Class Science and Scientific Truth

by Richard Levins

I would like to devote this complete session to discussing a single contradictory proposition. All science is class science, yet science also finds out real truths about the world. How do these two propositions fit together? How do you resolve that contradiction?

First of all, you don't resolve contradictions. You certainly cannot perform any verbal construct which will remove that contradiction because contradictions in life are not resolved by intellectual formulas. The resolution of the contradiction between science as the growth of human knowledge and science as ideology of oppression comes only with political revolution. The break from radical philosophy to Marxist dialectical materialism is the recognition that contradictions aren't resolved by intellectual exercise. Rather, you recognize those contradictions, examine them, understand them, fight them, participate in them.

I'd like to deal with two false views that arise in discussing this question. One view would say that science is essentially ideology; science is created by the bourgeoisie in order to befuddle the masses. Therefore, the intellectual content of science is irrelevant and what is important is its purpose, namely, as a weapon. Scientific theories are therefore essentially capricious. For example, the essence of Newtonian physics is to justify mercantile capitalism. This view discounts scientific knowledge and lays the groundwork for the various kinds of anti-scientific and mystical humanisms that have arisen at the present time as part of a resentment against the oppressiveness of modern technology.

Kedrov

The second view is economic reductionism. It is exemplified in some of the works of Bonifati Kedrov, a leading Soviet theoretician, on the development of science. Kedrov's analysis is that science develops as the result of the interaction of two sets of factors. Note that we are already dealing with a factor theory. First, that science resolves the problems presented to it by society in order to meet the needs of society, and, second, that science does this only if its own internal logic is in the right condition.

Kedrov's two-factor model for the development of science is a polemic against the belief that you can simply assign a task to science and expect it to be fulfilled. It is therefore part of the struggle insisting upon the autonomy of science in the Soviet Union. Absent from this model is any consideration of classes, of class struggle. When Kedrov posits that science resolves the problems presented by society to meet the needs f society, he doesn't consider who presents what problems to whom, and what makes a need. For instance, he talks about the need for society to have cheaper sources of energy. He ignores the fact that individual capitalists now go out to beat each other; it wasn't a question of an energy shortage in the last century. It is a question not of inability to produce more, but of the unfolding of capitalist competition. So Kedrov has taken classes out of the picture and sees science as a logical unfolding--on the one hand of its internal logic, on the other hand of the needs of society.

This view of science doesn't hold in relation to evolutionary theory, to cosmology, or to the other important scientific theories. Science becomes linked to production at a particular point in its development. Science has had different social functions at different periods. In the same way that there were court poets there were court astronomers. This differs from science being used in the development of commodities, or in a systematic rationalization of particular social relations, which are some of its major social functions today.

Now, it's necessary to combat both of these major views on the nature of science, and particularly the view that science is simply the unfolding of knowledge. Kedrov recognizes that science is different in different countries, and he says the idiosyncrasies and historical traditions of each country will stamp a character on that science. However, these are cancelled out when you deal with universal science. So he visualizes world science as a whole relatively free of the historical circumstances of individual countries. It follows from this that good people all over the world will participate in an international, universal science and will meet as colleagues regardless of the political system from which they come; and that developing countries should strive to reach thelevel of advanced science as quickly as possible.

Here is where we get into the political significance of these ideologies of science.

Science and Colonialism

First of all, science is part of bourgeois hegemony. In the colonial world, when

the foreign occupying troops retreat, they leave behind their investments. When their investments are pulled out, they leave behind their advisors; when the advisors are kicked out, they leave behind the textbooks and beliefs. And then they offer scholarships to indoctrinate and train the rising scientific generation in their own way of looking at the world, as one of the last outposts of imperialist control. So the struggle for real national independence is partly a struggle for intellectual independence, the recognition that the relation between a developed and so-called developing country is not that between advanced and backward, but between different patterns of development. What is needed in third world countries seeking to develop their science is not catching up with the science of western Europe and the United States, but making new departures--going a different direction in the social organization of science, in the way it sets problems, in the methodology.

Increasingly, we're recognizing these differences in many of the intimate details of the ways science is carried out. A scientific style sometimes has nothing to do with the nature of the problem but rather with the social conditions operative in the scientific community. For example, in order to study the growth of plants, you can put them into a controlled temperature chamber. You automatically regulate the light, the temperature, the humidity, and you have sensors every six inches detecting what's going on; then you put different plants into different chambers and see how they grow. Technically that's incredibly difficult to do. And so in your own country you can sit back and look at Madison, Wisconsin, where they have such a machine, and drool and say one day you'll have one too. Or you can say: in different parts of our country there are many kinds of different conditions. We can study the growth of plants under different conditions by taking what we have and watching it closely.

Or perhaps we'd like to study the patterns of wind. How do you do it? You can put up anemometers and measure the wind and get records for fifteen or twenty years. But you can also ask people who work with wind. Fernando Boytel, a Cuban meteorologist, in his book on the wind map of Oriente, describes how you can learn from different people in different trades. It's not just saying science can learn from people in the abstract. Charcoal makers work with wind. If the wind shifts they can lose their charcoal; it turns to ash. People who install windmills on ranches for pumping water work with wind. They have another kind of knowledge. So the task of the scientist as presented by Boytel is recognizing the ways that different people in Cuban society relate to wind. How do they perceive it and how can we learn from them?

That does not mean passively accepting all these judgments either. It's a question of integrating all of the abstract knowledge that you can get studying physics with the practical detail and very rich knowledge of people in their own crafts and lives.

So the intellectual liberation from the norms of bourgeois science is important in order to make science possible in a developing country, and not to feel deprived in relation to the "big science" that you're trying to emulate.

Science as Part of Culture

Next, bourgeois science is a way of making the real scene appear necessary, by saying it's determined by objective conditions. Those who work in the field of decision theory and in departments of policy at major universities claim that they are developing objective ways of reaching decisions so that these decisions will not be influenced by politics. Therefore it is part of a process of democratization. It's a profoundly anti-democratic way of approaching the world, in spite of the fact that science's own self-description is that it's democratic because there is a marketplace of ideas.

Third, at the present time in the international radical Marxist movement, one form of revisionism is to cut Marxism down to size from a completely different way of looking at the world to an alternative social program. It's a very attractive thing to do because we can then say to out colleagues at the faculty club: "You and I have our differences of opinion--pass the olives, please—but we're really basically similar. We're philosophers, you're philosophers. Marxism respects science and philosophy. It's just that we have a slightly different program. We would like to serve the poor." Cutting Marxism down to a form of humanistic liberalism requires cutting Engels out of the club. It means saying we're not really challenging the world view but only the particular social program.

Finally, in Brecht's essay, "Five Difficulties in Writing the Truth," he points out that when it's not possible to confront the regime directly, one can at least teach a different way of looking at the world. Nazi ideology was strongly anti-intellectual. It's enough to talk about the creativity of thought. Nazi ideology was saying that human nature determines society. Talk about comparative anthropology. Brecht was saying that an understanding of the world is part of the culture of the people. This is one of the ways of fighting bourgeois ideology on all fronts, even if the particular things you're studying are not

obviously and directly political.

In the same way, questions of art, literature and poetry have become part of the common culture of the left, things to debate about. Questions of science, our understanding of the whole world, are also part of the struggle to win an intellectual liberation.

Class Science and Scientific Insight

When we say that all science is class science, that is not equivalent to saying that all scientific claims are lies. Class science can give powerful and valid insights into the world but within certain boundaries and restrictions. I'd like to give you several examples of how this operates. Let's start with Euclidean geometry, which you study in high school. The Pythagoreans represented one of the most reactionary classes of Greek society, the landed slave holders. They were concerned about the growth of trade and the movements of populations. The world was falling to pieces. It was therefore appealing to them intellectually to say that the important things in the world do not change. Study those things that cannot be contaminated by physical objects, that are not tied to time and place; find the eternal truths. And these are the abstract figures--the line, the point, the triangle.

Furthermore, because the Pythagoreans were slave owners and had a contempt for the labor process, the rules of procedure in geometry could not smell like work. You have all had the problem: construct with straight edge and compass a triangle equal to another triangle. The rule is completely capricious and arbitrary. You can't use a protractor, other kinds of instruments or tables. This fit into the intellectual needs of the Pythagoreans.

Now this approach yielded great insights into geometric figures. The geometric figure is important later on for the study of other kinds of mathematics and physics. When you get beyond the whole spirit of Pythagorean mathematics, some of their results--not all of them--carry over. Much higher plane geometry consist of exquisite theorems which lead nowhere but are beautiful. And if you really get into the spirit of it, it can be a lot of fun. For example, all the medians of a triangle meet at a point, all the altitudes meet at a point, and all the angle bisectors meet at a point. Furthermore, these three points line up in a straight line. You have to go through a very elaborate process to prove this, and as far as I know that result has never been used to lead anywhere else, but it is beautiful.

So the Pythagoreans developed a geometry which has real insights into the real world, but also has certain restrictions. It will not look at aspects of nature because the important things are abstract structures. What they do not consider is as important as what they look at. Furthermore, they come across classic problems of impossibility. The two classical problems which proved unsolvable in the ancient world were trisecting the angle and squaring the circle. There is no rule of construction by which the angle can be trisected, whereas it can be divided into two equal parts. This was a terrible problem for the Pythagoreans. The world seemed to be incomplete and unsatisfactory. In fact, you can trisect the angle easily. Measure the angle, divide by three, measure again and draw a line. Within the framework of Pythagorean geometry, this was an impossibility. Within another framework it is trivial.

It is the framework which reflects the ideology and the class position. The results of the Pythagorean theorem that A squared plus B squared equals C squared became the starting point for analytic geometry. Nevertheless, analytic geometry is a negation of Euclidean geometry. Analytic geometry starts out by saying: Let's locate our objects in coordinates. We can then do all sorts of algebraic manipulations which make the Euclidean proofs much easier and which also reveal new domains of problems. Objects become different. You no longer need to work only with straight lines; you can work with curves. Later on, the curves can be irregular. So a new dimension opens up. The history of mathematics seems like a step-by-step progression, but, in fact, the whole philosophy of analytic geometry was different. Advances in mathematics involve both a continuation and negation of the previous kind.

Newtonian Physics

Newtonian physics posits that the object of interest, the problem, is the movement of masses from one place to another. What makes this the central problem of scientists in the Newtonian period is that mercantile capitalism is less concerned with transforming things than obtaining them from one place and selling them elsewhere. But the people who live there may not like it, so the other problem is ballistics. Newtonian physics can solve problems of motion quite well. So Newtonian physics is not a lie as far as its equations describe the movement of objects. It is a lie when it says that the important things about the world are changes in position of objects which themselves are not changing.

Newton stated as one of his laws: Bodies at rest remain at rest and bodies at motion continue at motion in the same direction and velocity unless impinged

on by an outside force. Taken literally, Newton was describing mechanical objects. That's okay within his framework. Extended to a view of the world, it is a very important part of the bourgeois epistemology. What it says is that the world would be fine if there weren't outside agitators. Stability is the natural state of the world, and if change occurs, that's puzzling, strange and ominous and has to be accounted for.

This is very different then from the viewpoint of dialectical materialism, which says that things are the way they are because of a temporary balance of opposing forces; that therefore the stability of objects is something to be accounted for, and change is what we expect. Stability becomes a special case of motion rather than motion becoming an anomaly in a static world.

Time and Space

Newtonian physics does something else as well. It externalizes time. Time becomes a coordinate with which to measure things; it's taken away from the events that are taking place in time. This timelessness is important in order to do physics. You simply name it, "Time 1" and "Time 2," without saying anything else about what's happening. This fits in well with the bourgeois world outlook because, in the production process, the laborer has been separated from the product and sells only labor time. This abstract time is bought and sold, and that is what is being watched. As David Biggans showed in his paper, "Doing Time under Capitalism," many of the early labor battles concerned who kept the clocks. Finally you have a system in which time becomes separated from events; it becomes measured separately as an object of interest. So the Newtonian mechanics, which solves real problems and gives us a more profound insight into the movement of objects in the physical world, is also congenial to a world outlook in which class relations have changed. That accounts for part of the tremendous power that it had in reshaping thinking.

The Newtonian mechanical approach to the world also did something else. In physics, if you're interested in the movement of objects, you can represent them on a graph. You draw coordinates to measure distance east to west and distance up and down, and locate something within these coordinates. Then you say that sometime later the object is someplace else; it's here and it moves. You develop a good mathematical apparatus for studying how it moves. Once developed, however, it raises the question: Can other things be though about as if they were moving? We can talk about social relations as rank, as if one person was higher than another, and we visualize it in space.

Or we can have lines to represent inventory and employment. Soon you can locate or see how things are changing by using the metaphor "things are moving." Each axis represents a different gas--oxygen, carbon dioxide, nitrogen and neon. Oops, there are too many axes. So mathematicians come back and say it really doesn't matter. We can take the idea of dimension and extend it into another domain. Gradually abstractions coming from the insights of physics have been extended to other areas, sometimes legitimately and sometimes illegitimately. This is one of the characteristics of science: often scientific results give insights into domains far beyond those for which they were developed. How come? Is it just luck? Why do certain things keep popping up in very different domains?

Similarity and Difference

I think the reason is the strong interconnections in the world. Things are similar, linked, related to each other by development in such a way that understanding a process in one domain can give insight into a process in another domain. And the further we get away from the particular local details, the more profound the insights and the greater the possibility of getting insight into other domains. But there is a contradiction to this process. Things are similar but different. The relation between the two—the contradiction between the similarities and differences of objects--has played an important role in the development of science. If things were totally different, there could be no way of studying the unknown by using the known. If things were all similar, study wouldn't be necessary because it would be self-evident. So it's because things are both similar and different that science is both necessary and possible. How you relate the similarities and differences will depend very much on your class view of what kinds of similarities seem to be real and important, and what kinds of things are unlikely to occur because they don't correspond to your world outlook.

The relationship between bourgeois science and bourgeois ideology is, firstly, that science is informed by bourgeois ideology. Bourgeois ideology sets the problems, defines good solutions, says which objects should be used in solving the problem, how to talk about it, and when to quit. But then the conclusions of science feed back upon bourgeois ideology. Science interprets, abstracts, generalizes and otherwise assists in the interaction of the ruling class and those who are ruled. Science provides physical and intellectual tools to solve problems posed by the ruling class. On the one hand, science helps form and test its results against the common sense of the ruling class and, on the other hand, helps form the common sense of the ruling class. If a result of

science is congenial to the ideology of the ruling class, it quickly becomes incorporated into the common sense of the culture. However, if the result is contradictory to that ideology, it is isolated, co-opted or misunderstood.

Evolution

The Newtonian view of time, congenial to the bourgeoisie, fit into the common sense very quickly. The notion of evolution, however, was discomforting. Biologists since the time of Darwin have been attempting to study evolution without recognizing change. The pioneer in this was August Weismann. Weismann saw that the world is changing, that animals now are different from those of the past, but he recognized change only on the surface. What's really happening, he stated, is that the same unchanging objects (which he called the germ plasm and which now we call genes) are reshuffled. So the appearance of change is there but reality is unchanging. A recent theory of evolution does the same thing. It starts with the facts that animals are all different and populations are fluctuating but seeks to understand this by finding what is truly unchanging and stable. The solution proposed is that evolution is merely the changing proportions of genes in the populations. No matter what the animals look like or what they do or where they live, it's really secondary.

Thus there are many intellectual maneuvers by which one can take a scientific result and yet not really assimilate it. Similarly, the anti-theological implications of evolution are not fully assimilated into thinking. Especially since the historic compromise of science with bourgeois rule, science won the right to free inquiry within its domain in return for not rocking the boat. Science is not to extend those implications which are more revolutionary beyond the narrow technical domain for which they were developed.

Dialectical Materialism

Dialectical materialism also arises in the context of the development of bourgeois science. Like other areas of scientific inquiry, it first studied a particular domain. The insights of dialectical materialism came out of the study of class struggle and human society, the domain where contradictions are most sharp. There the insights appeared which can then give greater insights into other domains where perhaps they are less obvious. So from the class point of view--sharpened by class struggle--we also get insights into the workings of the most general processes of structure, complexity, change,

transformation, interconnection and so forth, which can then be extended and tested elsewhere.

Dialectical materialism shares with bourgeois science several properties which were important in the struggle against feudal obscurantism: the challenge to authority and the demand for evidence; the need for independent testing and judgment; the belief that knowledge is not self-evident and requires work; and the awareness that intellectual detours are sometimes necessary to solve problems. In that sense, the early socialists prided themselves in having a scientific view. Dialectical materialism is, at the same time, fundamentally different from science as it developed with the bourgeois revolution. It is located not in the ruling class but in the challenging class. It does not depend on elite geniuses getting insights into the mysteries of the universe but rather sees science as a struggle of a rising class to better understand and control its world. Because it wants to overturn the existing order, change becomes the central object of interest. J.B.S. Haldane pointed out that dialectical materialism has relatively little to say about being but a helluva lot about becoming. That is the object of concern. Our most powerful insights lie there. We challenge the notions of Newton that things at rest remain at rest, and favor dynamic views, which envision more intimate kinds of interaction.

The Law of the Excluded Middle

Bourgeois science rests on certain logical propositions. For example, formal logic books state the law of the excluded middle: things are either A or B but not both. How do we deal with this? One way is to say that those categories are irrelevant. It can be said that, in fact, you cannot divide the world into things that are mutually exclusive. But that is not quite true. Hummingbirds and scorpions are quite distinct from each other. What is true is that you cannot divide any system completely into objects which are mutually exclusive and yet not trivial. You can divide it into classes of things which are mutually exclusive by saying, for example: Let's consider all animals as one set and nothingness, the absence of animals, as something else. It's a verbal game that doesn't get you very far. My proposition is that in the real world there's no way of dividing things up into categories which are simultaneously relevant, complete, mutually exclusive and non- trivial. As intellectual abstracts you can do it. Let A be a set of objects and let B be everything that isn't A. So what?

Thus it is a proposition about the real world, rather than about formal logic--

thou shalt not divide the world into mutually exclusive, complete categories at the pain of making tremendous errors. When biologists talk about dividing the world into the organism and the environment, we have to reply that there is a very intimate interpenetration of organism and environment. Organisms transform their environment, they define their environment, they create environments, and they are environments for each other. Each part of the organism is environment for other parts, and so on. By looking at the interpenetration of these objects we get a much more profound understanding of the world than by making a separation.

Interaction is a grudging admission that the world is really connected. The idea of interaction is that things have a common influence on each other as factors but do not influence each other very much. Interaction is a partial accommodation to the observation of interconnections. Mortality in the United States, for example, is 50 percent lifestyle, 28 percent environment, another percentage medical, and so on. By breaking the totality down and assigning statistical weights bourgeois science accommodates to the fact of interconnection in the world, but without really accepting it as an essential feature of the world. The paradigm is still: isolate something as much as possible; break it into its smallest parts; change things one at a time; and when you cannot help it, bring in interconnection in interactional terms. Hence statistics in bourgeois science speak of second-order effects, third-order effects, and so on.

The Social and the Biological

So I think that Engels was far too optimistic in saying that science, in spite of itself, is becoming dialectical. It's kicking and screaming all along the way, making grudging recognition of those things that it cannot avoid. But the issues of interconnection are becoming increasingly political issues.

Interconnection, when we look at medical problems, means the inseparability of the social and the biological. Traditional epidemiology says that the cause of a particular disease is a particular kind of bacterium. Bacteria get into people through the water or air. Traditional epidemiology then gives an equation. If this is the number of people and this is the chance of being exposed to the bacteria; and if exposed, this is the probability that the bacteria can grow in lung tissue; and if they grow in lung tissue, this is the probability that you don't have resistance; a formula can be developed for a rate of epidemic. The equation makes it look as if traditional epidemiology is talking about nature. But each of the numbers put into the equation is also a

social event. What determines the likelihood that your lungs come in contact with a particular bacterium? It depends on crowding, housing conditions, and whether you're traveling long distances in cattle cars to work. It depends on urban air conditions as well as meteorological conditions. There are social aspects of resistance, too. Resistance is determined in part by what has been breathed in the past. We know that nutrition is important to disease resistance, and trauma also. After a while we realize that it's not a question of saying that there's a biological sphere and a social sphere and then finding their connections. Rather, the same objects are simultaneously biological and social; they are bacteriological entities at the same time as they are class entities. We always have to treat them from both perspectives in order to understand the dynamics of the system.

Environmental Struggles

In dealing with an environmental struggle, we face the same issues. The corporation officials urging factory expansion want to examine the environmental impact in the narrowest possible way. Can you prove that the dust from our factory is, in fact, going to kill children? Contrariwise, those opposing the company must argue that its actions have multiple effects. You don't know what will happen when chemicals spill out onto the limestone. Limestone is full of potholes. The chemicals may end up in the drinking water. The factory will kill plants; it will cause a decline in agriculture. The factory's wastes will affect fishermen. If the mangroves are cleared in order to build a wharf, the egrets won't have a proper place to nest; they, in turn, eat insects in the pastures. This means that the cattle farmers will have to use more insecticides. And so on.

As you trace the battle over any environmental issue, it is clear that the left is demanding a more complete understanding of the whole system while the right wants the problem narrowed to the technical detail. So the dialectical proposition--that the world is richly interconnected and must be treated as a whole system with contradictory aspects--becomes a hot political issue rather than simply a debating point in philosophy seminars. The same would be true of other propositions of dialectical materialism.

The Battle around Science

Scientists and people working around science and politics within a capitalist society are living within two different ideological worlds. We are living within

the world of bourgeois science and ideology which sets our problems and determines, to some extent, the agenda of science. At the same time, we are part of a revolutionary movement which says that's bullshit. Bourgeois science is evading the interconnection of things, refusing to take into account what must not be ignored.

The battle, therefore, for dialectical materialism is both an abstract one involving the most profound differences about the way in which the universe is viewed and also one of very practical politics. We get into the battle of planning health services, utilizing natural resources, studying impact on the environment, problems of conservation. All of these are battles in which self-conscious Marxist understanding becomes essential for an independent position. In the developing countries, it is a struggle for a different science, which is intellectually independent and geared to the needs of the new society. But in a world in which science is intellectually dominated by the bourgeoisie, it becomes necessary to confront bourgeois theory, to transform, negate, use and battle against it. And that's what creates the richness of the panorama we're in, the battle around science: being in, but not of, bourgeois science, battling from the inside but only on the condition that we have space outside. Otherwise it is impossible. It's idealist to say that we are going to transform science and make it dialectical. In fact, our commitment is to produce not a better differential topology but rather the power of the working class.

Discussion

Q: Is science literally class science or do interpretations of scientific knowledge differ because the knowledge is seen through the filters of different ideologies? Is it possible that some scientific knowledge can be incorrect or incomplete because it derives from methodology that is limited by a particular ideology?

RL: The question proposes an alternative model of science which says that science gets objective knowledge about the world by interacting with the world; however, this objective search for knowledge is distorted, blinded or inhibited by class perspective. If so, the truth of science comes from its being free of class; its falsehood comes from the biases of class. Therefore, the task becomes to peel off the class skin over an objective, rational kernel. I would say, in opposition, that both the falsehoods and truths of science are class-determined. Only by defining some sort of mystical body of science can we have a separate zone, an ideal creation which is the objective part of science as distinct from its zone of class science. Class position is the negation not of

objectivity, but its mode of operation. At the same time, the lies, short sightedness and narrowness come from class position as well.
This is true even of a rising class. So the dichotomy that reactionary classes have lies about nature while progressive classes have truths about nature is not completely true. Precisely that class which is most desperately struggling to solve the immediate, urgent and pressing needs of the people will also be most impatient with theoretical detours that seem to postpone these needs.

Therefore, class viewpoint is intrinsic to all intellectual processes. That by itself does not guarantee that something is either true or false. When we talk about the state of a science, we have to talk about not only its positive propositions about the world but also what it is silent about. The pattern of ignorance is as much a product of the science as the specific knowledge. We see most strongly the biases of class viewpoint in the pattern of knowledge and ignorance. This is true, for example, in epidemiology, agriculture and pest control. What is defined as out-of-bounds or irrelevant is an intrinsic part of the ideology of that science. So I think that the notion of science simply as a list of positive results is misleading.

Q: As Marxists we want to develop a better knowledge of our world in order to improve our conscious praxis. Can one of the panelists suggest more precise steps in the process of problem-solving? Shouldn't we start by clarifying the empirical data, looking for laws of average and regularity, and proceed toward the formulation of laws and interconnections that can describe the actual process?

RL: It's a tricky business to set up laws about scientific method. They have a spurious universality that doesn't work. Dialectical materialism does teach us what to be suspicious of at the beginning. For instance, one starting-point is to ask why is this scientific problem being posed? Why do we want to solve it; how did it get on the agenda of science? Whose question is it? Many of the questions about the hereditary basis of behavioral differences between human races were put onto the agenda of science by racists. We know the history and political content of this branch of science. It's always important to see where a problem comes from before we decide whether it's a real problem and what to do with it.

Secondly, it's a good rule of thumb to assume that things are far more transitory than they appear, and what seems to be universal probably is not. Find out the areas or aspects in which it is not universal.

Third, what is it connected to? As against the bourgeois paradigm that

isolates the question as much as possible, a lot of us brainstorm as far afield as possible. What possible connection might there be between this object of study and others of your concerns? We get into fantasies that have to be discarded later but it's less prone to error than the assumption that things are unrelated until proven otherwise.

Fourth, talk to people who are affected by the problem. They will always have a more sensitive knowledge and will make more subtle distinctions than the academic description. In that process be ready to learn, but not necessarily to believe everything. For instance, Fernando Boytel found the peasants in one part of Cuba believed that trees sometimes grow toward the wind rather than away from the wind. What he found is that they grow away from the wind but toward the light, and growing toward the light might overrule the wind advantage. So you enter into a dialectic with the knowledge of the people in which you integrate theoretical knowledge obtained from scientific praxis with the detailed, intimate knowledge of the masses of people who have direct interactions with a concerns for those objects of study.

Fifth, which intellectual tools are needed for resolving a problem, and why? You have to ask, are we doing this with an ultra high- speed, super-duper blinkatron because the company has a salesman at this university or is it that it is really the best way of getting the knowledge we want?

We challenge what science does because it's a social process in which the self-evident truths of science are the shared biases of that community. The rules of scientific objectivity in testing are adequate for filtering out the random errors that separate individual scientists, but not for picking up the shared biases of their class position. So always be suspicious, look at things as broadly as possible, and then be skeptical of the results.

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