Science and Technology Advice for the Congress: Insights from the OTA Experience

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Introduction

The question of creating, or re-creating, a scientific and technical advisory apparatus for Congress encompasses a set of more specific questions about the nature of scientific and technical advice and the relationship between its successful provision and the design of institutional relationships to do so. The paper by Smith and Stine (2001) covers the surprisingly long sweep of the history of science advice to the US Congress, describing actions that Congress has taken to assure itself of access to technical expertise. Additional papers written for the workshop articulate a suite of possible alternatives for the new institutionalization of such a capacity, ranging from a new-and-improved Office of Technology Assessment (OTA) to a system of distributed analysts still performing for Congress.

This paper attempts to fill the considerable gap between the history of congressional action on scientific and technical advice and proposals for new institutions: there should be something to learn from the critical appraisal of experience for the planning of new enterprises. The paper thus focuses on the kind of work that OTA performed and how that work was connected to the agency's institutional structure and relationship with Congress on one hand, and scholarly perceptions of the performance of policy analysis and technology assessment on the other. It is based on two principles. First, as Bruce Bimber (1995:23) writes in his analytical history of OTA's life cycle, "The degree of politicization of expertise may be more an institutional phenomenon than a product of the preferences or style of politicians, the moral or professional commitment of experts, or an inexorable trend away from neutrality." Second, that liberal-democratic

governance is under some obligation to be informed about the causes and effects of its own operation, and that this obligation extends to understanding the intellectual underpinnings of public action.[1] The enterprise of this workshop and these papers, I believe, mobilizes these principles.

The first section of the paper recapitulates basic information about OTA relevant for the discussion here. The second section of the paper relates some of the details of OTA's own inquiries into the nature of its advisory, assessment, and analytic activities. The third section synthesizes some relevant scholarship about the institutionalization of expertise and the conduct of technically sophisticated policy analysis and assessment that, written mostly after OTA's demise, may be relevant for the recreation of an congressional science advisory capacity. The paper then concludes with a discussion of issues that proposals for new institutions for advice, analysis, and assessment will likely have to address.

OTA in Brief

Congress created OTA in 1972 after a long debate and for a number of reasons better described elsewhere (Smith and Stine 2001; Herdman and Jensen 1997; Bimber 1996; Kunkle 1995). The new office was to provide "early indications of the probable beneficial and adverse impacts of the applications of technology and to develop other coordinate information which may assist the Congress" (PL 94-484, in OTA 1995). Representative Olin Teague, later chairman of OTA's congressional governing board,

[1] This principle is inspired by such perceptive observers of the role of knowledge in the democratic tradition as Dahl (1989), Ezrahi (1990), and Lindblom (1990).

saw technology assessment – along with the National Science and Technology Policy, Organization, and Priorities Act of 1976, the National Science Foundation Amendments of 1968, and the energy and environmental laws of the period – as one of the "keystones of the structure of a national science policy" (OTA 1976:2).

What is most important to recognize about OTA's founding for this paper is that it was augured by both an institutional (and not merely partisan) conflict of crisis proportions between the Congress and the executive branch that implicated expertise and technology (as well as war powers and fiscal authority), and also by the intellectual and social movement of technology assessment that – together with consumerism and environmentalism – upped the ante for the foresight involved in making public decisions.

OTA's governance structure hinted at the synthesis of these motivations. On the political side, OTA was governed by the Technology Assessment Board (TAB), consisting of six Senators and six Representatives, evenly divided between the two parties, and chaired in a rotating term by one of its own. On the expert side, OTA was advised by the Technology Assessment Advisory Council (TAAC), consisting of ten expert members of the public, appointed by the TAB, the comptroller general (who heads the General Accounting Office), and the director of the Congressional Research Service. TAB had formal control over OTA's analytical agenda and remained engaged over OTA's history. TAAC had no formal operational authority and was, perhaps consequently, less active and engaged.[2]

OTA grew slowly to a recognized but still diminutive stature. By 1980, its budget reached the plateau at which it would stay till its demise, about $22 million (in 1995

[2] Herdman and Jensen (1997) describe a change over time in the TAB from a kind of joint committee to a board of directors, and in TAAC from active managers to a visiting committee.

dollars; Bimber 1996).[3] The number of its staff hovered around 200, but because a significant number were contractors (not to mention fellows and detailees) who were with OTA only for a limited duration, the specific number of full-time OTA employees was often difficult to determine. Most employees were analysts with advanced degrees, working in a relatively flat organizational structure.[4] The full-time employees contributed more general expertise, institutional memory, and specific knowledge of the congressional client; the contractors and others brought more specific expertise and links to external, ad hoc networks.

OTA's printed output consists of about 755 documents, comprising full assessments, background papers, technical memoranda, case studies, and workshop proceedings.[5] Full assessments, which were comprehensive analyses of book length, were the most visible product. From start to finish, a full assessment consumed some 18 to 24 months and cost approximately $500,000 in direct costs. The typical full assessment followed the process outlined in Table 1.[6]

[Table 1]

OTA could generally not conduct an assessment without a specific charge from Congress,[7] but assessments were often stimulated by discussions among congressional

[3] In 1995, the year of its closure, OTA's budget represented about one percent of the legislative appropriations bill.
[4] OTA (1993:70) documented 25% of the staff with a master's degree, 37% with a PhD, and 10% with a JD and/or MD. Natural science and engineering accounted for 55% of the PhDs and 42% of the master's degrees.
[5] This work is archived in OTA (1995) and at web sites maintained at the National Academy of Sciences and at Princeton University.
[6] See Wood (1997:150-56) for specific evaluations of each stage of the process.
[7] Committee chairs could request reports for themselves or on behalf of the ranking minority member or a majority of the committee. The TAB and the OTA director, who was a non-voting member of the TAB, could also request assessments.

and OTA staff and even informal solicitations from OTA.[8] The TAB had to approve every proposal for an assessment before work began, helping to insulate the agenda from politicization by partisan interests or capture by individual committee agendas.

A staff of two to six analysts – including contractors – would then organize a advisory panel of (usually) non-governmental experts and stakeholders to help scope, frame, and guide the assessment. Staff would pursue the assessment through a promiscuous variety of methods, circulating preliminary drafts to the members of the advisory panel and, often, to additional outside readers. The final draft was subject to more formal internal and external review prior to being submitted to the director and the TAB for approval and release. Again, the TAB as primary audience applied a strong discipline toward objectivity in the writing of reports. Congressional testimony and contact with Administration officials, press, and stakeholder and public groups often followed the issuing of reports.[9]

In performing this work, OTA is variously described as having provided science advice (or scientific and technical advice) to Congress, as having conducted technology assessments (per its name), and as having performed policy analysis, particularly for issues with a high scientific or technological content. All three descriptions are accurate, perhaps to different degrees, and one could if so motivated sort OTA's written work into each of the categories. But these three categories are themselves overly broad. Table 2 presents a further classification of tasks in providing scientific and technical analysis.[10]

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[8] Among the important questions for OTA were whether OTA had sufficient resources to conduct the assessment, whether it could successfully provide the information requested, and whether congressional interest was broad and bipartisan.

[9] In addition to publishing full reports and smaller documents, OTA also briefed congressional staff, fielded inquiries, and provided testimony and other informational services.

[10] I have listed contemporary issues for each of the categories, but OTA's own reports could easily be sorted into these categories.

[Table 2]

The actual diversity of the work harkens back to the first question alluded to above about the nature of scientific and technical advice to Congress. If an institution is to be created or recreated, which forms of advice are most important? For the delivery of which forms of advice will the institution be structured? Even if some forms of advice or analysis are best associated with one kind of institution, is it more or less effective to assign other forms of advice or analysis to that institution?

To be effective, this workshop will likely need to be clear about identifying these various tasks and mapping their performance onto an appropriate structure. The following section describes OTA's efforts at understanding the nature of its work and how this understanding shifted over time from "technology assessment" to "policy analysis."

OTA Studies TA

During its nascent years, OTA had access to the burgeoning literature on the philosophy and methods of technology assessment but paid it relatively little attention (Coates 1999), perhaps because the new office lacked a "critical mass of staff, resources, and experience to establish a consistent methodology – even at a general level" (Wood 1997:146). Toward the end of the term of its first director, former Connecticut congressman Emilio Daddario (1973-1977),[11] OTA made an initial effort to consolidate knowledge about methods of technology assessment in government and the private

sector. The review, which culminated in a report based on hearings before the TAB (OTA 1977:1), concluded that technology assessment was an increasingly useful tool for medium- and long-term management in both the public and private sectors,[12] could provide early warning of unanticipated consequences as well as analysis of options and alternatives, and should be "tailor-made to fit the resources, timing, and needs of the decision makers."

Under its second director, former Delaware governor Russell Peterson (1977-79),[13] OTA engaged in a priority-setting enterprise that solicited input from more than 5000 members of the public (OTA 1979). Wood (1997:146) observes that the priority-setting process became politicized over concerns that OTA was "becoming too independent from congressional oversight and needs." Bimber (1996:56) writes even more critically that "[t]he exercise was a classic policy analyst's attempt at determining national priorities through technical non-political means. It outraged many legislators who recognized it as a rejection of Congress's own agenda-setting processes."[14]

The senior staff members who participated in the process nevertheless devised criteria (which might be useful for posterity) for determining whether OTA might fruitfully conduct an assessment on any given topic:

- Does the assessment involve the impact of technology?
- Is there congressional interest?

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[11] Daddario was a Democrat who, as chairman of the Science, Research, and Development Subcommittee of the House Science Committee, was instrumental in OTA's legislation and in other science policy initiatives in the 1960s. See Smith and Stine (2001) for more details.

[12] The hearing highlighted research managers from industry who praised technology assessment as a managerial tool, in part perhaps to defuse some criticism from industry that greeted OTA's creation with fears of a regulatory body. See "The Debate over Assessing Technology," *Business Week* (8 April 1972), available in OTA (1995).

[13] A Republican and former industrial scientist, Peterson was also a strong environmentalist, and he left OTA somewhat hastily to be the president of the National Audubon Society.

[14] Kunkle (1995) similarly reports that Congress was not pleased with the independence OTA exhibited under Peterson and the priority-setting exercise.

- Does the technology impact significantly on human needs and the quality of life?
- Would the assessment provide foresight?
- Can OTA do the assessment (OTA 1979:ii)?

Shortly thereafter, OTA leadership changed again. Under director John H. Gibbons (1979-1993), OTA fell back into a closer orbit around Congress for the purposes of setting its priorities, but Gibbons – whose party affiliation was unknown when he was appointed – maintained a strict and distant neutrality with respect to partisan and jurisdictional maneuvering (Bimber 1996). OTA also continued to be distinctly reflexive about its work, initiating several large-scale internal studies and many more smaller discussions (Wood 1997). The first such study, the Task Force on TA Methodology and Management, began shortly after Gibbons took office and reported in 1980. This report crystallized consensus around the OTA process described above, particularly the diverse methods – including advisory panels, workshops, and stakeholder participation – and the central role of staff. Earlier, OTA had made heavier use of contractors and, as is the case with reports from the National Academy of Sciences complex, relied on advisory panels for a great deal of the writing as well. Wood (1997:146-47), who chaired the task force, reports that it also demonstrated a consensus around the need for tighter management of OTA studies, including so-called "project review checkpoints" that would help assure both timely completion and balanced, high-quality results, but that it did not achieve any consensus around "a deeper level of technology assessment methodology, nor on specific methods or techniques."

In September 1992, OTA began another self-study process to scrutinize and improve the work it conducted. This self-study marked a break from the past, identifying OTA's work as a specific form of policy analysis, although the printed report begged the

question of what policy analysis is by defining it as the activity of policy analysts (OTA 1993:2). This operational sleight-of-hand, however, was not new for OTA, as technology assessment had often been defined not by a suite of techniques or intellectual perspectives but as whatever OTA happened to be doing. It was clear, though, that OTA's mission had morphed from the early-warning aspect emphasized in its organic legislation to the provision of "thorough, objective information and analysis to help Members of Congress understand and plan for the short- and long-term consequences of the applications of technology, broadly defined" (OTA 1993:1).[15]

The self-study identified two standard aspects of OTA's policy analysis: the description of the context of a policy problem and the presentation of the relevant issues or findings that might require congressional attention; and the discussion of potential solutions or options that Congress might choose to adopt. It was not clear, however, what the appropriate balance of attention to context and options was. OTA's particular brand of policy analysis was distinguished, of course, by "highlighting the relevant aspects of science and technology" and by its broad involvement of stakeholders in the process of analysis (OTA 1993:3).

From a process that included written evaluations of OTA reports from former congressional staff, telephone interviews with then-current congressional staff, and a workshop with ten outside experts from different fields but familiar with OTA, the self-study identified three primary criteria of good policy analyses: objectivity, reader-friendliness, and timeliness. Congressional staff identified OTA's reputation for objectivity as one of its "chief assets" (OTA 1993:35). However, the study found that what staffers meant by objectivity seemed to vary from a lack of issue-related bias to

[15] See also Blair (1994).

evidence of scientifically based literature and data. When presented with a selection of reports to evaluate for objectivity, the staffers found only minor departures from objectivity in a minority of the sample – but one report was severely criticized. The objections lodged against these reports centered around the apparent lack of empirical justification for some of the findings and the presentation of options that bordered too closely on, or lapsed into, recommendations.

Although objectivity may have been the primary desideratum for an OTA report, qualities not directly related to the analysis were also critical to OTA's congressional client. The self-study found that "reader-friendliness" and "timeliness" ranked with objectivity as the most important qualities in an OTA report (OTA 1993:5). The study found OTA's scores on these criteria a bit lower, as reports often lacked such reader-friendly production qualities as a useful executive summary (written with a structure parallel to the report) and a thorough index, and often took two years or longer to produce (although the higher the demands for objectivity and production quality, the longer production is likely to take). The importance of these criteria, however, suggest that planning a new institution for the provision of advice, analysis, and/or assessment should not overlook aspects of service to the congressional client that are ancillary to the intellectual performance of analysis itself and that would require strict oversight to secure, particularly if a distributed system performed the analyses.

Overall, the self-study concluded that the quality of OTA's policy analysis was "often good – and frequently regarded as better than that of other policy organizations," but with "considerable variation in the quality and methods of policy analysis from report to report" (OTA 1993:4).

Roger Herdman, an assistant director of OTA under Gibbons, became OTA's fourth director in 1993 when the latter accepted an appointment from President Clinton to become the director of the White House Office of Science and Technology Policy. Herdman began to implement some changes at OTA in response to the self-study; he also established a Long Range Planning Task Force to examine alternative structures for OTA's staff, eventually flattening out OTA's organization even further based on the task force's recommendations (Wood 1997:148).

Other reforms, some hastily planned, were in the works in summer 1995 when Congress eliminated OTA by not appropriating any funds for it. The motivations behind this action are, like the details of its origin, more fully discussed elsewhere (Smith and Stine 2001, Herdman and Jensen 1997; Bimber 1996).[16] In retrospect, the criticisms articulated in the self-study, particularly the recognition by OTA staff that "[t]he expectations of congressional committees that request OTA studies keep rising [and that] OTA staff…are expected to do more, better, faster – without compromising the integrity of the assessment process" (OTA 1993:77) seems prescient to the congressional hostility that resulted in its de-funding. However, it is also important to realize the strong relationship between a particular moment in the agenda of the Republicans who gained the majority in Congress during the 1994 midterm elections and perceived deficiencies in OTA's work.[17]

[16] Bimber (1996:59) recounts "the Mattingly affair," in which freshman Senator Mack Mattingly attempted to defund and deauthorize OTA after Republicans took control of the Senate in 1981, as presaging OTA's difficulties in 1995.

[17] It is unclear whether it is necessary to agree on why OTA passed in order to agree on what, if anything, should replace it. If OTA suffered from fundamental flaws, then a new office could arise out of an improved structure. If OTA suffered from a unique confluence of events, then a similar structure could be

Institutionalizing Analysis and Assessment

The demise of OTA provides the opportunity to reconsider the provision of scientific and technical advice, analysis, and assessment to Congress, both organizationally and conceptually. Other papers in the workshop discuss new organizational options directly (and also see Hill 1997 and La Porte 1997). Conceptually, the half-decade since OTA's demise provides the opportunity to inform consideration of new organizations with more recent scholarship and other developments in technology assessment. Many of these developments have taken place in the agendas and performance of technology assessment organizations in other countries, which Vig (2001) deals with directly.[18] Below, I discuss four of these developments: public participation in technology assessment; new styles of technology assessment, including constructive and real-time technology assessment; the practice of assessments for both political and technical virtuosity; and, similarly, the structuring of institutions to produce political and technical virtuous assessments.

Public participation. The first important development concerns the increasing role of lay-citizens in the process of assessment or analysis. Although OTA made extensive use of stakeholders as members of panels and reviewers of drafts, it made little effort to include lay-citizens in its work (Bereano 1997). Nevertheless, other technology assessment practitioners have adopted – often to good effect – participatory methods such as citizens' panels (Joss and Durant 1995; Guston 1999; Hörning 1999), scenario workshops (Andersen and Jaeger 1999; Sclove 1999), and focus groups (Dürrenberger,

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reconstituted. If the entire congressional environment environment changed, then perhaps no similar institution could succeed.

Kastenholz, and Behringer 1999). In aggregate, these participatory methods are also known as interactive technology assessment (Grin, van de Graaf, and Hoppe 1997).

How the policy analytic and public deliberation versions of technology assessment accommodate one another is an important, but open, question intellectually and practically.[19] There is, however, no necessary competition between the two models and, moreover, there ought to be complementarities (Guston and Bimber 1998). Whereas, participatory mechanisms offer little chance of serving as more than brokers of analysis that has been performed by more expert actors; they do offer the prospect of creating broad, novel frames and insight into public attitudes about the acceptance of or hostility toward new technologies. It seems likely, then, that "public policy is best served by the flourishing of both enterprises," but there need be no presumption "that both enterprises must fit comfortably in the same institution" (Guston and Bimber 1998:8-9).

Planning for a new capacity for congressional scientific and technical advice and analysis should confront this challenge of finding ways in which the participatory and analytic modes complement each other. It is plausible that, as in some of the European experience, participatory mechanisms are important for public education around a scientific and technical issue, and such an educative role may also contribute to building a broader constituency for analysis. But in OTA's experience, effective, successful stakeholder participation was time-consuming and expensive – and critics found OTA's work neither timely nor cheap. It is unclear whether broader participatory mechanisms outperform stakeholder participation on these criteria and to what extent they could and should be incorporated into a new technology assessment institution.

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[18] Also see Vig and Paschen (2000).

New styles of technology assessment. A second important development regards increasing the interaction between assessment and analysis on one hand, and the design of new technologies on the other. With enough forethought and lead time, interactive modes of technology assessment, coupled with the expert modes, can serve a constructive role in technological and societal choice – maximizing the benefits and minimizing the problems that may be associated with knowledge-based innovation. This so-called "constructive technology assessment" (Schot and Rip 1997) does not conceive of technologies as pre-formed black boxes that society must adapt to, but rather as more flexible entities that are co-produced by the social contexts of their invention and use. It attempts "to broaden the design of new technologies" through "[f]eedback of TA activities into the actual construction of technology" (Schot and Rip 1997: 252). The tenets of constructive technology assessment include: socio-technical mapping, a combination of traditional stakeholder analysis with the plotting of technical activities; early and controlled experimentation to identify unanticipated consequences and, if need be, ameliorate them; and interaction between innovators and the public (as described above) to articulate better the demand side of technology development.

More recently, Guston and Sarewitz (forthcoming) have continued on this trajectory to describe "real-time technology assessment," which conducts historical and social scientific research in direct collaboration with the natural science and engineering work being assessed. Real-time technology assessment differs in three ways from constructive technology assessment: 1) although it engages in socio-technical mapping and demand-side articulation, it does not involve experimentation because its focus is the

[19] Vig and Paschen (2000) refer to these two styles as the "instrumental" and "deliberative" modes of technology assessment, respectively.

knowledge-creation process itself; 2) it uses a variety of social scientific methods to investigate how public knowledge, perceptions, and values about emerging technologies change over time; 3) and it integrates retrospective, historical work on the social impact of innovation with prospective scenario analysis to render contemporary innovation more amenable to understanding and modification.

Clearly, a congressional advisory mechanism of whatever makeup should not be directly involved in constructive or real-time technology assessment. That is, the staff of such an organization should not themselves collaborate with natural scientists and engineers for the purpose of steering their research. But if the prospective angle envisioned by OTA's legislative charter is to be retained at all, the new mechanism may find constructive and real-time technology assessment interesting and appropriate methods with which to experiment.

The practice of assessments. A third development, alluded to by Smith and Stine (2001), concerns how assessments or analyses may be conducted to achieve both political and technical goals. Until recently, the literature on technology assessment and policy analysis has neglected the relationship among intellectual function, analytical process, and institutional form. Objectivity, roughly synonymous with Smith and Stine's "disinterestedness," was seen as either an intellectual standpoint or, if associated with process or structure at all, was attributed to distance or insulation from interested parties. Such insulation would, however, render the demands of agenda-setting and relevance almost insuperable.

This situation creates what Guston and Bimber (1998:10) refer to as "the dilemma of expert independence": the demand by the policy-making consumers of analysis to

maintain control over the agenda of experts and over the process of interest aggregation and representation; and the countervailing demand by the producers to be independent in their production of the analysis. The dilemma must be addressed, however, because of the mutual interest of the policy-makers and experts – not to mention citizens – in relevant analysis for decision making.

A variety of scholarship over the last decade has begun to identify procedural and institutional factors that promote disinterested analysis while still satisfying requirements of relevance as well. Projects organized by William C. Clark on "social learning and the environment" and on "global environmental assessments" (GEA) have been at the forefront of such scholarship (although they focus exclusively on international environmental assessments, which overlap at least somewhat but necessarily completely with technology assessments).[20] The Social Learning Group (2001) taps a broad array of national case studies in the both the developed and developing world to examine the interplay of ideas, interests, and institutions in the practice of environmental management. Among their conclusions is that a large number of factors beyond the technical adequacy of environmental assessments, e.g., the capacity of local institutions to learn from assessments, moves nations to informed environmental action.

The GEA project has focused on the design and management of effective assessments and the information systems that link global environmental assessments to local decision making (GEA 2000). It will provide a variety of case studies and commentary aimed at improving the practice of environmental assessment (Farrell and Jaeger in preparation). GEA research suggests that "much about what makes some

[20] Clark began on this theme in a paper (Clark and Majone 1985), closely related to OTA's work, on the critical appraisal of science and technology policy analyses.

assessments more effective than others seems to be tied up with the *process* by which they are developed, rather than just the *product* itself" (Clark and Dickson 1999:6; emphasis in the original). GEA research also defines criteria of good assessments – saliency, credibility, and legitimacy – which it finds to be products of the procedural elements of an assessment, including when in the evolution of an issue is an assessment conducted, how an assessment structures its audience, and how an assessment manages to negotiate the interface between politics and science (Clark and Dickson 1999).

This emphasis on "learning" and on the process of assessment leads to different ways of evaluating assessments. It displaces attention from the bound volume of the report to the greater variety and forms of communication, including the interactions that produced the report in the first place. Thus, when critics point to the "useless" and tardy book-length OTA report that failed to change a congressional vote or a program budget, they adopt a discredited "silver bullet" account of policy analysis. A full evaluation of policy analysis or technology assessment includes not only these "actual impacts" of the study, but also its more nuanced impact on general thinking about the issue (e.g., how an issue is framed), as well as the learning engaged in by participants in the process (including both analysts and stakeholders) and non-participants (the targets of the advice as well as the general public).[21] With OTA, it was often felt that the report was important significantly in that it represented a great deal of negotiation and learning among analysts, staff, and stakeholders that increased knowledge and reduced conflict in preparation for congressional action.

[21] I develop and apply this point in Guston (1997) and Guston (1999). An impressionistic evaluation on these criteria might rate OTA moderate on actual impact, high on impact on general thinking and on learning by participants, and low on impact on learning by non-participants.

Structure of institutions. In a related way, other recent scholarship has addressed how institutions can be structured to promote the effective production and use of relevant and disinterested advice and analysis. Sheila Jasanoff (1990), for example, in her account of science advice in executive agencies, anchors the helpfulness (if not the objectivity) of advisory committees in accounts of successful "boundary work" (see also Gieryn 1999). In the context of advising such agencies as the Environmental Protection Agency (EPA) and the Food and Drug Administration, successful boundary work generally means the parsing of the distinction between science and policy – and thus the respective roles of science advisors and policy decision makers – in a more rather than less ambiguous way. That is, science advisors are more successful when they, and staff, elide rather than reify any distinction between science and policy. Jasanoff also finds that, as in OTA's experience, the social aspects of peer review and balancing interests and stakeholder participation contribute to the technical and political credibility of science advice.[22]

Jasanoff (1990:209-16) points to another organization intimately involved in negotiating the complexities of regulatory science, the Health Effects Institute (HEI). Jointly funded by EPA and the automobile industry, and bolstered by prominent and interdisciplinary advisory panels that provide peer review, HEI has established itself as a credible sponsor and broker of research relevant to regulatory decisions that incorporate the health effects of air pollution. Following a review by the National Research Council (1993), HEI continued to improve its credibility by broadening, rather than narrowing, its

[22] Gibbons (1993:417) agrees that OTA's involvement of "the principal stakeholders and interested public in its work by use of advisory panels and reviewers, while retaining full responsibility for the finished product, has contributed to its level of credence and political acceptance and also its high standing in the technical community."

engagement with stakeholders and its efforts in producing relevant, timely research (Keating forthcoming 2001).

Such attention to the design of institutions providing scientific and technical advice for executive functions is vital, especially if one considers Bimber's (1996) argument about the natural trend of executive agencies to move toward the politicization of expertise. OTA demonstrated that Congress, on the other hand, could encourage a trend toward neutral expertise by forcing responsiveness to the diverse ideological and jurisdictional agendas of two parties and multiple committee chairs.[23] In Bimber's argument, this studied structural neutrality, both manifest in and managed by the TAB, still did not permit OTA to provide the highly particularized informational products that might have extended or ensured it existence. OTA was structurally and intellectually neutral, but it may have provided too generalized a benefit for a particularized institution such as Congress.

In addition to scientific advisory committees, HEI, and OTA, there are a variety of other organizations that exist "between politics and science." In other work (Guston forthcoming 2001), I attempt to formulate a more general theory of such "boundary organizations" which: 1) exist at the mutual frontier of politics and science but have strict lines of accountability into each; 2) involve the participation of actors from both sides in addition to professionals who serve a mediating role; and 3) produce goods and services of value to actors on both sides as well. Drawing on examples in research policy (Guston 2000a) and in environmental policy including HEI (Keating forthcoming 2001), agricultural extension (Cash forthcoming 2001), and global climate change (Agrawala,

Broad, and Guston forthcoming 2001; Miller forthcoming 2001), I argue that the presence of boundary organizations improves the context for the production of relevant knowledge and its application by decision-makers and, moreover, that it does so while minimizing attendant risks of politicizing the science or scientizing the politics. The boundary organization proposes an almost Madisonian solution in the reciprocal sharing and balancing of interests and accountability between politics and science.

This perspective is sympathetic to the vision of the position of policy analysis in Granger Morgan's introduction to the Workshop. Morgan (2001:8) characterizes policy analysis as a joint product of theories, facts, and other expert knowledge with policy problems as defined by decision makers. Most critical about Morgan's characterization is the interposition of policy analysis between the technical experts and decision makers (the second characteristic of boundary organizations, above).[24] It stands in contrast to a mechanism for the exchange of advice and analysis that some critics of OTA have called for, namely, more direct contacts between researchers and members of Congress.[25] Yet the model of direct contact fails on at least three accounts to distinguish between advice or analysis, on one hand, and advocacy on the other: 1) the exchange in direct contact is likely to be private rather than public, and it would therefore suffer from apparent if not actual politicization; 2) the exchange would not be subject to critical appraisal by peers

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[23] In Hill's (1997) similar argument, Congress is a uniquely demanding client for policy analysis because of its two-party, multi-jurisdictional organization, and the specificity of this demand helped create a quality product.

[24] This interposition was also critical to the vision of science in democratic politics that Don K. Price (1965) articulated in his "spectrum from truth to power" in which the "estates" of professional and administrative practice applied knowledge, according to private and public rules respectively.

[25] For example, Newt Gingrich, the former Republican Speaker of the House who presided over OTA's demise, recently reiterated his opposition to OTA by suggesting that direct contact between scientists and members of Congress would be preferable to staff-to-staff contact. Gingrich made these remarks at the Symposium on Allocation of Federal Resources for Science and Technology, hosted by the National Science Board for the release of a new draft report (NSB 2001:16) which, among other recommendations,

and other concerned parties, and it would therefore likely suffer substantively even in the unlikely event that it was impartially rendered;[26] and 3) individual researchers are likely to have some insight over narrow and near-term extensions of their work, but not over the broad array of societal consequences that would ultimately interest decision makers. Thus, a member of Congress is not likely to be able to rely on a single expert, or even a small sample culled by the member's staff, to provide analysis of the non-trivial implications of scientific and technical complexities. Although it may be politically astute to take greater advantage of individual experts skilled as communicators than OTA did, the process behind the analysis needs to be conducted in a public and participatory way for the appearance and actuality of both neutrality and rigor.

Conclusion

The recapitulation of the history of OTA demonstrates an organization poised on the awkward boundary between politics and science, charged to provide technically-oriented, unbiased foresight to a traditionally short-sighted, partisan, and particularized legislative body. Not surprisingly, the early history of OTA was shaky. Also unsurprisingly, this charge led to OTA's frequent and reflexive study of the practice of assessment and analysis, ultimately finding that nearer-term policy analysis began to dominate its activity.

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advocated the creation of "an appropriate mechanism to provide [Congress] with independent expert S&T review, evaluation, and advice."

[26] This logic is essential to not only the important role of peer review in scientific publications but also to the strong bipartisan support for using forms of peer review in regulatory science, not just in analysis for Congress and the Federal regulatory agencies (e.g., S. 746 in the 106th Congress) but also in courtrooms (Berger 2000; Breyer 2000) and states (CGS 1999). See also Chubin and Hackett (1990), Jasanoff (1990), Smith (1992), and Guston (2000b).

In discussing and, perhaps, promoting a new mechanism for the provision of scientific and technical advice to Congress, this Workshop will need to address a large number of questions about the relation between the nature of that advice and the structure and performance of that mechanism. OTA's experience, its reflexive study of practice, and additional scholarship suggest a number of those questions. Table 3 makes them explicit.

[Table 3]

In its brief survey of OTA's history and the recent literature on assessment and analysis, this paper has not explicitly offered answers to these questions with respect to a new or recreated scientific and technical advisory mechanism. It has, however, alluded to some of the answers that practitioners and scholars have found in other contexts. More pertinently, the paper has proposed that how the design of such an advisory mechanism answers these questions will go a long way in determining the quality of its analysis and the success of its organization.

Table 1: Stylized OTA Process*

1. OTA staff have re-request conversations with Committee members and staff
2. Committee(s) makes formal request of OTA for a study
3. OTA submits project proposal to TAB
4. TAB approves proposal
5. OTA organizes staff, selects advisory panel
6. OTA staff plan project plan and engage in data collection and analysis (including advisory panel meetings, workshops, contractor reports, briefings, surveys, site visits, etc.)
7. OTA staff draft final report (with revisions after both in-house review and external peer review)
8. OTA transmits draft to TAB for approval
9. TAB approves and releases summary and full report (including embargoed press packet and press conference, electronic dissemination, and mailings to Congress, study participants, interested parties and libraries)
10. OTA staff conducts policy outreach (including testimony at congressional hearings, briefings and informal talks with committee members and staff, interaction with staff of executive branch agencies, and addresses to various communities)
11. OTA staff pursue possible follow-on activities (such as the preparation of supporting documents, provision of more congressional testimony, and requesting for new assessment activities)

* Derived from OTA Assessment Process, OTA (1995).

Table 2: Tasks in Providing Scientific and Technical Analysis

- Advice & Analysis for Federal R&D Policy

  e.g., How do we set priorities in the R&D portfolio? How do we anticipate and measure the societal outcomes of Federally funded research? Are particular programs performing to expectations?

- Application of Science and Technology in Support of Other Federal Policies

  e.g., What technologies are available to assist persons with disabilities and integrate them into the economy and the community? How can the results of research on learning be best incorporated into the curriculum? What role can new technologies play in easing energy shortages?

- Identifying the Nature of Consensus and Disagreement in Scientific Controversy

  e.g., What is the role of anthropogenic sources in global climate change? How much arsenic is safe in drinking water? How important a determinant of human behavior is genetics?

- Policy Implications of Current Developments in Science and Technology

  e.g., What are the trade implications of new agricultural biotechnologies? What are the arguments for or against a moratorium or ban on human cloning? What are the national and economic security risks of reliance on the Internet?

- Assessing the Technical Merits of Proposed Major Federal Initiatives

  e.g., Can an anti-ballistic missile defense work? What kinds of scientific contributions can we expect from the International Space Station? Can new oil drilling and pumping technologies operate safely enough to preserve wilderness environment?

- Forecasting Developments in Science and Technology for Societal Response

  e.g., Developments in nanotechnology and biomaterials will augment human-machine integration – should we care? What is our obligation to protect and preserve any life discovered on Mars or elsewhere beyond Earth? Will advanced computing and/or robotics cause technological unemployment?

Table 3: Critical Questions for the Design of Institutional Arrangements to Provide S&T Advice to Congress

- Who controls the agenda for inquiry?
- How can partisan tensions be managed?
- How can jurisdictional tensions be managed?
- Which advisory, analytical, and assessment tasks will be undertaken?
- What is objectivity (or disinterestedness or neutrality) and how can it be achieved?
- How can timeliness and reader-friendliness be ensured?
- Will there be other products beyond "reports"?
- Will reports emphasize context or options?
- Will reports present options or make recommendations?
- How can the scope of reports remain within the intent and purview of the Technology Assessment Act?
- Can and will the participatory and analytical modes of assessment be reconciled?
- Will new modes like constructive and real-time technology assessment be explored?
- How will learning from the analysis or assessment best be promoted?
- How will a new mechanism situate itself between experts and decision makers?
- Will there be direct interaction between members of Congress and experts, or mostly between staff and policy analysts?

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