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THE FUTURE OF OTA

Structure and Governance

The experience of the last fifteen years has, I think, confirmed the wisdom of the present governance of OTA. In the report of the ad hoc Panel on Technology Assessment of the National Academy of Sciences, a number of possible models for an OTA were considered, including both a Congressional and an Executive Branch locus. The Panel never reached a consensus, although it seemed by a small margin to favor a mechanism centered in Congress with considerable ramifications in the Executive Branch.[1] In the end the Congress chose a purely Congressional office supervised by a non-partisan Technology Assessment Board (TAB) comprising equal representation of both houses and both parties, with the chairman and vice chairman being of different parties and the chairmanship rotating between the House and the Senate. In the Technology Assessment Act of 1972 as originally proposed, the Technology Assessment Board was envisioned as an independent board comprised of balanced Congressional membership and a majority of part time outside public members appointed by the President. To the disappointment of many in the science and engineering community who had been advocating the OTA, a floor amendment proposed by Congressman Jack Brooks eliminated the public members and any involvement of the Executive Branch in the appointment process. As a concession to the concerns of the technical community, the final version of the Act provided for a Technology Assessment Advisory Council (TAAC) composed of experts from outside government, which would be appointed by the members of the TAB and would be

purely advisory.

In retrospect I think this amendment was very wise, although I did not believe so at the time. The exclusively Congressionally-oriented governance structure gave a political legitimacy to OTA which it could never have achieved with any of the original organizational concepts. It came closest to the Joint Committee model proposed by the ad hoc Panel, although that model had envisioned a system of outside contracts and grants administered by an executive agency under the direction of the Joint Committee.[2] Nevertheless, a temporary price was probably paid for the final arrangement. Although it had very high political legitimacy, especially in the Congress, it lacked credibility in the scientific and engineering community and experienced difficulty in establishing professional standards of staffing and operation--a problem that has now been almost completely overcome, largely due to the skillful and sensitive management of the present Director.

Perhaps another price paid for the present arrangement is that OTA has never been able to assume the government-wide coordinating, reviewing, and standard-setting role for technology assessment that had originally been envisioned for it in the NAS Panel report.[3] In my view this remains a piece of unfinished business, which I will take up later in this essay.

As for the general aspects of staffing, mix of expertise and skills, size and mode of operation, I feel there is little to suggest in the way of improvements. OTA seems to have arrived at a good balance between extramural and intramural operations, and has developed modalities for obtaining inputs from a wide cross-section of the non-governmental technical community as well as the general public which are an excellent model for all advisory committees. At the same time, by keeping final

responsibility for the content of reports in the hands of the full-time staff, the office has avoided becoming a target for lobbying by special interests or people with parochial agendas. Although the staff has excellent specialized credentials, they cover a very broad range of assignments requiring "quick study" outside their immediate fields of expertise. In other words they operate as well-informed generalists rather than specialists or experts, thereby avoiding some of the pathologies of expertise in government decried by Laski.[4]

The Methodology of Technology Assessment

The OTA has adopted a general style and mode of approach in its reports which I think has been very successful and has contributed to the high degree of professional credibility that it now enjoys. Although this style is regarded as excessively non-partisan and non-normative by some critics with strong policy preferences, I believe it results in OTA achieving long term impact at the price of some sacrificing of immediate short term influence on policy decisions on the political agenda. While often providing a certain amount of ammunition to both sides in a controversy, it has also served to rule out by the force of its evidence and analysis certain arguments and contentions or "myths" which would have otherwise continued to plague Congressional debate. It has served an especially valuable function in clarifying the reasons for disagreements among experts, and helping to illuminate the distinction between technical disagreements and value-based differences. In this respect, OTA reports come closest to conforming to the model of "conflict mapping" recommended by Roberts et al.[5] An important mechanism is the project advisory panel system which aims at bringing to bear the widest possible range of viewpoints and types of expertise before the scope and approach of study

has been well defined.[6] The output of the Office, however, is not restricted to the final reports approved by the TAB, but includes a number of intermediate products such as proceedings of workshops, technical memoranda, and even reports commissioned from individual scholars. Few government reports are subject to as thorough outside review as the full reports of OTA, and I believe OTA makes more of an effort to secure review by potential critics than do most other organizations such as the National Research Council or the National Science Board. Furthermore, as described by the OTA director, Jack Gibbons, "OTA is explicitly organized to make its agenda of work a matter of public record" by providing "briefings, memos, and testimony on the status of the work and any preliminary results that are pertinent to pending Congressional decisions."[7]

In summary I have very little to recommend in the way of changes in the governance and structure of OTA, or in its relations with the Congress or other Congressional agencies such as the CRS and the GAO. It is important that the Director and the TAB retain final control of OTA's agenda, something that is greatly aided by the fact that it is able to respond to only a small fraction of the requests for studies that are directed to it. This provides a strong incentive for the Congressional committees to negotiate with the Director, the Board, and each other to reach agreement on the definition and scope of the studies it does undertake, often consolidating many different requests into a single, redefined study plan. Negotiation rather than unilateral control is essential to the agenda setting process, however, and it is important that this be understood by both sides. It is essential that this rather delicate relationship be taken into account in the recruitment of future directors and staff. I also feel that OTA must strongly resist the temptation to grow

and become more internally differentiated as the pressures on it increase. As indicated above, the very fact that the staff is too small to enable them to overspecialize is one of the greatest strengths of OTA, and that is probably a function of its relatively small size.

Relations to the Executive Branch and the Corporate Sector

In the original report of the NAS Panel, it was emphasized that for technology assessment to become an effective instrument of policy it was essential that it become widely diffused throughout the government and the private sector. To quote the Panel:

"The objective of any proposal we make--whether or not limited to federally influenced technology--should not be to transfer these assessment responsibilities to a new organization or to duplicate existing assessment activities in a new setting, but to subject such responsibilities and activities to critical review and constructive guidance in the hope of developing consistent principles and higher standards within a pluralistic frame. Any new assessment structure in the government should therefore supplement and coordinate existing mechanisms rather than supersede them. It should perform the function of examining and influencing the ground rules and criteria of evaluations that are conducted within the agencies themselves."[8]

To the extent that OTA's reports have been widely diffused, quoted and republished (and its reports have generally been best sellers compared with most government reports), OTA has provided a model for how TA should be conducted to both other federal agencies and the private sector. In this respect it has fulfilled the hope of the Panel that creating "a new identity for technology assessment" would "have a galvanizing effect in stimulating interest in the subject, providing an outlet for this interest

within the professions."[9] However, it is less clear how much it has "influenced the ground rules and criteria of evaluation that are conducted within the agencies themselves." With respect to environmental impact assessments this latter function has been performed by the Council on Environmental Quality CEQ), at least to the extent that it has provided guidelines for the required content of environmental impact statements. However, the EIS is a form of TA which is largely restricted to the assessment of specific projects rather than generic technologies, and there appears to have been little spillover from the EIS process to TA more broadly. Furthermore, the CEQ provided only guidelines for what should be considered in an EIS, but very little guidance as to "criteria of evaluation", e.g. the relative weight to be given to risks and benefits, or the distributional consequences of technological projects.[10]

It is true that OTA has occasionally published reports which evaluate or criticize reports promulgated by the Executive Branch. A notable example is the critique of the national energy plan put forward by ERDA in 1976 in response to a Congressional mandate.[11] A report on the use of global models, published in April, 1982, could also be considered as a critique (though implicit rather than explicit) of the Global 2000 exercise undertaken as an interagency effort near the close of the Carter administration.[12] But, generally speaking, OTA has done little to develop or exercise a leadership or coordinating role, other than by example, with respect to the methodologies or processes of TA, nor has it attempted to evaluate the performance of technology assessment in government agencies or industry. Its leadership, in other words, has been implicit rather than explicit.

It seems that there should now be sufficient experience with both

Technology Assessment and the Environmental Impact Statement process through federal and state government so that an authoritative critical evaluation of the state of the art as it is now being practiced could be made. Furthermore, a progress report might be issued every few years. In this way the knowledge and experience developed in carrying out individual TA's could begin to become cumulative and contribute to the continual improvement of the art. An example of what might be done is the CEQ's review of experience with the EIS process performed in 1976 but, to the best of my knowledge, never repeated.[13] However, even this review is neither as critical nor as authoritative as what I would have in mind. Such a review of TA should, in fact, include substantial input from outside the government, particularly including industrial experience.

One argument that might be raised against the above suggestion is that there is really no "methodology" of TA, that each TA performed is sui generis, using methodology eclectically as appropriate to the specific circumstances. Trying to develop a systematic methodology or recommend government-wide guidelines for TA would be too constraining, limiting desirable experimentation and flexibility. I do not agree, especially if TA is viewed as a social process more than merely a kit of intellectual tools. I believe there has been a good deal of generic learning which could be integrated more systematically into the future conduct of TA both inside and outside OTA. This generic learning comes not only from experience with TA and the EIS process, but also from a growing body of experience and knowledge relating to conflict resolution and negotiation over science-intensive public policy disputes.[14]

Of particular importance is the conduct of TA in the corporate sector. The Technology Assessment Panel of the NAS observed, for example, that it

is "crucial that any new mechanism we propose foster a climate that elicits the cooperation of business with its activities" and that "private industry be encouraged to find its own technical solutions—not compelled to follow solutions formulated from above."[15] For a long time industry responded to environmental, health and safety regulation by dragging its feet—publicly opposing regulation as unnecessary or excessively burdensome, and as inhibiting innovation,[16] and then responding by doing the minimum necessary to conform with the law. There are indications that this climate is changing, especially among the larger companies, and that more and more companies are recognizing the advantages of anticipating the possible need for regulation rather than merely reacting to government initiatives or public interest group agitation.[17] In part this has come about through reinterpretation of corporate liability by the courts to the effect that obedience to the law is an insufficient defense if an internal corporate technology assessment could have turned up evidence of potential harm from a corporate activity to workers or third parties. It seems important now to build energetically on this change in attitude by incorporating the experience of the corporate sector to a greater degree in the evaluation of the art of TA. This is, of course, already done to some extent by OTA through incorporating industrial scientists and engineers on its panels and in TAAC, but what I have in mind would draw more deeply on experience with specific technology assessments conducted by industry, treating them on a par with assessments conducted in agencies of the Executive Branch. In other words, I think it is time that industry be incorporated more intimately in the social learning process that is necessary to the progress of the art of TA.

The specific functions I have in mind in all the above recommendations

are, in fact, outlined in some detail in the original Panel report.[18]

Early Warning vs. Current Technology Assessment

A significant part of the function originally envisioned for OTA was that of early warning, i.e. "to provide foresight on emerging issues" before they emerge to the point of political visibility.[19] There has been a feeling among successive Directors of OTA that the office has not fulfilled that function as well as it might have. In part this has come about simply because, almost by definition, an issue of interest to a Congressional committee has already "emerged" into the political arena; it has passed the point where it is only a "cloud no bigger than a man's hand." Congressional interest, however, is not as much of a constraint as is sometimes asserted, as long as the issue being identified is one that can be significantly affected by current government policies. Thus issues such as stratospheric ozone depletion and the greenhouse effect were capable of arousing lively Congressional interest and extensive hearings even when their actual impact was believed to be 40-50 years in the future. This was because regulation of current industrial activities could in principle significantly ameliorate the future problem. Still, it is necessary to get the attention of at least one or two busy Congressmen to convince them the issue is a significant one. OTA is in a good position to do this if enough information is available from outside scientific sources to make a case, as was true for stratospheric ozone and greenhouse gases.

A type of early warning less easy to attract attention has to do with effects arising from the interactions of a number of different and apparently unrelated problems. One might appropriately refer to such effects as a "syndrome", in analogy with medical conditions where many different disease processes interact. We are barely at the threshold of

being able to identify such environmental or socio-ecological syndromes because the components which give rise to them usually occur in different scientific specialties. One possible such syndrome that is just emerging is the interaction between 1) greenhouse warming (and concomitant stratospheric cooling), 2) sinks for ozone in the stratosphere, 3) biological productivity of coastal zones as affected by temperature, ultra-violet radiation, and carbon dioxide concentration, 4) rate of acidification of soils as a function of temperature and changes in the biogeochemical cycles of other elements such as nitrogen, phosphorus, and sulfur as affected by all the other variables. Another example might be the impact of the exploitation of genetic engineering techniques in agriculture and forestry on the diversity of the gene pool for economically important crops and trees (this could go either way depending on just how the technology is used). Still another example is the second and third order consequences of the application of information technology in production and distribution. What makes these issues so difficult to come to grips with is that we often do not even know which kinds of expertise are important in analyzing and assessing them. Here OTA might be able to perform a unique function in bringing together experts who had never previously recognized the relevance of their expertise to an emerging environmental or sociotechnical syndrome. This is one of the reasons why I consider the preservation of the "generalist" character of the OTA staff so important as well as the extent of outreach of this staff to an unusually diverse intellectual community.[20]

Technology Focused vs. Problem Focused Assessment

The term "technology assessment" is usually considered as referring to the evaluation of the impacts and consequences of the implementation and

diffusion of particular technologies or clusters of technically interrelated technologies. It is technology-centered rather than problem-centered. Fortunately, OTA has chosen not to interpret the term quite that narrowly and has frequently conducted assessments which start from a social problem and examine the alternative technologies which might possibly contribute to its solution. Nevertheless, one only has to examine a list of titles of OTA reports to see that the office feels under a certain amount of pressure to present even problem-centered assessments as though they were really technology centered. As long as the competing solutions to a given social problem are simply alternative technologies, the focus on the technology centered approach is not really a constraint; one can consider a very broad array of alternative technologies. But there are many cases where non-technical and technical solutions may be in competition with each other, e.g. where regulation or internalization of social costs through pricing may be a better solution than new technology, or where internalization of a social cost may not be possible except through the invention of a new technology of distribution--a solution which is neither purely technical nor purely social. There is thus a non-negligible danger that the technological focus may lead to overlooking attractive options. I cannot cite any specific example of this in past studies; indeed, in its energy assessments OTA has often been in the forefront of considering non-technical alternatives. But I think the danger is there, and is exacerbated by the understandable propensity of politicians to look for technological solutions which appear to have minimal redistributional consequences. For this reason I think it would be wise if OTA undertook to increase the proportion of explicitly problem-centered assessments on its agenda, and gave more attention, even in its purely technological assessments, to the

distributional consequences of the options presented for Congressional consideration.[21]

Surprises, Non-Linearities and Discontinuities

Technological and social forecasting is usually an important element in technology assessment, since its aim is to anticipate the consequences of the deployment of new technologies before they become painfully obvious. Most such forecasts tend to be simple extrapolations of the recent past, with the effect of a new policy or technology being considered as a perturbation from a more or less stable state. Since technologies and policies can be introduced only relatively slowly, it is expected that systemic changes will appear only slowly and can be adjusted to. In recent years, however, we have come to realize the importance of surprises, random events, and discontinuities.[22] Events such as TMI, Chernobyl, or the Iranian revolution, though their probability can be estimated, cannot be foreseen as to their exact timing. Yet their impact depends critically both on their exact timing and on the vulnerability of the system to such perturbations. Such systemic vulnerabilities can develop gradually without any clear signs that can be readily recognized by anybody but close students of the system, until some random event triggers a sudden transition of the system to an entirely new state, with entirely different parameters and behavior than the original system. Such effects are well known in ecological theory,[23] but they also occur is sociotechnical systems. Furthermore, adverse consequences of a new technology, or, for that matter, benefits can appear in a highly non-linear manner, often synergistically with apparently unrelated developments in another part of the system.

In addition, there is a tendency to make forecasts of the future

parameters of a large-scale system based on the most probable development (e.g. the most probable average global temperature rise due to the accumulation of greenhouse gases) and then forecast the biospheric and, eventually, human effects based on this most probable value. But the consequences of warming can depend in a highly non-linear fashion on its magnitude. Thus catastrophic human effects could result from parameter values out in the tail of the probability distribution, but where there is still a not insignificant probability of that parameter value occurring. Thus, in the global warming example, an average warming three times the most probable value might still occur with, say, a one percent probability, which one would regard as unacceptable if the consequences were sufficiently severe.[24] But we are not accustomed to think of gradually cumulating effects in this way. It follows from this discussion that there is a strong need for considering distribution functions for key parameters of a problem arising out of uncertainty and looking at human consequences for several different values of parameters in this distribution. If the function of technology assessment is foresee the consequences of policies or technologies and let the political process choose the most desirable policy according to prevailing social values and preferences with regard to consequences, then it is obligatory not to deal just in most probable outcomes but in probability distributions of possible outcomes. This is something that is infrequently done.[25]

Science Advice vs. Technology Assessment

There has always been an ambiguity in the mission of and Congressional expectations from OTA. Although the original legislative language seemed to call for primarily technology-focused assessments of generic technologies prior to large-scale deployment, Congressional expectations seemed to call

in practice for essentially a Congressional analog of the President's Science Advisory Committee (PSAC). There has thus been a continuing debate as to whether the original concept of TA was too restrictive, and whether what Congress really needed was comprehensive access to non-partisan technical advice independent of what they received from the Executive Branch. While I have no strong opinions on this point, I feel that the opportunity costs of a significant broadening of the mission would be considerable. Adequate fulfillment of the narrower mission already requires a very high degree of selectivity on the part of the Director and TAB on what is undertaken. If some of the suggestions I have made above regarding problem-focused assessments and the early warning of impending "syndromes" were adopted, the mission would already be considerably broadened. Thus, a general scientific advisory function would almost certainly require considerable expansion of OTA, with attendant bureaucracy and overspecialization discussed above. The present concept of technology assessment does not appear to be too restrictive if OTA and the TAB want to occasionally step outside its narrow definition, as they did in the Health of Science study in the 1970's, or to some extent in the present "Technology and the American Economic Transition" study. It seems to me better to stick with the narrow definition wile informally permitting an occasional departures from it rather than explicitly broadening the mission.

Public Participation

As hinted above, I believe the present mechanisms being used by OTA allow for adequate input from the public, and that any appreciable expansion of public participation would be excessively burdensome and result in reduced output of OTA which the Congress could ill afford to have

happen.The only possible exception to this recommendation would be that OTA might wish to commission occasional public opinion surveys related to technology assessment issues as a supplementary source of additional input to its regular TA activities. This might be especially useful in connection with such issues as future space policy and the regulation of biotechnology. In one sense it could be regarded as a form of "early warning" function, since unanticipated public opposition to particular technologies could be one of the "surprises" that affect the evolution of technological diffusion.

International Aspects

As one looks to the longer term future, one could envision OTA becoming the most important node in a multinational network of TA activities, in which exchange of information and experience between countries and between the US and international institutions could become an important added value. The OTA has already attracted much favorable attention abroad, and a number of countries are experimenting with the establishment of government-sponsored TA activities. A good deal of what is done in some international organizations, such as the DSTI unit of OECD, is really a form of technology assessment. The assessments conducted in the US on specific emerging technologies could often benefit greatly from an international perspective. This is particular true in regard to technologies for the delivery of "collective" services such as urban services, waste management, or labor market services and employment training in relation to rapidly changing technology.[26]

Recapitulation

In summary, the preceding essay reaches the following conclusions: 1) The present system of governance, staffing, and size of OTA is probably

close to optimal, and it should resist any pressures for growth. If there is to be any growth of TA as an activity, which I think is in the public interest, it should be in the Executive Branch and the private sector.

2) With respect to the overall mission of OTA, the present fairly circumscribed definition of TA is probably satisfactory provided some occasional departure from the narrow definition is tolerated on an opportunistic basis. It should not aspire to become a sort of "Congressional PSAC."

3) The function originally envisioned for OTA of reviewing and coordinating technology assessments performed in the Executive Branch and the private sector should be strengthened, primarily for the purpose of providing for greater cumulative learning about the methodologies and organizational processes for performing TA.

4) The early warning function of OTA needs to be further strengthened and expanded, with particular attention to the treatment of surprises, discontinuities, and non-linearities and more systematic exploration of the probability distribution of societal outcomes.

5) There should be even more emphasis on problem-focused as opposed to technology-focussed assessments, and greater exploration to identify "syndromes" involving the mutual interaction and interdependence of apparently unrelated problem areas.

6) OTA should continue to expand its international contacts and to take greater advantage of TA being performed in other countries and by international institutions. Ideally it should aspire to become the most important node in an international network of TA institutions.

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