of action and that those very schemes are transformed by the interaction with external objects. In his language, 'accommodation is always the accommodation of a scheme of assimilation'.[6] For him the object is necessary for action but the meaning of the object is given by the scheme of assimilation. One can hardly be more constructivist than that and yet incorporate the role of external objects into the theory. These external objects are necessary, for otherwise schemes would be empty and would never be transformed. Nevertheless, no knowledge of reality can be obtained outside the subject's schemes of action and perception. In a sense his model incorporates Kant's distinction between the noumena and the phenomena — the connection between the two being given by the schemes of action which are transformed by the extension of experimentation on different objects — but rejects any Platonist interpretation of the 'existence' of mathematical objects.

Concerning the 'material' dimension of science, most readers of Pickering's previous book, *Constructing Quarks*, will probably be surprised to see Pickering now insisting that 'the world of science happens to be quite evidently and amply stocked with material agents' (9). He now criticizes most SSK accounts of science for having excluded material resistance and limited themselves to social variables of scientific practice (10). As often happens in religion, a new convert (in this case to a form of realism, albeit 'pragmatic') can be a more ardent champion of a new 'cause' than the veteran believers who take many things for granted. Pickering's conversion seems to have occurred during his work on Morpurgo's apparatus (a magnetic levitation electrometer): this case 'first convinced [him] of the necessity to include material agency in [his] understanding of scientific practice' (73, note 4). Thus, he now thinks it is important to remind readers that machines often accomplish 'tasks that are simply beyond the capacities of human naked minds and bodies, individually or collectively'. In case some readers might still have doubts, he continues: 'A windmill grinds grain very much faster than a miller could do by hand; my television set shows me events distant in time and space that I could not otherwise hope to view; a machine tool cuts metal at a speed and with a precision that no one could otherwise hope to achieve' (7). This may look quite 'traditional' — to use Pickering's favourite derogatory adjective (it appears five times on pages 24–25 alone!) — but it will certainly be comforting to those who have been so much castigated over the last ten years for their 'traditional' realism and for their insistence on saying that reality somehow constrains (yes: constrains — more on that later) scientific practice.

Conscious that explicit reference to 'resistance', and sentences like 'capture and framing of material agency [. . .] depends on how the world is' (182) and that '*how the material world is* leaks into and infects our representation of it in a non trivial and consequential fashion' (183) could be read as a return to a form of 'traditional' realism, Pickering insists that those resistances are truly 'emergent in time' and should not be conceived as being already there, independent of the human action that meets such a resistance. He is thus vehemently opposed to what he calls 'correspondence realism' — a doctrine hardly discussed in contemporary philosophy of science, where in fact the dominant tendency is an anti-realist empiricism.[7] To say that 'representational chains of science terminate not "in the world itself" but in specific captures and framing

of material agency' (187), or that 'we never grasp the pure essence of material agency' (54), is to talk as if Kant never wrote his *Critique of Pure Reason* in 1781 and had not already distinguished *noumena* (the thing itself) from *phenomena* (what appears to us), only the latter being the object of sensible intuition. But given that Kant wrote the book, most philosophers know very well that we have no access to 'the thing in itself', and that 'everything is representation', to use another recent buzzword. So, the reader will not, I think, find here any 'renewal' of realism, but simply a new language to restate positions already classical (I dare not say 'traditional') in philosophical circles, but discussed in terms too loose to meet the more exacting levels of argumentation found in circles really interested in the central and complex problem of the relations between noumena and phenomena or, to talk like Piaget, between object and subject.

Agency of Inertia?

By adding the word 'agency' to 'material', Pickering wants his 'material agency' to be an active one as opposed to the passive one of traditional materialism (10, note 16). Moreover, this agency is, he tells us, 'emergent' in relation to a given goal, and action, of a scientist. Thus, '[i]t *just happened* that, when Glaser configured his instrument this way (or this, or this), it did not produce tracks, but when he configured it that way, it did. This is the strong sense of temporal emergence implicit in the mangle' (53, my emphasis). 'That the first grain to be examined moved in the same direction when the direction of the electric field was reversed *just happened* in the real time of Morpurgo's practice'. So, all accommodations '*have to be seen* as temporally emergent responses to situated obstacles' (92, my emphasis).

Now, despite the performative injunction ('have to be'), there is no argument in his case studies showing that anything really emerges in time, and, in all his examples, 'resistances' come as *effects* of the actions of scientists. Though I think his discussion of 'emergence' is purely metaphysical and does not really contribute to our understanding of scientific practice, it is so central to Pickering's book that it cannot pass unnoticed. Thus, he insists that talking about resistance does not suggest that what resists and the resistance itself is always there, but on the contrary that it emerges *only* in the

interaction with the scientist. But if one admits a certain realism about material agency, as Pickering does, one can hardly avoid a certain realism about the entities that are at the origin of this agency: then the question of the 'emergence' of 'material agency' and of 'resistance' becomes purely metaphysical or trivial, for it is clear that by definition we can experience resistance only during the interaction. So, to say that resistance emerges only at the intersection of the realms of human and material agency (66–67, 92) is true by definition and has no empirical consequence. Of course 'the contours of material agency are never decisively known in advance' (14) — and, by the way, this is why, abandoning the Cartesian dream of total deduction of the world, scientific practice, at least since Galileo, has an *empirical* dimension! — but it does not follow that resistance or agency 'emerge' in any strong sense. On the contrary, it is hard to understand how a 'block' can arise or emerge if it is not already there waiting to be 'seen', as it were, in the interaction.

To believe, as Pickering seems to do, that 'material agency' is genuinely emergent in time and not continually present in culture is simply taking a purely phenomenalist point of view. He thus seems to be not far from the position of Bishop Berkeley for whom 'to be is to be perceived', whereas for him 'to be is to be interacting with'. In fact, Pickering's position on the ontology of matter is uncertain and we never know if 'emerge' means 'coming into existence' or simply 'becoming visible'. In a note (14) he writes that 'material agency is temporally emergent in relation to practice' but that 'whether material agency *per se* is temporally emergent is another matter' because of the 'relative reliability of certain machines' like magnets, cars and TV. I confess not to understand the distinction suggested here and will pass to a concrete example to suggest that all his 'emergence-talk' is a far cry from a convincing alternative to 'non emergent', 'traditional' realism.

Imagine a blind man in a room containing some furniture here and there and observe his actions. Adopting Pickering's point of view leads us to describe his movements in the following way. The goal of the blind man is to advance straight in front of him. After a few free steps, he stumbles on an object that resists him so that he must stop advancing in his chosen direction. He then 'accommodates' that 'resistance', Pickering would no doubt say, by choosing to move sideways — and this choice 'just happens' in the real time of practice. After a few steps sideways he decides to move

forward again — and of course we must insist that this new choice 'just happens' — and meets no resistance for his next four steps, until he falls after having met a new resistance. And so on. After a while, he constructs a mental map of the room and locates (in his own coordinate system based on direction and number of steps) where he met the various resistances. He also notes that he meets these resistances every time he walks to a given place. He concludes that they are thus time-invariant 'resistances'. The blind man never knew the presence of these 'material agencies' that resisted him *in advance* but only when he tried to move in certain places. So, in a sense, these resistances 'emerged' only when he happened to be in those places. But their *persistence in time* was such that he could not conclude that 'material agency' really 'emerged' in time except in the trivial sense that he perceived and felt nothing before meeting the obstacle.

This time-invariant feature of resistances is even present in Pickering's discussion, though he does not really elaborate on it. Interpreting Otto Sibum's reconstitution of Joule's experiment on the mechanical equivalent of heat, Pickering uses his language of the emergence of resistance and material agency and notes that the 'resistances' met by Sibum were essentially the same as those met by Joule more than one hundred years before because 'it seems impossible to doubt that much the same kind of manglings bore upon Joule's human performances as bore upon Sibum's' (109). Given that, it seems clear that there is no genuine 'emergence in time' here, except again in the purely phenomenal sense that nothing would have happened if Sibum did not remake Joule's experiment or made a completely different one. To state that resistance is not the property of the material agency but is 'liminal', at the intersection of human and non-human agency (92), is not a conclusion warranted by the case studies examined but simply a metaphysical postulate never borne out by the descriptions offered. Of course, adopting a phenomenalist viewpoint is legitimate, but it must be perceived as it is — that is a metaphysical point of view — and not presented as an alternative borne out by the empirical cases presented. And repeating constantly, like an incantation, that resistance 'emerged', does not change the phenomenalist postulate into a demonstration.

All the examples studied in the book suggest that the material world *is* the origin of resistances in the case of material interaction with humans, and no particular problems are generated by admitting

this as an empirical fact. These examples also suggest that while we can agree with Pickering not to 'put phenomena first' I see no problem in 'putting phenomena last'. Why cannot we accept *post facto* reconstructions, when they are useful in predicting other similar instances? For though the blind man certainly postulated the existence of the furniture in the room only after having interacted with it, it served him well in his future movements to take account of these *persisting* resistances. He could even use his map to suggest to fellow blind men entering the room to take care not to hurt themselves in certain places where there are 'material agencies' waiting to 'emerge' on them. In short, the persistence in time of the resistances offered by material objects largely deprives the notion of 'emergence' of any significant content.

Pickering extends his notion of 'resistance' to much more than 'matter' and talks about resistance emerging in the work organization of the factory. Thus, using David Noble's work on the introduction of numerically controlled technology (N/C) in the workplace, he writes that 'resistance to the introduction of N/C emerged', '[resistance] was truly emergent in practice' and that 'it simply turned out in practice that the rate and quality of parts production dropped', and thus that 'the first accommodation of management to resistance failed' (160–61).[8] In the case of 'conceptual manipulations', Hamilton's work is analyzed as a series of steps involving resistances to the achievement of his goals, resistances generated by the 'disciplinary agency', and accommodations generating 'free' and 'forced' moves leading finally, and contingently of course, to the construction of quaternions.

The Verbal Unification of the World

Far from helping to unify different phenomena under the same 'theory', this verbal unification only muddies the water further by amalgamating completely different dynamics. At this point it is not Piaget that comes to mind but the Frederick Engels of the *Dialectics of Nature*, who subsumed under his general law of the transformation of quantity into quality everything from the development of capitalism to the boiling of water.[9] This was probably one of the first Theories of Everything (TOE). Like Engels, Pickering is so fascinated by the generality of his approach that he sees 'no reason why [his] general analysis of practice should not continue to apply

to realms of nonstandard agency' (244) — that is, cases involving 'dwarves, demons, *cobalos*, *virinculi montani*, *Bergmännlein*' (243). And to exclude nothing, he notes that in physics, the bootstrap approach, based on S-matrix theory, 'was itself a mangle-ish approach to particle theory' (251) and invites scientists to pursue this approach, which would generalize the mangling to nature itself, in order to really have a Theory of Everything.[10] Though Pickering's latest ruminations might be welcomed by physicist John Hagelin, president of the Natural Law Party and candidate for the Presidency of the United States — and who promises that meditation and levitation will solve crime problems in the US[11] — I must candidly confess that I find this part quite surrealist. But, of course, I am 'traditional'. More seriously, since Pickering seems to see a *virtue* in the fact that his dialectic is 'scale invariant' (243), it may be worth recalling Aristotle's observation that there is an inverse relation between the extension and the intension of a concept. Put more simply, a notion applicable to everything is empty.

Anyway, standard or not, I think we should be careful in talking about 'agency'. This notion is bound to raise a lot of confusion because of the many different and contradictory meanings that the term can have. First, as Pickering notes, there is the *semiotic agency* as in Callon and Latour (12). Second, there can be a *material agency* like that of an electric charge, an entity which, according to contemporary physics, does have the capacity or power (the ancients called it the 'soul' or the 'animus') to attract or repulse other charges, or of a magnet which also has the power to act at a distance on objects. There is also the agency of machines, which should be distinguished from that of the elementary entities just mentioned, as machines contain many components and thus have a distinct ontological status.[12] So, writing that 'The world, I want to say, is continually *doing things*, things that bear upon us [...] as forces upon material being' (6) can be trivial and 'the world' is too vague an expression to make possible the necessary distinctions made above. The same problems arise with the notion of 'emergence'. In complex historical events (or in physical *effects*),[13] there is a definite sense of contingent emergence as the meeting place of independent causal series, as Cournot said. But this 'emergence in time' cannot be put on the same level as the putative 'emergence' of a material entity. In the latter case the term is metaphorical, whereas in the first case there is a truly contingent emergence of events. So,

whereas *events* do emerge in time, as historians know well, Pickering has not shown that *entities* likewise emerge.

Spontaneous Breaking of Symmetry?

Enough about the metaphysics of 'emergence'. In fact attributing agency to non-humans may be seen as a trick to come back to realism while still looking 'symmetrical', a posture that still seems to be a *sine qua non* to be *persona grata* in certain places. Though Pickering curiously thinks that Callon and Latour are right in attributing agency symmetrically — contrary to Collins and Yearley, who attribute it only to humans — he rejects their approach by noting that there is not complete symmetry between humans and non humans because he cannot make sense of scientific practice 'without reference to the intentions of scientists, to their goals and plans', whereas he does not 'find it necessary to have insight into the intentions of things' (17). It is fascinating to observe that the force of the 'principle of symmetry between humans and non humans' is such on our author that he asks 'why should SSK adopt [an] asymmetric stance concerning material and human agency?' (10), and also takes the time to fault a musical metaphor used by Michael Lynch because it remains 'asymmetric' (22, note 35). Concerning the importance he gives to goals, he even writes that this is 'an aspect in which the symmetry between human and non human agency *appears to break down*' (17, my emphasis), as if it were after all only an appearance and that at some deeper level (as a physicist would say) symmetry would be restored. Though Pickering seems sorry to commit the sin of breaking this principle of symmetry, I, on the contrary, find it rather difficult to understand how this *a priori* fixation on symmetry has taken such a hold in sociology of science. Here, my criticisms concern only the 'principle of symmetry' between human and non-human, the now 'traditional' (*sic*) principle of symmetry between true and false statements, formulated by proponents of the strong programme being, on the contrary, a useful and productive methodological tool.

In short, the attempt to recover some symmetry by attributing 'agency' to objects does not work, for it is limited to 'resistance'. At best, Pickering's 'material agency' is bringing us back to the seventeenth-century notion of inertia as resistance to motion, a

remnant of animism strongly criticized by Kant, who observed that it did not make sense to talk about a *force* of inertia, the concept of force being external to the object, whereas inertia refers to an internal property of matter.[14]

So, the 'posthumanist' philosophy advocated by Pickering, which is supposed to decentre the focus from the human agent who would (should?) no longer be 'calling the shots' (26), is still very much humanist despite the constant, and incantatory, use of the term 'agency'.

Individualistic History and the Dialectic of the 'Ping-Pong Table'

It is worth noting that Pickering's model leads to a very individualistic, subject-centred and one-dimensional kind of narrative history. It is striking that his reconstruction of the story of the building of the bubble chamber is in fact quite traditional in its narrative structure, and I am not sure it differs much from what he termed the 'scientist's account': Glaser tried *X*, it did not work so he tried *Y*, and so on. And this one-dimensional history of a 'ping-pong game' between reality and the scientist, is always the same. Thus, after having described the 'ping-pong' of resistance and accommodation, which Glaser played while constructing his bubble chamber, Pickering admits that he 'could indeed tell the story of the genesis of [Morpurgo's apparatus] along just the same lines as I told the story of the [bubble chamber] [. . .] but just because this part of the story reproduces the features that I analyzed in Chapter 2 [on Glaser] I will not go through it here' (72–73).

This concentration on individual practice is very much in tune with the sociological tradition of methodological individualism, where actors were conceived as totally free to make any decisions they wish as if they were not constrained by anything, even a conceptual horizon of the kind provided by, say, a paradigm or internalized schemes of actions like Bourdieu's habitus. Comparing the original analysis of the history of the bubble chamber and of the introduction of numerical control in the factory, offered by Galison and Noble respectively, with Pickering's own reformulation, shows that the former are much more complex and multidimensional than the summary offered by the latter, as if his model had the unintentional consequence of transforming multidimensional narratives into

unidimensional ones. Ironically, we can thus apply to Pickering the 'judgement' he applies to 'traditional philosophy of science and social theory', that 'history tends thus to appear as an endless repetition of the same [. . .] The past becomes a litany of, say, endless, and endlessly depressing, clashes within a standard array of interests' (241), just by replacing the seven last words by 'clashes between resistance and accommodation'. So, in terms of writing complex historical narratives, the reader is I think better served by Noble's book. By contrast, Pickering glossed Noble's noble prose with turgid sentences like 'so we have the idea of the Taylorite sociocyborg as the basic unit for the machinic capture of agency in the metalworking industries' (159), or 'the idea of N/C was to shift the balance of agency within the basic cyborg unit' (159). Back to Noble's prose, please!

The cases of the bubble chamber and of N/C technology, as treated by Galison and Noble respectively, strongly suggest that a model of action limited to resistance and accommodation cannot do full justice to the complexity of their narratives. It is thus hard to believe that 'unlike traditional explanatory schemes, the mangle *encourages us to notice the difference*' between pre- and post-World War II science, if only for the reason that Pickering's analysis of these events is essentially based on Kevles's book, *The Physicists* — surely not an example of 'avant-garde' historical analysis — from which this difference is clear enough. One could also point to Noble's *America by Design*, and to other historians who manage to 'notice the difference' without using the 'spectacles' of the mangle.[15]

Pickering's model is so much centred on the dialectic of resistance and accommodation that there is in fact little discussion of the role of the scientific community in evaluating the results of this dialectic. This is of course also true of Piaget, who has been criticized for his lack of attention to social aspects of the learning of the child, but since he was only interested in the growth of knowledge in the child, this limitation is not fatal. It is more disturbing in Pickering's case, and his individualism seems to be an unintended by-product of his model.

Now, if science is somewhere social, what is considered as 'scientific' can only be the product of a collective agreement, and this dynamic lies outside the duo of the scientist struggling with material agency. It seems that what we observe here is a movement

inward, also visible in Gooding's work on Faraday: the micro-analysis of practice first suggested by SSK is now pushed to the limit where, paradoxically, it converges on the individual in his relation to the world. No surprise that this leads to the nearly psychological study of the creativity of individuals, be it in the most recent form of cognitive studies.[16]

Pickering is conscious of the move though he does not really elaborate upon its consequences, sociological and philosophical. He simply writes that 'scientific objectivity can be located already at the level of individual practice'. Successful manoeuvres 'confer objectivity on the products of their practice prior to any social ratification' (196). This would demand more development because it is not clear that the term 'objectivity' retains the same sense in the passage from individual to collective practice. For my part, I think, like Bachelard, that the notion of scientific objectivity is a social category which does not apply to individuals.[17] And since Pickering likes to ally himself with pragmatism, it may be worth noting that for pragmatists like James and Pierce the notion of 'truth' also presupposes a community.[18]

Resistance and Constraints

The unintended proximity to methodological individualism may be related to Pickering's obsession with getting rid of the term 'constraints'. I understand that he might be afraid of the 'police metaphor' (197), and feel that 'the language of constraint is the language of prison' (65), but the question is not one of *liking* constraints or not, but of seeing what this notion achieves in sociological analysis.

Contrary to what Pickering suggests, the main difference between constraint and resistance is not that the first is synchronic and the second diachronic, or that constraint 'resides in a distinctly human realm' whereas resistance exists 'only at the crosscutting of the realms of human and material agency', and even less that constraint is not emergent and resistance is (66–67), but that constraint is a structural concept whereas resistance is not. Since the question of emergence is purely metaphysical one could easily say — and insist! — that even the constraints 'emerge' in interaction: so this question is not the dividing line between the two notions. Resistance

only suggests an opposition to something that comes by. Constraint, on the other hand, must be understood as in physics: it is a structural limitation to movement. A system with no constraint has a different set of possible trajectories from a constrained system. It thus suggests the existence of a structure. Moreover, a constraint is not necessarily material and substantial and, as we have shown elsewhere, what is a *constraint* for someone may be a *resource* for someone else, placed in a different position.[19] So the analogy with the wall of a prison may be frightening but is not a good one, for it suggests too much a material substance. A better analogy, though still imperfect, would be with the movement of a particle in a field. Not all trajectories are compatible with a given field configuration. (And here one clearly sees that, if one wishes, one can consider the interaction of the particle and the field as *emerging* in the sense that the force at a given point exists *only if the particle is there*. This is, by the way, the point of view of operationalism in physics, which is a form of phenomenalism and thus seems to fit Pickering's proclivities.)[20] For example, in his book on Mozart, Norbert Elias shows very well that given the structure of court society in the eighteenth century even a genius like Mozart could not follow the trajectory he wanted. In this sense he was subject to constraints, and here the notion of resistance is not sufficient, for Elias also shows that Mozart did resist (and reacted to) the imposition of the court model.[21]

The analysis of structural constraints also opens up the possibility of making sense of comparative analysis. Thus, concluding his detailed analysis of the demise of the GE pilot programme of N/C, Noble notes that 'at the Topeka dogfood factory of General Foods Corporation, for example, a similar scheme was introduced around the same time as the Pilot Program, with similar results and consequences.'[22] Pickering's total contingency model, on the contrary, always leads to the conclusion that these things 'just happen'.

In short: I think that the notions of constraint and resistance do not cover the same semantic field and are thus both needed for sociological analysis because they point to different phenomena. Structural constraints have to be taken into account in order to understand fully the actions of scientists and their accommodations to the resistance of their objects. And here constraint is not simply an actor's category (66), but an analytical one.

Conclusion

Pickering wrote somewhere that he thinks while writing. The book discussed here certainly confirms this habit. Taken as 'working notes' on several complex questions, it is certainly thoughtful, but as an expression of a coherently argued view of scientific practice, it leaves, as we have tried to show, much to be desired. His main notions — 'resistance', 'emergence', 'posthumanism' — are not sufficiently analyzed in the light of the historical, methodological, philosophical and sociological problems they raise. More importantly, argumentation is too often replaced by general characterization of straw opponents as 'traditional', 'non emergent', 'humanist', as if the constant repetition of these terms would by itself be sufficient to give more weight to the 'mangle' *weltanschauung* presented as an alternative.

• NOTES

1. In his review of the book, Ian Hacking also devotes a paragraph of exegesis to the 'mangle'. See Hacking, 'Matter over Mind', *Times Literary Supplement* (10 May 1996), 15.

2. A. Pickering, *Constructing Quarks* (Chicago, IL: The University of Chicago Press, 1984).

3. Piaget's theory has evolved over half a century. His latest formulation can be found in *L'équilibration des structures cognitives: problème central du développement* (Paris: Presses universitaires de France, 1975), translated in English in 1985 by the University of Chicago Press as *The Equilibration of Cognitive Structures: The Central Problem of Intellectual Development*. For his views on structuralism, see his book *Le structuralisme* (Paris: Presses universitaires de France, 1968). Piaget also published a book formulating a general evolutionary theory of knowledge, *Biologie et connaissance: essai sur les relations entre les régulations organiques et les processus cognitifs* (Paris: Gallimard, 1967). For an entry into the vast literature on Piaget, see R.F. Kitchener, 'Bibliography of Philosophical Work on Piaget', *Synthese*, Vol. 65 (1985), 139–51, and Kitchener, *Piaget's Theory of Knowledge: Genetic Epistemology and Scientific Reason* (New Haven, CT: Yale University Press, 1986). It is worth noting that Kuhn knew Piaget's work quite well and discussed it in detail in his 1964 paper 'A Function for Thought Experiment', reprinted in *The Essential Tension* (Chicago, IL: The University of Chicago Press, 1977), 240–65. He also participated in a symposium organized by Piaget on the theories of causality in 1966 (paper reprinted in ibid., 21–30).

4. See, for example, *Le sens pratique* (Paris: Minuit, 1978). It is striking that Bourdieu's basic conception of 'practical sense' is analogous to Piaget's stage of concrete operations.

5. For details, see J. Piaget, *Introduction à l'épistémologie génétique 1: la pensée mathématique* (Paris: Presses universitaires de France, 1972; first edition 1949). Note that a similar conception of mathematical knowledge has been revived by Philip Kitcher in his book *The Nature of Mathematical Knowledge* (Oxford: Oxford University Press, 1984), his central thesis being that 'mathematics describes the operational activity of an ideal subject' (111), like 'children [who] come to learn the meaning of "set", "number", [. . .] by engaging in *activities* of collecting and segregating' (107–08). Though Pickering cites this book, Kitcher also ignores Piaget's work on mathematical knowledge.

6. Piaget, *L'équilibration*, op. cit. note 3, 12.

7. See, for examples taken at random from my bookshelf: J. Leplin (ed.), *Scientific Realism* (Berkeley, CA: University of California Press, 1984); Hilary Putnam (edited by J. Conant), *Words and Life* (Cambridge, MA: Harvard University Press, 1994), 'The Question of Realism', 295–312.

8. I will leave to Noble the burden of answering Pickering's comments about his supposedly 'traditional' analysis of the power structure in the factory, for this discussion would lead us too far from our main theme. Let us note, nevertheless, that without using trendy language or repeating endlessly that everything emerges, Noble's narrative can leave no doubt about the non-deterministic route taken by the history of N/C. He writes that 'beyond the *very real constraints of energy and matter*, exists a realm in which humans' thoughts and action remain decisive'. In plain English his approach clearly takes into account human and non-human agents. See David Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Oxford University Press, 1986), xi, my emphasis.

9. F. Engels, *Dialectics of Nature* (New York: International Publishers, 1940), Preface and Notes by J.B.S. Haldane.

10. For a history of S–matrix theory, see James T. Cushing, *Theory Construction and Selection in Modern Physics* (Cambridge: Cambridge University Press, 1990).

11. See 'The Thinking Universe', *The Mind Body Connection*, No. 3 (September 1993), 19–30.

12. Likewise 'effects' like the Hall effect, or the Zeeman effect, do not have the same ontological status as electrons or neutrinos. Pickering's reference to Hacking on this point fails to make these distinctions and thus misses the point about entity realism (187, note 7). Bachelard was probably among the first to observe that above a science of facts there was now developing a science of effects.

13. See note 12.

14. Max Jammer, *The Concept of Mass* (New York: Harper Torchbooks, 1961), 82.

15. D. Noble, *America by Design* (Oxford: Oxford University Press, 1979). See also S.S. Schweber, 'The Empiricist Temper Regnant: Theoretical Physics in the United States 1920–1950', *Historical Studies in the Physical Sciences*, Vol. 17, No. 1 (1986), 55–98.

16. See, for example, David Gooding, 'Putting Agency Back into Observation', in A. Pickering (ed.), *Science as Practice and Culture* (Chicago, IL: The University of Chicago Press, 1992), 65–112.

17. I discuss that in Y. Gingras, 'Following Scientists Through Society? Yes, but

at Arm's Length!', in J.Z. Buchwald (ed.), *Scientific Practice: Theories and Stories of Doing Physics* (Chicago, IL: The University of Chicago Press, 1995), 144–47.

18. H. Putnam, *Pragmatism* (Oxford: Blackwell, 1995), 24, note 7.

19. Y. Gingras and M. Trépanier, 'Constructing a Tokamak: Political, Economic and Technical Factors as Constraints and Resources', *Social Studies of Science*, Vol. 23 (1993), 5–36.

20. He mentions that his theory is 'about the visible, about the world of appearances' (250). Like all good empiricists he believes only in things '*visible*' (174).

21. N. Elias, *Mozart: Sociologie d'un génie* (Paris: Seuil, 1991).

22. Noble, op. cit. note 8, 320.

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S|S|S

RESPONSES AND REPLIES

In the Land of the Blind ...

Thoughts on Gingras

Andy Pickering

> I do not think that the workings of the mangle are hard to grasp in any particular instance, but two aspects of the overall analysis are. One is the concept of temporal emergence ... posthumanism is the second [that] thought tends to bounce off and even recoil from. [*The Mangle of Practice*, 23, 26]

I feel I should reply to Yves Gingras' long Review of my book, *The Mangle of Practice*, because it is so derogatory; I do not want to leave it uncontested in the literature.[1] I will not address all of Gingras' critical remarks, which form a disconnected series from my point of view, and which sometimes amount to no more than sarcastic jeering. I want instead to pick up a couple of points from his Review to indicate just what it is that he has failed to grasp about my book. If these points are understood, then all else falls into place.[2]

When Gingras announces that he ...

> ... will pass to a concrete example to suggest that all [Pickering's] 'emergence-talk' is a far cry from a convincing alternative to 'non emergent', 'traditional' realism ... [YG, 323]

... he approaches two of the central topics of my book: temporal emergence and, not so much realism as a philosophical topic, the decentred, post-human, intertwining of the human and the non-human (which, I argued in Chapter 6 of *The Mangle*, does indeed bear interestingly upon our thinking about realism). What is this 'concrete example'? It begins:

> Imagine a blind man in a room containing some furniture here and there and observe his actions .... The goal of the blind man is to advance straight in front of him. [YG, 323]

Gingras then conjures up an image of this person stumbling over chairs and tables and eventually constructing a 'mental map' of the obstacles he

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has encountered [YG, 323–25]. At the same time, Gingras describes the production of this map in the language of resistance, accommodation and so on, that I developed and exemplified with real examples in *The Mangle*, before concluding:

> In short, the persistence in time of the resistances offered by material objects largely deprives the notion of 'emergence' of any significant content. [YG, 325]

Gingras clearly regards this 'concrete example' as a *reductio ad absurdum* of much of the *The Mangle*. It demonstrates that nothing in my analysis is inconsistent with the simple-minded intuitions about knowledge and practice that the example instantiates.[3]

How should I respond? First, I can say that I am happy to have developed an analytical apparatus capable of grasping how the blind find their way around. I had not thought about this, so it is an unexpected payoff. Second, taken at face value, the example accomplishes what Gingras wants. Nothing really emerges, no real novelty, in the practice of this blind man – the obstacles were there all along; and likewise, a strong correspondence realism is warranted about the blind man's eventual 'mental map of the room' – we can readily imagine that he identified the obstacles correctly. But third, the example is rigged. Designating the object of thought as a blind man invokes the fact that Gingras' readers are not blind. We can see in advance what the furniture is; we know what is going to happen when the blind man goes this way or that; we know that his mental map is correct. And beyond that, we sighted readers are implicitly invited to conjure up a fixed universe for this blind man: the chairs and tables are *here* and *there*; they never move; no new obstacles appear to his progress – that is why the blind man can . . .

> . . . suggest to fellow blind men entering the room to take care not to hurt themselves in certain places where there are 'material agencies' waiting to 'emerge' on them. [YG, 325]

Is taking the position of an omniscient observer watching lesser mortals stumble around a fixed universe a good strategy in science studies? No. It is a rotten one.[4] Think about a real example: Donald Glaser's development of the bubble chamber, for instance, as discussed at length in Chapter 2 of my book.[5] In an obvious but very important sense, and unlike Gingras' imaginary blind man, Glaser *transformed the furniture of the world*. Before he embarked upon his project, there were no bubble chambers anywhere: the very phrase 'bubble chamber' did not exist, and if someone had made it up it would have been without content. After Glaser had done his work, the phrase and the object existed, the latter playing an extremely important rôle in particle physics. This was the kind of transformation I sought to analyze in *The Mangle*, not just in this instance but throughout. The analytical apparatus that I developed there was aimed precisely at getting to grips with such transformations, in which *real novelty emerges* in

practice. That is what all the talk about modelling and multiplicity, resistance and accommodation, agency and, certainly, emergence was about. And it is clear, isn't it, that Gingras' 'concrete example' fails entirely to speak to my concerns? It is, in fact, very hard to see how his metaphor could be extended to cover them without turning into my story. In short, Gingras has simply overlooked (if that is the word) the interest in temporal transformation that runs through my book.[6]

A second respect in which that is true can also be extracted from Gingras' 'concrete example'. Only the blind man's knowledge is transformed in his dialectic of resistance and accommodation with the furniture. But this was not the case with Glaser and the bubble chamber. As discussed at length in Chapter 2 of *The Mangle*, both Glaser and the bubble chamber were transformed in Glaser's practice. The bubble chamber itself was clearly transformed, passing from non-existence to existence in Glaser's small prototypes, and then mutating still further in the practice of Glaser and others (I followed the story up to the liquid-xenon chamber). Likewise, Glaser's plans, goals and interests were mangled, as I put it; so was the social location and structure in which he worked; and so, too, was his knowledge of bubbles. And these transformations in the furniture of the world (the bubble chamber and its evolving shape and performance) and in Glaser the human actor were, I argued, constitutively interlinked in the process of mangling. One cannot understand what became of the bubble chamber without thinking about what became of Glaser, and *vice versa*. Observations like that were at the origin of my arguments concerning the need for a decentred, post-humanist, analysis of scientific practice that would recognize the reciprocal coupling of things human and non-human, and that could openly acknowledge that much of the historical action, in science and beyond, lies at the interface of these two realms. Once again, it is clear, isn't it, that Gingras' 'concrete example' fails even to make this issue thinkable?

I want to pursue this point just a little further. Gingras' blind-man story serves to effect a clean split between the human and the non-human. The non-human table and chairs just persist obdurately in time, while the non-sighted human has actively to accommodate himself to them. All of the interesting action is on the human side. The story thus invites us to think about how we humans individually or collectively come to terms with a dead and uninteresting material world, and hence functions as a rhetorical support for what I called traditional approaches in the humanities and social sciences, approaches that construe their object as purely human. I thought 'traditional' was a pretty bland term, though Gingras is very excited about it, repeating it over and over again and throwing it back in my face: 'But, of course', he announces, 'I am "traditional" ' [YG, 326].

What should one say about this? First, Gingras is honest, at least about himself: he wants to be a traditional, humanist sociologist. He wants to think about a world of humans among themselves, as Bruno Latour might put it; he doesn't want to think about the material world and its reciprocal engagement with the human. The blind man stumbling upon chairs is

enough for him. But second, my book develops at length many empirically grounded arguments against that style of sociology. Gingras says that I engage with 'straw opponents' [YG, 332], but that is false: just look at the ten-page argument with David Bloor on SSK at the end of Chapter 4, for example, or the eight pages on David Noble at the end of Chapter 5. I have only heard David Noble on the radio, but I know the other David, who is certainly not made of straw. That Gingras, how dare he?

I could go on into the niceties of social theory. Gingras [YG, 328] explodes into an attack on the 'individualism' of my book under the heading, 'Individualistic History and the Dialectic of the "Ping-Pong Table" ' (nice sneer, Yves): 'This concentration on individual practice is very much in tune with the sociological tradition of methodological individualism'; and so on. This fits in perfectly with his blind-man story. But it is funny, then, that, as Gingras knows, I began my thinking on the mangle with individual practice, but found myself led into the macro. Chapter 5 of *The Mangle* is all about a classic macrosocial topic, struggles between workers and management; and in Chapter 7 I discuss the enmeshing of scientific and military enterprise in fighting World War II.[7] 'Individualistic'? Hardly. Readers of Gingras' Review should know that a difference between myself and Gingras is not that I am interested in the micro and he the macro, but that we differ over how the macro is to be conceived. Gingras follows a line traditional in social theory that envisages macrostructures as 'constraints' on more micro phenomena [YG, 330–31]; I argue in *The Mangle* against that position and in favour of a view of the mangle as scale-invariant (as applying, that is, to the macro as well as the micro, and to interlacings of the two).[8] It is a truism of academic life that the better arguments do not always win the day; I did not expect Gingras to change his tune on reading my book (though I hoped he would). But when he tells the readers of *Social Studies of Science* that my book is 'individualistic' he is again simply evading, rather than reviewing, my text.

Notes

1. Yves Gingras, 'The New Dialectics of Nature', *Social Studies of Science*, Vol. 27, No. 2 (April 1997), 317–34 [YG]; Andrew Pickering, *The Mangle of Practice: Time, Agency, and Science* (Chicago, IL: The University of Chicago Press, 1995).
2. The last and explicitly tentative postscript to *The Mangle* discussed the possibility of seeing my analysis as a TOE, a 'theory of everything'. I will not reply here to Gingras' mockery of that [YG, 325–27], but for a recent and less tentative elaboration of my ideas, see my 'On Becoming: Imagination, Metaphysics and the Mangle' (forthcoming).
3. This tactic is reminiscent of Harry Collins' and Steven Yearley's rewriting of the works of Michel Callon and Bruno Latour, intended to demonstrate the 'prosaic' nature of the latter: see H.M. Collins and S. Yearley, 'Epistemological Chicken', and M. Callon and B. Latour, 'Don't Throw the Baby Out with the Bath School! A Reply to Collins and Yearley', both in Andrew Pickering (ed.), *Science as Practice and Culture* (Chicago, IL: The University of Chicago Press, 1992), 301–26, 343–68.
4. Lest I seem in what follows to make too much of Gingras' blind-man example, I want to note that it is isomorphous with the extended discussion of Piagetian psychology with which he begins his attack [YG, 319–20]. There again, one is invited to take the position

of omniscient observer of an only partially competent subject (in this instance, an adult observing a child). No-one who had even begun to get the hang of my book would invoke this trope twice.

5. Not Chapter 4, as stated by Gingras [YG, 317]. The bubble chamber is the first empirical study discussed in *The Mangle*; it seemed to me the right place to begin the exposition there, and it therefore seems the appropriate example to juxtapose to Gingras' Review.
6. In the very next paragraph after his discussion of the blind man, Gingras throws in a remark on my 'repeating constantly, like an incantation, that resistance "emerged" ' [YG, 324]. At the end he comes back to my 'constant repetition' of key terms [YG, 332]. There is a fair amount of such repetition, deliberately, in *The Mangle*. It derives from reactions to my earlier book, *Constructing Quarks: A Sociological History of Particle Physics* (Chicago, IL: The University of Chicago Press, 1984), where reviewers frequently took the tack of treating my analytical commentary as quite detached from the book's empirical substance. Literary infelicity was a price I was willing to pay in *The Mangle*, to fix the reader's attention on what I took to be important, interesting and possibly difficult features of the text. Obviously this tactic had no such effect on Gingras.
7. Gingras says: 'It seems that what we observe here is a movement inward . . . : the microanalysis of practice first suggested by SSK is now pushed to the limit where, paradoxically, it converges on the individual' [YG, 329–30]. The trend both within *The Mangle* and of my subsequent work actually goes in the opposite direction: on the latter see, for example, A. Pickering, 'Cyborg History and the World War II Regime', *Perspectives on Science*, Vol. 3 (1995), 1–48; Pickering, 'History of Economics and the History of Agency', in J. Henderson (ed.), *The State of the History of Economics: Proceedings of the History of Economics Society* (London: Routledge, 1997), 6–18; Pickering, 'Science as Alchemy', to appear in a volume edited by Clifford Geertz, Joan Scott and Michael Walzer (Russell Sage Foundation/Princeton University Press); and Pickering, 'The Alchemical Wedding of Science and Industry: Synthetic Dyes and Social Theory' (forthcoming).
8. When Gingras says that 'the question is not one of *liking* constraints or not, but of seeing what this notion achieves in sociological analysis' [YG, 330], and goes so far as to italicize 'liking', the reader might imagine that in *The Mangle* I just state my distaste for the term and leave it at that. Not so. The longest relevant passage is the concluding part of my long argument with David Noble mentioned in the previous paragraph, and focusses on Noble's use of the cognate term, 'limits' (Gingras cites Noble with approval in this section of his Review, 331). Gingras' assertion that I understand actors as 'totally free to make any decisions they wish as if they were not constrained by anything' [YG, 328] simply shows that he cannot imagine any alternative to his notion of constraint other than 'total freedom'. Given that a central concept in my analysis is 'resistance', I think he is wrong. His reference to 'Pickering's total contingency model' [YG, 331] is similarly misleading. I argued that practice has a discernible and graspable structure that includes contingency as an integral and inseparable part – I have nowhere stated that contingency is all there is. Incidentally, it is worth noticing that when Gingras elaborates on the idea that 'Constraint . . . must be understood as in physics' [YG, 331], he picks on precisely a notion of constraint that I am very familiar with and argue explicitly against.

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From the Heights of Metaphysics:
A Reply to Pickering

Yves Gingras

I felt I should reply to Andy Pickering's short Response to my long Review of his book; I did not want to leave it uncontested in the literature.[1] I will pick up a couple of points from his comments to indicate just what it is that he has failed to grasp about my Review. If these points are understood, then all else falls into place.

Though Pickering writes that my critical remarks 'form a disconnected series' [AP, 307], I think on the contrary that the seven sections of my Review raised questions about each of the central themes of his book.[2] Of course, for the sake of clarity – and to respect the property of a language that is written linearly from left to right and from top to bottom – all could not be 'mangled' together, and they were presented in sequence, which may explain their apparent unconnectedness from Pickering's 'point of view'. So let us briefly recall the content of those sections, answering his comments along the way.

In the first section, I pointed out that the 'dialectic of resistance and accommodation', which is the central analytical tool proposed in the book, was reminiscent of Piaget's theory of knowledge acquisition, but with one major difference: Piaget was explicitly structural in his analysis (via the concept of 'scheme'), whereas Pickering is purely phenomenalist. I thought a comparison of the two would make clear the limitations of Pickering's dialectic, which offers no way (except verbal) to make possible a real integration of different elements of practice through their incorporation into a practical scheme of action, which orients (and thus limits) future action [YG, 319–20]. The second section discussed Pickering's return to realism, and showed that his approach was simply a restatement, in a new language, of classical positions, using terms too loose to effect a 'renewal' of the debate. But on these sections, Pickering has nothing to say.

The third section, on agency, again focused on a concept central to Pickering and followed in detail the way in which this 'agency' supposedly works. I concluded that since things 'just happened' (as Pickering writes so many times in his book), agency was in fact a kind of inertia that just *resists* action, instead of acting by itself. For if words have meaning, 'agency' must be more than 'resistance'. It is in this context that I sketched out the example of the blind man. I insisted that I thought this discussion purely metaphysical, but that it could not be passed over, given the importance it

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seemed to have for Pickering. Now, true to his 'metaphysical turn', he devotes most of his Response to this example, although it takes less than two pages out of sixteen in my Review. Though I used that example, as well as Otto Sibum's reconstitution of Joules' experiment, to talk about the problem of the persistence of entities in time, which makes Pickering's concept of emergence problematic, his comments are limited to repeating that things really emerge in time. Thus he tells us that before Glaser embarked upon his project, 'there were no bubble chambers anywhere' [AP, 308]. Of course there were none, but the point here is that, as I wrote in my Review, Pickering again confuses *machines*, which are composed objects, and *entities*, which are not composed; they thus 'have a distinct ontological status' [YG, 326]. And to make things even more complete, I added [YG, 333, note 12] that 'effects' like Hall or Zeeman effects also had a different ontological status, only to make clear that if one wants to talk about ontology one should take these differences seriously, or at least *argue* against them. This I take to be the kind of confusion that makes Pickering's 'metaphysics' superficial. But in his Response, Pickering chose not to raise (or to grasp?) those questions, preferring to repeat the obvious: the bubble chamber did not exist before Glaser, and here is a proof that things emerge in time . . . .

Section four took up the question of Pickering's 'theory of everything' (TOE). Far from a simple 'mockery' [AP, 310, note 2], this section took seriously Pickering's writing about '*cabalos, virinculi, montani*', and other demons [*MP*, 243]. By the way, I must note that in the reviews I have seen of *The Mangle*, no-one seems to have taken that part seriously: reviewers, curiously, simply pass over in silence on the concept of 'non-standard agency'. As a firm believer in argumentation and in charitable interpretations, I choose to look at the consequences of what seems at first sight to be a 'non-standard analysis' in the sociology of science. But to be complete on that topic, I should have added that for the blind man of my example, if things happened to move around him in curious ways, he would probably attribute that to a playful friend playing tricks on him, before thinking about ghosts, or any other non-standard agency . . . . In all cases, however, he would apply the principle of sufficient reason: nothing happens without a reason. And I am ready to bet on this anthropological description of what he would do! The other comment I made on Pickering's TOE was, I think, also important, but was somehow made difficult to read. I thus take the present opportunity to correct a sentence that contained two important typos that made it incomprehensible. I noted that by making his concepts applicable to everything, he was falling into an old trap described long ago by Aristotle, that 'there is an inverse relation between the *extension* and the *intension* of a concept' [YG, 326] – or, in less philosophical terms, a notion applicable to everything is empty. But on this Pickering has nothing to say.

Section five discussed what I saw as a 'spontaneous breaking of symmetry' in Pickering's treatment of humans and non-humans. On the one hand, he writes that since he cannot attribute goals to non-humans,

while he cannot make sense of scientific practice 'without reference to the intentions of scientists', the symmetry between humans and non-humans 'appears to break down' [*MP*, 17]. In his Response, Pickering criticizes me for effecting a 'clean split between the human and the non-human' [AP, 309]. Now, as any reader can see, it is Pickering himself in his book who 'effects a clean split' in giving intentions to scientists and refusing them to objects which only react to human actions. My blind-man example took that assymetry into account, so it is no surprise that it is not symmetrical. By saying that my story of the blind man 'invites us to think about how we humans individually or collectively come to terms with a *dead* and *uninteresting* material world' [AP, 309, emphasis added], Pickering is nearly right – except that the little particle 'and' is here again creating confusion by amalgamation: *dead* yes, but *uninteresting* no; objects *are* dead (excluding the living ones of course, which are not treated by Pickering) but very *interesting* for scientists, as well as for historians and sociologists of science. Instead of commenting on my being 'traditional' (curiously not seeing its ironical tone), Pickering could have used space to explain why he is in fact not symmetrical in his descriptions of actions, and why symmetry should be expected *a priori*. Clearly, my comments meant that I was willing to be enlightened on that apparent contradiction in the book: but, despite the clear title of that section of my Review, Pickering does not seem to have grasped the problem.[3]

This brings us to the section on individualistic history, which suggested, again on the very basis of Pickering's descriptions of events, that compared to the original analysis of the bubble chamber and N/C technology provided respectively by Peter Galison and David Noble, Pickering's treatment was turgid in style and fundamentally based on a very individualistic treatment of action, which goes so far as stating (as, again, I noted in my Review) that 'scientific objectivity can be located already at the level of individual practice ... prior to any social ratification' [*MP*, 196]. I then noted that this view is hardly compatible with Pickering's self-professed pragmatism [YG, 330], but that does not seem to be a problem important enough to be raised in his Response. When looked at from the point of view of the general structure of the narratives proposed, it is plain that everything in them is like a ping-pong game, be it between Morpurgo and his apparatus, Glaser and his bubble chamber, or even between workers and management. And it is significant that, as I noted in my Review, Pickering admits that he could indeed have told the story of Morpurgo along the same lines as he told the story of Glaser [*MP*, 72–73]. The problem was not the absence of macrosociological actors, but the fact that they are all treated similarly in a simple diadic relationship. But only a detailed comparative treatment of the different narratives could show that convincingly, and the examples provided in my Review simply pointed the reader in the right direction, so that s/he could easily find others.

We finally come to the last section, on resistance and constraint. Here the point is not the inability to 'imagine any alternative to ... constraint other than "total freedom" ' [AP, 311, note 8], but to see how Pickering

manages in his book to provide any alternative. It is true that he has 'nowhere stated that contingency is all there is' [AP, ibid.], but the book clearly insists (like a mantra) that 'things just happened', and the only concept used to limit total freedom is of course the 'resistance' of the objects. But as I suggested in my Review with the example of Mozart [YG, 331], there are often social structures that play an important rôle in limiting possible actions. But here again, Pickering chose not to raise these questions.

Pickering may be right that 'the better arguments do not always win the day' [AP, 310], but they certainly have more chance of doing so when their presentation is not too mangled and, above all, when their author takes the time to answer competing arguments point by point by paying attention to their precise formulation, instead of simply stating that the original arguments were 'hard to grasp'. But this is not an easy task when one is contemplating one's own *oeuvre* from the top of a mountain, while looking down on those who tediously try to make sense of the bits and pieces of arguments collected in a book and who, finding them wanting, simply point to inadequacies, ready to be enlightened in their valley of the blind.

Notes

1. Andy Pickering, 'In the Land of the Blind . . . Thoughts on Gingras', *Social Studies of Science*, Vol. 29, No. 2 (April 1999), 307–11 [hereafter 'AP']. For my Review, see Yves Gingras, 'The New Dialectics of Nature', *ibid.*, Vol. 27, No. 2 (April 1997), 317–34 [hereafter 'YG'].
2. His book, of course, is Andrew Pickering, *The Mangle of Practice: Time, Agency, and Science* (Chicago, IL: The University of Chicago Press, 1995) [hereafter '*MP*'].
3. Here is another example of the difficulty Pickering has in grasping an argument: he writes that it is false to say, as I did [YG, 332], that he engages with straw opponents, and mentions his 'ten-page argument with David Bloor on SSK' [AP, 310] as if I did not mention that explicitly in my Review, when I wrote [YG, 321] that he criticized SSKers for having excluded material resistance and limited themselves to social variables. Of course, the difference comes simply from the fact that, while noting these specific instances, I formulated a general statement [YG, 332], after having noted other instances of false debates [YG, 322, 329 & 333, note 8].

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