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Separating Disputes over Facts from Disputes over Values

(with Andrew Marino and Robert Becker)

The classical argument over the relationship between facts and values has been extended to technical controversies, with critics objecting that a clear separation is impossible. This argument has obscured more than it has clarified, since it suggests that a total separation of statements of fact from any evaluative statement is necessary. That is not true. All that is required is a separation of blatant evaluative or normative statements from statements of fact. Values which are shared by all the contending interest groups, or values which are too subtle to affect practical decisions, may be intertwined in the statements of fact without causing a problem.

A practical decision to build a nuclear power plant can easily be analyzed into factual questions, such as "How many cancers-per-year will be produced in the population exposed to radiation?" and into normative questions, such as "How many cancers-per-year should be accepted in exchange for the amount of electricity generated by this plant?" The problem is not so much that questions of fact and value are not empirically separable, but rather that an adversary may find it rhetorically useful to state his factual hypotheses in terms which make them difficult to evaluate.

It is intrinsically difficult to demonstrate the absence of an effect or the impossibility of an event. An opponent of apple juice might argue that apple juice, consumed at the rate of five gallons per year per

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person, has harmful effects on the human organism. Proponents of apple juice would probably dispute this statement, which might then be argued before the judges of a science court. Consider now the positions of the judges: in order to reject the hypothesis, they must have evidence of "No effect" on all conceivable forms of mortality and morbidity. This is nearly impossible. Furthermore, even for the forms of mortality and morbidity which the defenders of apple juice did examine, the most that they would be able to say would be that they *discovered* no harmful effects, which is a weaker statement than that there *are* no harmful effects. The problem here is the intrinsic difficulty of proving the nonexistence of something-even if it does not, in fact, exist.

The report of a science court would certainly not affirm the dangers of apple juice, but neither could it reject the hypothesis outright. The report might, therefore, be interpreted as casting doubt on the safety of apple juice, even though there is no basis for such concern.

Adversaries might find it useful to state their hypotheses in vaguely probabilistic terms which contain no clear-cut criteria for realistic assessment. It might, for example, be asserted that "ionizing radiation probably increases all forms of cancer in humans." "Probably" is a vague term; judges have no clear criterion for deciding whether or not an effect is "probable." More precise criteria are easier to evaluate, but may sometimes be as misleading as vague terms.

Suppose the hypothesis had been stated as follows: "A population exposed to 170 rads/year of ionizing radiation will have significantly more colon cancers than a similar population not exposed." "Significant" has a precise meaning in statistics, i.e., that the probability of erroneous rejection of the "null hypothesis" is less than .05. If $p = .06$, then the null hypothesis is-in the technical sense-sustained, even though this result would clearly suggest that radiation actually did cause the cancers.

We must expect these kinds of rhetorical devices to appear in the factual statements which adversaries submit. For example, a scientist-opponent of the supersonic airplane has suggested that a science court examine this hypothesis: "In 1971 there was sufficient scientific evidence to establish *probable cause*...that 1.8 million tons per year of nitrogen oxides [as NO_2] injected by supersonic transports... at an elevation of 20 kilometers would reduce stratospheric ozone by...a global average of up to 20 percent. ..." At first glance, this looks like a precise, factual statement. But the phrase "probable cause" is vague, with no clear criterion for deciding whether or not it could have been established.[1] Furthermore, the claim that ozone is reduced

"up to 20 percent" is necessarily sustained with any reduction greater than 0 percent, no matter how small. In order to refute this claim, one would have to demonstrate the nonexistence of any reduction. Thus, the hypothesis has been stated in a way that there is little risk of the claimant being shown to be wrong.

It would be a great error to assume that adversaries purposively distort facts as a ruse to support their own positions, though it would be naive to believe that this *never* occurs. In particular, it is wise to take into consideration the pressure on a technical expert who is engaged in a heated controversy, especially if he is opposing an "establishment" position with few resources of his own. There is a common tendency in such a situation to take a defensive posture, stating one's technical position in a manner that provides little opportunity for a clear refutation by the other side.

When such statements appear on both sides, as is frequently the case, the task of sorting out *who* is saying *what* is exceedingly difficult for the layman. The sophisticated judges of a science court would have an easier time sorting out the claims, but the difficulty of evaluating such statements is great. Obviously, the substance of scientific dispute must be stated in a way which allows meaningful assessment through scientific methods. This is true of any other procedure which requires the separation of factual disputes from value disputes.

The Role of the Referee

In the science court procedure, a referee has the task of obtaining factual statements with supporting documentation from the adversaries, determining which statements are accepted by both sides and which are not, and attempting to mediate differences between the sides. No doubt, much of the mediation will focus on problems of wording, such as are discussed above, so that the substance of the factual claims will be stated in a manner that allows fair assessment, allowing either a confirmation or a refutation by reasonable scientific means. It would appear that procedures other than the science court would have the same problem in separating factual disagreements from value disagreements, and, therefore, would require some mechanism to function as a referee.

Given the central importance of the referee function, it is disturbing that we have little sense of the feasibility of performing this role. The relationship between adversaries is usually hostile, and the referee has no sanctioning power with which to enforce the cooperation

necessary for the production of workable factual statements. It would not be surprising, under these circumstances, to find that each side's statements are so "loaded"-so prohibitive to adequate testing-that the entire procedure falls apart.

In order to assess the workability of the referee's role, I attempted to promote an exchange between technical experts who were involved in a controversy over high-voltage transmission lines.

The Transmission Line Controversy

Citizens' groups in upstate New York and in Minnesota have opposed the construction of new, very high-voltage transmission lines. As in most other technical controversies, objections include both technical and nontechnical issues. Opponents of the proposed construction are afraid that the lines are more dangerous than the utility companies realize, or will acknowledge, and there has been dispute over the magnitude of the hazards associated with extremely low-frequency electromagnetic fields of the type which these installations would produce. Technical presentations by both sides of the controversy have appeared in the permit hearings of the New York State Public Service Commission. More- or less-adequate summary accounts have been reported in the mass media.

Quite apart from this scientific issue, there have been objections to the use of the power of eminent domain by the utility companies to enforce the purchase of rights-of-way from farmers who are reluctant to sell sections of their land; this is seen as infringement of individual property rights. Other issues which have been raised are that (1) construction of the lines would promote the related construction of nuclear power plants; (2) utility companies do not serve the public interest; and (3) certain elected officials have not properly performed the duties of their offices. In Minnesota, particularly, there have been destruction of property and incidents of physical violence between the protestors and national guardsmen who were sent to protect the construction sites.

Drs. Andrew Marino and Robert Becker, of the Veteran's Administration Hospital in Syracuse, New York, have been technical critics of the lines, and have argued their case in public hearings and other community settings. I attempted to act as a referee between Becker and Marino, the salient technical opponents, and four experts who were closely associated in hearings and published accounts with the argument that fields from the transmission lines are not hazardous.[2]

The Procedure of the Referee

Could a referee elicit from experts testable statements of alleged facts which seemed relevant to the policy issue, but were relatively divorced from strong value implications? Acting as referee, I wrote to each expert involved, identifying myself as a nonpartisan, and explaining my interest in the transmission line controversy as a test case for a science court; I enclosed an article about the science court from *Science* magazine. I asked for aid in constructing and critiquing a list of alleged statements of fact which are under dispute.

Most of the experts contacted did respond, although some of them required reminders before they did so. Most of them, apparently, read the *Science* article, and made some effort to construct or criticize the facts lists. However, only opponents of the lines produced explicit lists. The other experts cooperated mainly by providing me with critiques of those lists, which I then channeled to Becker and Marino. Becker and Marino then prepared a revised list in response to the criticisms, which I sent to the pro-line experts along with a request for comments. Three of the four experts who received the list responded.

Of course, this procedure was only a rough approximation of that which would occur in the initial phases of an actual science court. But it did carry out the crucial attempts to enlist the cooperation of experts who—in some instances—regarded one another with enmity, and also to obtain fairly worded statements which would set out the areas of factual disagreement. What, then, was the result of this attempt?

Revision of the Lists

The strategy of Marino and Becker in compiling their original list was to assert first that biological effects from transmission line fields were *possible,* since they believed that at least one of the pro-line experts had maintained that such effects were not possible. This done, they then asserted that biological effects were not only possible, but *likely.* Finally, they argued that such likely effects cannot be shown to be safe (and therefore, it is inferred, may be dangerous).

Here are the explicit points of their argument:

1. Extremely low frequency (ELF) electric (and magnetic) fields *can* cause biological effects in human beings exposed thereto.

2. It is likely that ELF electric (and magnetic) fields associated with high-voltage transmission lines will cause biological effects in human beings exposed thereto.
3. No biological effect that is likely to occur in human beings exposed to the fields of high-voltage transmission lines can be shown to be nonhazardous.

This list was criticized by most of the pro-line experts as vague and untestable. The first statement, asserting that the fields *can* cause *biological effects* in humans, was criticized because they felt that the term "biological effects" is too broad to be meaningful in an empirical sense, given the wide variety of such effects which would have to be examined. Also, the statement that the fields *can* have effects is irrefutable, because opponents would have to show the converse: that fields *cannot* have effects. This is the problem of nonexistence which was discussed earlier. This same problem appears in the third statement which requires for refutation a proof of the nonexistence of hazard. `The second statement maintains that field effects are *likely,* but there is no clear criterion for assessing whether or not an effect is "likely."

This initial list of statements shows the tendency—a common one in acrimonious dispute—to make ostensibly substantive empirical claims which are logically or pragmatically irrefutable.

To appreciate the impact of the exchange of statements and critiques among the experts, one must be aware of the fact that the opposing sides had had virtually no direct contact during their long involvement in the controversy (from 1974 until 1977), and they never before had been called upon to compare their scientific positions on a point-by-point basis. An important misconception soon became apparent. Becker and Marino had attributed to one pro-line expert the view that it was impossible to produce biological effects from low-intensity fields-a view that that expert denied to me, acting as referee, that he held. Thus, at least one point of dispute was settled by the exchange.

Becker and Marino prepared a revised list in an attempt to respond to the critiques of the first list; this list appears in Exhibit 7. Here their allegations are phrased in the form of epidemiological hypotheses with a degree of specificity that is common in standard journals in that area. They alleged that people exposed to fields created by transmission lines (of a given design) for a period "as short as five years" will differ from a control population not so exposed in several enumerated characteristics.

EXHIBIT 7

Revised List of Facts Relevant to Siting Electrical Transmission Power Lines

People exposed for a period as short as five years to the electromagnetic field created by a 765 kV transmission line (as specified, for example, in "Application to the State of New York Public Service Commission for Certificate of Environmental Compatibility and Public Need," submitted by Rochester Light & Electric Corporation and Niagara Mohawk Power Corporation, January 1974) will be more likely to differ from a control population not so exposed in the following characteristics:

1. Growth, as measured by rates of change of physical parameters (e.g., height, weight).
2. Biological stress, as measured by physiological indicators (e.g., corticoids, serum proteins, circulating lymphocytes, blood pressure) and incidents of stress-related diseases (e.g., gastrointestinal and cardiovascular disorders).
3. Functioning of the central nervous and cardiovascular systems, as measured by neurohormone patterns, EEG, EKG, and the ability to adapt to blood volume changes.
4. Psychological behavior, as measured by decision-making capability, rates of acquisition of learned responses, gross activity level, reaction time, short-term memory, and motor coordination.

A refutation of this type of statement no longer requires the impossible demonstration that these fields *cannot* cause effects. An adequate refutation would consist simply of a comparison of exposed and unexposed populations and a demonstration that differences between them are no greater than one would expect by chance, using conventional levels of statistical significance. (The statement could be improved by specifying the details of such a study, including significance levels which would be accepted as test criteria).

Becker and Marino attempted to add specificity to their statements by listing four broad biological variables as effects and then giving specific indicators which are conventionally measured in physiological and psychological research on these broad variables. One such broad variable, and its exemplar indicators, is "Growth, as measured by rates of change of physical parameters (e.g., height, weight)."

One pro-line expert wrote that the revised list was still "almost impossible to judge...on the basis of current scientific knowledge or through a reasonable, empirical experiment." He suggested cogent improvements, such as a better specification of both the level of the electromagnetic field and the period of exposure alleged to cause effects. He also pointed out that the specification of exemplar indicators for the broad biological variables leaves uncertainty because, if no differences appeared on these exemplars, Becker and Marino could respond that additional indicators should be examined, and they would again be in the bind of having an infinite variety of indicators that

might be considered. This expert suggested a complete specification of the indicators that would be examined; these modifications could be incorporated into a further revision.

Two other pro-line experts found the revised statement sufficiently specific that they could disagree that the allegations were true for humans. The fourth pro-line did not comment on the revised list.

The statement of alleged facts could be improved further, but there is little doubt that the revised list is a substantial improvement over the initial list. These results support the contention that a referee can obtain from opposing (and hostile) experts a list of alleged facts which are empirically meaningful, which are points of disagreement, and which are reasonably separated from the policy decision. In this case, the appraisal of biological effects from electromagnetic fields can proceed independent of decisions on whether or not to build transmission lines, or on levels of risk which are "acceptable" to the public.

Politics Dominate Scientific Inquiry

There is one more lesson in this largely-successful attempt to separate the factual disputes of the transmission line controversy from its value disputes. Once done, it was not possible to bring the experts together to debate their positions on factual issues; the pro-line experts as a group did not want any sort of involvement in a science court procedure.

Why were the pro-line experts reluctant to act as adversaries? One of them objected to the idea of a science court: "The concept of a `Science Court' is foreign to the scientific method, ..." "the adversary approach...is anti-science." One of them objected specifically to Marino as an opponent, claiming that "his arguments and conclusions are sophistic."

Some of the pro-line experts thought that the public exposure of a science court was more likely to hurt than to help their side. One said that it "may impute scientific credence to Dr. Marino's arguments which they do not deserve." Another said that the transmission line issue should not be considered in an untried science court, because it might "go wrong." One wrote: "It would be unfortunate to find that, as a result of untested procedures...the science court might directly contradict the deliberate considerations of these same issues by well-established bodies such as the National Academy of Sciences...The potential impact upon the Nation's system of transporting electrical

energy which might result from a Court decision inconsistent with those of other government agencies ought to be seriously considered in determining whether these issues are ripe for science court arbitration, particularly in the absence of any prior experience with such a court."

In the transmission line dispute, it is the proponents of technological development who object to a debate of scientific disagreements, in part, because it publicizes and perhaps legitimizes environmental criticism of the lines. Why, after all, enter the debate if it is more likely to improve the relative position of the other side than of one's own side?

This response emphasizes that many technical controversies are primarily disputes over political goals and only secondarily concerned with the veracity of scientific issues which are related to these goals. Why, then, should anyone care about resolving factual disputes? If the final report of a science court would probably not alter the positions of the adversaries and their interest groups, why bother?

One reason is that a reasonably sophisticated and relatively unbiased report on the factual matters in dispute could have an important impact on that portion of the public which has not yet taken a side in the controversy, but whose interests are at stake. If, in the controversy over the fluoridation of drinking water, a science court reported that there were, indeed, grounds to doubt the safety of fluoridation, then it is likely that previously uninvolved people would join the opposition to fluoridation in their communities. If the technical objections raised against transmission lines or nuclear power plants were found to lack any scientific basis, and this was reported by a credible source, then political power would most likely shift to the proponents of these technologies as electricity became scarcer and more expensive, and previously nonaligned citizens became involved. The resolution of factual disputes may not serve the interests of those directly involved in the debate, but it would be in the best interests of the public at large.

Notes

1. Johnston (1976). A footnote adds, "In legal matters, *probable cause* is sufficient for a grand jury to recommend that a case be tried in a court of law, rather than be dismissed.

2. During this exercise, I acted independently of Marino and Becker. Afterward, we three decided to share the lessons learned during the dispute.