The Political Economy of Science and Technology in Israel: Mutual Interests and Common Perspectives

Gerald M. Steinberg

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The Centrality of Science and Technology in Israel

Although Israel is a small country, both demographically and economically, the emphasis on science and technology is very pronounced. Scientific and technological activities are central to the economy, political system, and social structure. There are over 16,000 scientists and engineers in Israel, and 69 per ten-thousand in the labor force are engaged in R&D related activities.0 On a per capita basis, these totals are among the highest in the world. In 1990, approximately 4.5% of GNP went to research and development, compared to 2.7% in the U.S., 2.3% in Britain, and 2.6% in Japan.1 Members of the scientific community, such as Moshe Arens and Yuval Neeman have also become major political figures, and in many ways, this community is closely linked to the political and social elite.

Science and technology also play important ideological roles in Israel. Forty years ago, the economy was largely based on agriculture. Science and technology were seen as the major path to industrialization and modernization. Ideologically, scientific development was perceived as a basic component of modern political Zionism. In his visionary tract, Altneuland (Old-New Land), the founder of political Zionism, Theodore Herzl, emphasized the role of science and technology in the revival of the Jewish people.2 Similarly, David Ben-Gurion, the leader of the independence movement and Israel's first Prime Minister, frequently spoke and wrote of the centrality of scientific development in the rebirth of the nation. Zionist leaders also viewed scientific and technological achievement as a source of international political power and leverage. Many attributed the 1917 Balfour Declaration, in which the British Government recognized Jewish aspirations for a "national home", to the scientific contributions of Zionist leader Chaim Weizmann to the war effort.3

This ideological and political emphasis provided the impetus for the early creation of advanced research institutes, such as the Weizmann Institute and the Israel Institute of Technology (Technion), and of the system of universities in the country. These institutions have received significant support, and the Israeli leadership continues to view research and development as central factors in the economic, social, and political development of the country.4 Political leaders view scientific and technological development, as expressed in projects such as the Lavi combat aircraft program, the

Shavit launcher and Ofek satellite programs, and the Arrow Anti-tactical Ballistic Missile, as sources of national pride and independence.

Israeli foreign policy and national security are also closely linked to the activities scientific and technological community. In these policy arenas, the importance of science and technology in Israel is even greater than the role of these factors in the United States in the 1950s and 1960s.5 The Israeli military has used qualitative superiority, in the form of advanced military technology and skilled personnel, to offset the massive demographic and financial advantages of the Arab states. This has led the Ministry of Defense to invest heavily in military-related R&D, and in the development of the necessary infrastructure. A large proportion of the nation's scientists are linked in some way to the defense establishment and armed forces.

In many ways, the views of the members of the Israeli scientific community on science and technology-related social and political issues are relatively homogenous. There are few debates or controversies among the scientists, even on vital issues such as nuclear deterrence or the environment. This high level of homogeneity is particularly noteworthy given the generally conflictual nature of Israeli society and political debate. It may also be a reflection of degree to which Israeli scientists still hold the classical Baconian view that science is apolitical and "above" politics.6

Indeed, despite the general coincidence of political and social views between the scientific community and the governing elite, Israeli scientists are often accused of pursuing professional goals that are irrelevant to national needs. Israel is a mobilized society, in which resources are focused on national goals such as defense, immigrant absorption, and economic development. In contrast, in a broad sense, the scientific community tends to be independent and universalist, based on internally selected goals and structures, such as peer review. Israeli scientists, like their counterparts in the United States and other societies, view the state as a source of resources alone.7 Outside of the government-controlled defense sector, state intervention in attempting to define scientific goals and research projects is seen as interventionist.

To a large degree, the continuing strength of universalist values is a reflection of the role that prominent Jewish scientists played in promoting these values. In the last century, Jewish scientists in Europe and the Soviet Union were alienated and victimized by nationalism. In Nazi Germany, the teaching of "Jewish physics" (relativity) was anathema, and Jewish scientists were forced to flee. The emphasis on universalism of science can be seen, to some degree, as a response to this historic experience. Similarly, the scientific community invoked the values of the "universalism of science" in demanding freedom for Jewish scientists in the Soviet Union who had been isolated for decades under Stalin and his successors. Many of

these scientists moved to Israel, and the universalism of science remains an important element in the Israeli scientific community.

The Structure of the Israeli Political-Economy

Israel has existed as a modern state for less than five decades, and the central political, military, and economic conditions and institutions have been transformed significantly since 1948. Given the centrality of science and technology, the evolution of political and economic conditions and institutions have necessarily been accompanied by, and in many cases, directly involved changes in the role of science, and in the interaction between science and the state.

For the first thirty years of its existence, (and for the pre-state decades of the New Yishuv), Israel was highly centralized, both politically and economically. The country was dominated by an all-encompassing elite which consisted of the socialist (or social-democratic) Labour Party (Mapai, at times in a coalition with smaller allied parties such as Mapam and Ahdut Avodah or Rafi), and the Histadrut General Labour Federation. This elite controlled educational institutions, aagricultural marketing cooperatives, and a large part of the industrial base. Thus, although formally and juridically pluralist, Israeli society and the economy was, in fact, largely closed and monopolistic.

At the same time, the economy was never characterized by central planning or resource allocation, on a scale similar to the Soviet Union, or in developing states such as India and Brazil. Like Italy and France in the 1950s and 1960s, in Israel, the government and dominant labor federation (the Histadrut), in combination and often indistinguishable, dominated critical sectors of the economy (energy, transportation, etc.) As will be shown below, these structural conditions were reflected in economic policy and the application of technology to development.

In the 1970s, following the "earthquake" of the 1973 Yom Kippur War, which greatly weakened the elite structure, political competition increased and the pluralistic environment was strengthened. In the 1977 elections, the Labour Alignment lost control of the government, and through the 1980s, was only been able to regain some power as a partner in a broad-based coalition with the Likud and smaller parties. The Likud leadership, in coalition with the Israeli Liberal party, took steps to reduce the role of the state in the economy, and allowed the role of the market to increase. The central role of the Histadrut in the economy has also diminished significantly. Thus, in the past decade, Israel has begun the transformation from a operationally monopolistic centrally planned system to a mixed, or pluralist market- oriented system.

Economics, Science and the State

In the first chapter of this volume, Solingen notes that the political economy of science is "the set of interacting local and international, state, and market processes affecting the demand and production of scientific knowledge, its location, and the associated distribution of costs and benefits."8 In the Israeli case, the perceived importance of science and technology in economic and military development has given the scientific community ready access to political and economic leaders. This situation also provided preferred access to resources, as well as extensive control over the distribution of these resources. As noted, Ben-Gurion sought to apply science and technology to the solution of many of Israel's economic and security problems. He created the Science Corps in 1948, at the beginning of Israel's War of Independence, and provided the Corps with a relatively high level of scarce national resources. The National Council for Research and Development Council (NCRD) was located in the Prime Minister's Office. (In 1982, the NCRD was transferred into the newly created Ministry for Science and Technology.)

As in the case of many other industrialized and industrializing countries, the scientific community and the state are highly interdependent, and the degree of interdependence in the Israeli case is particularly pronounced. A very high proportion of R&D activity is supported by the state. Over 60% of national R&D funds are provided by the government, through institutions such as the Office of the Chief Scientist of the Ministry of Trade and Industry, the Israel Investment Center, and the Ministry of Defense. Some 22% of R&D funds are provided by industry, compared to a average of about 50% in other developed states. Industry employs one-quarter of the R&D manpower, as compared with 72% in the U.S. and 62% in Japan.9 (Some 50% of national R&D funds go to the military sector, approximately the same level as in the U.S., compared to 22% for China, and less than 5% for Japan.10)

Within the industrial sector, most of the R&D is performed by government-owned firms, such as the Israel Aircraft Industries (IAI), which is controlled by the Ministry of Defense and is the country's largest industrial employer, the National Armaments Development Authority (Rafael), and Israel Chemicals. Other major technology-intensive firms, such as Tadiran (electronics) are owned by the Histadrut, and are also closely linked to the government.

Universities perform 30% of national R&D, which is relatively high (compared to 12% in the U.S., for example) but less than previous levels. In the 1960s, universities accounted for 65% of civil research.11 In general, while the universities receive the bulk of their support from the state, they are largely free to set research agendas and priorities. The university research system is closely linked to the state Council for Higher Education and the University Planning and Grants Committee (which is modeled on a similar British system.) These institutions, as well as the university structure and the Academy of Scientists, cushion the individual scientists and

researchers from external interference and provide for the distribution of resources on the basis of peer review. In 1989, the Ministry of Education sought to become involved in the process of university allocations, but this effort was successfully rejected by the universities. Thus, despite the very high level of dependence on the state for resources, the Israeli scientific community is still relatively autonomous, at least at the level of basic research.

R&D and Economic Policy

The economic and social development of the state, and the process of modernization in the Zionist movement and in Israel, is largely based on and linked to science and technology.12 The state has provided significant resources to the scientific community in order to stimulate economic development, and, as noted above, over 60% of R&D (including some of the university-based research) is funded through the national budget. (All universities in Israel are state institutions, and are funded through state allocations, donations and student tuition fees.) Science and technology-based industries are a major aspect of the strategy for industrialization and for the development of exports. In many cases, the strategy for creating new employment opportunities is synonymous with the development of technologically advanced industries.

In the past decade, the Office of the Chief Scientist and the Israel Investment Center have emerged as the primary vehicles for government support of industrial research and development. Together, these agencies provide hundreds of millions of dollars in direct subsidies for R&D projects to firms. The OCS provides from one-half to two thirds of the funds for "approved projects", while the firms put up matching funds for the rest. Although these funds are ostensibly designed to promote specific high-risk R&D ventures and projects by small firms with little capital for such undertakings, in fact, up to 60% of the allocations go to large, well-established government and Histadrut firms, such as IAI, Tadiran, Israel Chemicals, etc. every year, regardless of the nature of the projects involved. In other words, the system of support for applied industrial research has become highly bureaucratized and institutionalized, with the type of patron-client relations that are typical of many such government subsidy programs. The government agencies have close professional, political, and social relationships with the technical personnel and management of the recipient firms. Allocations are divided informally based largely on previous divisions, and new firms have great difficulty "breaking in".

Similarly, the Israel Investment Center, which, like the OCS, is linked to the Ministry of Commerce and Industry, also provides direct subsidies to firms. The ICC's mandate is to broadly develop industry and employment in the country. In practice, this agency has also focused on technology-intensive industries. While some of the ICC funds go

to subsidize foreign investment in Israel (firms such as Intel and National Semiconductor), many of the same firms that are funded by the OCS, such as IAI, are also subsidized by the ICC. The patron- client relationship between the ICC and the recipient firms is similar to that developed in the case of the OCS.

The extensive military research and development is also designed to promote economic as well as national security objectives. Over one third of industrial employment in Israel is centered in the military sector, and technology-based military products account for approximately $1.5 billion in exports annually, or about 12% of total exports (20% excluding diamonds and agricultural products).13 Military technology has also been seen as "the leading edge" of technology-based export industries, which account for some $2.5 to $3 billion in total exports annually (including chemicals, electronics, and the military sector).

Science and technology are also considered to be crucial in the area of immigrant absorption, on the one hand, and emigration, on the other. Israel produces many more scientists and engineers than can be absorbed by the universities and industry, and, as a result, many members of this community emigrate in order to seek employment in their professions. This might be considered to be sign of over- investment in advanced education and training in the natural sciences and medicine, but the cultural and social value placed on scientific professions expands consideration of this issue beyond the narrow economic issues.

Instead, politicians and members of the scientific establishment call for government policies designed to create jobs in order to end the "brain drain". Furthermore, from the perspective of Zionist ideology, emigration from Israel is an ideological affront, and it is considered the duty of the government to provide resources in order to halt this process. The Ministry of Education and the Ministry of Science and Development have allocated funds specifically for the purpose of "bringing back expatriate scientists".

The Israeli government has also made major efforts to provide jobs and other resources for immigrants. Between 1989 and 1991, over 400,000 immigrants arrived, increasing the Israeli population by ten percent. (By the mid-1990s, at least one million Jews are expected to have immigrated from Russia and the other republics that constituted the Soviet Union.) A very high percentage of this group have scientific or technical training. Special funds have been created to allow the universities to create new positions and research programs for these immigrants. Although all immigrants ("olim") are given special assistance, the additional support for scientists and engineers indicates the particular political and ideological importance attached to the absorption of this group.

Thus, in many ways, the Israeli government and economic structure have become highly dependent on R&D and on the scientific and technological community for the creation of jobs, economic development, exports, and immigrant absorption. Through the emphasis on R&D, the economy has grown and developed relatively rapidly and successfully. As a result, the political and social leadership, including most parties and major figures, continue to view science and technology as the key to national development and growth. This perception is expressed in terms of support for highly ambitious projects such as the Lavi combat aircraft, the Mediterranean - Dead Sea Canal, the Arrow missile, and the undifferentiated subsidies provided for industrial R&D discussed above.

Policy for Science and Technology

Analysis of the "political economy of science" also includes the interaction of politics, economics, and the role of the scientific community in establishing "policy for science". Issues includes the procesess by which resources for research and development are distributed among the competing claimants, diversification, social and geographical concentration, and leadership patterns.14

In the Israeli case, many of the major institutions for research and development were established before the state was founded in 1948. They were largely autonomous, and science and technology policy in the 1950s has been described as "a period of largely spontaneous and uncontrolled growth, characterized on the one hand by initiative on the part of bodies within and outside government ministries, and on the other hand by the absence of overall planning and coordination."15

In 1949, shortly after the establishment of the state, the government created a Scientific Council to serve as a central advisory body. The Council had little impact on established processes, but did create new research institutes in applied physics, fiber research, geology, and arid-zone research. In general, however, Israeli R&D in this period was independent of the government, and heavily oriented toward basic and theoretical research. Critics charged the scientific community and the government with neglecting applied research that could alleviate the national problems caused by massive immigration ("the ingathering of the exiles") and the constant military threat.

In response, in 1959 the government created the National Council for Research and Development Council (NCRD), which was charged with developing a national R&D policy, coordinating activities, and administering the institutes created earlier. This agency was located in the Office of the Prime Minister, in order to insure access and resources. In practice, however, the NCRD, like its predecessor, had little independent power or budgetary authority, so that it was unable to influence the universities or

government ministries. Civil R&D in Israel continued to emphasize basic research, and was largely decentralized throughout this period.

Continued demands for redirection of the relatively large scientific and technological effort towards national needs led to yet another reorganization effort in the late 1960s. In this round, the individual government Ministries were recognized as the core of power in the state, and as a result, positions of Chief Scientists were created in most major ministries, including Commerce and Industry, Education, Defense, Agriculture, etc. Chief scientists were expected to lobby for increased funds for applied R&D within their ministries, and to control and supervise research programs.16 Some, such as the Office of Chief Scientist in the Ministry of Commerce and Industry, were relatively successful, largely as a result of their connections to the political system. For example, the growth of R&D funds in this case was linked to the fact that Haim Bar-Lev, who had served as Chief-of-Staff of the Israeli Defense Forces, became Minister. He brought the former Head of military R&D, Yitzchak Yaakov, with him to be Chief Scientist in the Ministry. Both belonged to Israel's political elite, thus insuring a high level of budgetary allocations.

The system of chief scientists succeeded in greatly increasing interest in and support for applied research among the various ministries and industries. At the same time, the NCRD was expected to play a coordinating role, but, given the political power and independence of the individual Ministers and ministries, this was impractical. By the mid-1970s, the Chief Scientists of the major ministries were the primary determinants of applied R&D policy in Israel.

During this period, basic research has remained under the control of the universities and of the Israeli Academy of Sciences. The academy is an independent body, but has taken on the task of coordinating basic research and lobbying the government for increased funds in this area.

In 1982, Yuval Neeman, one of Israel's pre-eminent physicists, was elected to the Knesset as Head of the Tehiya Party and became a Cabinet Minister. To accommodate him in a broad coalition government, the Ministry of Science and Development was created. The NCRD was incorporated into the Ministry, and this provided the coordinating function of this agency with greater visibility. In practice, however, the Ministry has had little impact on the structure of science and technology in Israel. Reflecting the acceptance of the universalist view of the scientific community, basic R&D has remained decentralized and under the control of the individual universities and researchers (for basic R&D), and applied research continues to be determined by the individual ministries.

The Scientific/Technological/Political Elite

Many analysts have studied the links between knowledge and power in modern industrial societies. These studies have shown that in many cases, scientific and technological "experts" have been able to turn their professional knowledge into political power.17

From the beginning, members of the scientific community were part of the social and political elite, and despite fundamental political and economic changes, their position has continued without interruption. The respect and importance given to academics and intellectuals in Jewish society continued, and a position on the faculty of a major university was and continues to be highly esteemed. (This in spite of a strain of anti-intellectualism that accompanied Labour Zionism's rejection of the traditional diaspora society, with its emphasis on "unproductive" scholarship, and rejection of "worldly materialism".) Dr. Chaim Weizmann, the head of the Zionist movement for many years and Israel's first President, was an accomplished chemist.18 After Weizmann's death, the position of President was offered to Albert Einstein. Dr. Ephraim Katzir, a prominent biologist, also served as President, and was selected as a result of his scientific achievements. The office of President is largely ceremonial, but the selection of scientists for such a position is an indication of the importance of science in Israeli society, the esteem in which scientists are held, and the close links between the "political class" and the scientific community.

At the same time, at lower policy-making levels, scientific knowledge, in and of itself, does not provide a direct link to political power. The state, and quasi-state institutions such as the Histadrut Labor Federation and the Jewish Agency, dominate most aspects of the social system and power structure. These institutions, in turn, are controlled by political parties. Individual scientists and engineers have access to power within the structure of the party system and as part of the ruling elite, but not by virtue of their knowledge or scientific achievements. (A detailed study of the role of physicians shows that this professional group of "experts" has almost no impact on health policy in Israel.19)

In Israel, the type of institutionalized framework for scientific and technological advice that is found in many advanced industrialized states is also very limited. As noted, there is some institutionalization at the Ministerial level, and the NCRD plays a minimal role in coordination. There is, however, no structural equivalent to the American White House Science Council, or Office of Technology Assessment, for example, to provide advise and evaluation of scientific and technological policy at the highest level.20

Instead, high-level interaction between the top decision makers and the scientific community in Israel is based largely on informal personnel connections among the elite. As noted, well-known scientists are included within the boundaries of the

social/political elite, and the economic and military importance of these factors highlight the potential political role of the scientific and technological community. Ben- Gurion had close personal relations with many of the nation's leading scientists, and met with them frequently. Since 1977, the personal links between the political leadership and the scientific community have been more impersonal, but the broader relationship between these two groups has been maintained.

In the past decade, individual members of the scientific community, particularly those connected with military R&D such as Yuval Neeman and Moshe Arens, have become part of the political leadership, and assumed independent political roles. Neeman studied engineering at the Technion, and later became a theoretical particle physicist. He worked with Murray Gelman at the California Institute of Technology, and made important contributions to the application of group theory in elementary particle physics. He was also closely involved with the Israeli Ministry of Defense, served as Deputy Director of Intelligence and Military Attache in London and became head of Tel Aviv University. At the same time, Neeman was active in Israeli politics, was a founder of the Ha'Teyiha (Renaissance) Party, was elected to the Knesset in 1981, and served in the Cabinet as Minister of Science and Development and Minister of Energy.

Arens studied aeronautical engineering at MIT, returned to teach at the Technion, became a manager in the aeronautical engineering division at Israel Aircraft Industries (IAI) and headed the Kfir combat fighter production effort. Like Neeman, he became active in politics, was elected to the Knesset in the Likud Party, and has served as Ambassador to the U.S., Foreign Minister, and Minister of Defense.

Neeman and Arens were able to rise relatively rapidly in the political hierarchy in part because of their scientific and technological achievements, that automatically made them a part of the Israeli decision-making elite. Both were connected with the defense establishment, and this provided greater political visibility and access. However, both exercise power by virtue of their political positions, rather than their expertise.

It is also important to note that both Arens and Neeman have combined their political and technological interests and the boundary between these functions is unclear. As a manager in IAI, Arens pursued the development of Israeli combat aircraft, and when he became Ambassador to the U.S. and Minister of Defense, he continued to support the Lavi effort, even when the costs of this project made it untenable. (When the U.S. Department of Defense sought to limit U.S. support for the Lavi, Arens intervened with Congress. As domestic criticism of the costs of the Lavi mounted, Arens argued that the technological performance of this aircraft would ultimately lead the U.S. military to acquire the Lavi. When the project was cancelled in 1987, Arens resigned, but returned to the Cabinet in 1988 as Foreign Minister.)21

Similarly, Yuval Neeman has been active in promoting science and technology related projects. He was a major supporter of the Mediterranean Dead-Sea Canal Project (which was ended with little progress in 1985), the Lavi, and, more recently, Israel's space efforts.

As prominent members of the scientific and technological community, Neeman and Arens, as well as others in similar positions, are generally considered to be experts in issues relating to scientific or technological policy. Many Cabinet members relied on their evaluations with regard to the Lavi and the Canal projects, without acknowledging that close links with the scientific and technological community, and a tendency for "technological enthusiasm" (see discussion below) might lead to distortions in their evaluations. Given the homogeneous nature of the scientific community, in which conflict is generally absent, very few individuals challenged these views.

The Impact of Israel's International Position on Science and the Scientific Community

Security requirements, and the constant threat of warfare in the region, have strongly influenced the direction of R&D and Israeli science and technology. As noted, Israeli strategy emphasizes technological development in order to maintain a qualitative advantage over the Arab forces, thereby attempting to offset large quantitative and demographic disadvantages. This situation contributed to the initial development of the defense industries and their subsequent growth.

Over one-half of national R&D expenditures go towards military related programs, which is very large by any standard. This emphasis on military applications is reflected in the fact that 78% of all the national R&D expenditure is focused on the electrical, electronics, and aerospace sectors. (In Israel, both sectors include major military components and are based on foundations created for the military, although civil R&D in both sectors has increased in recent years.)

The Ministry of Defense and IDF have consistently supported the development of local technological add-ons and up-grades (electronics and avionics) to improve the capability of imported weapons platforms, to adapt them to the Israeli requirements and environment, and to extend the lifetime of these weapons. The Science Corps and its successors have also developed specific weapons systems and related technology not available elsewhere, such as mini-RPVs to provide real-time images and data to battlefield commanders, advanced decoys, ship-to-ship missiles, battlefield communications, etc. When the major suppliers of main battle tanks (and the UK in particular) refused to provide such weapons to Israel in the late 1960s, Israel produced the Merkava main battle tank, including advanced computerized fire-control and other electronics systems. In the past few years, IAI and Rafael have been developing anti-

tactical ballistic missile technology (the Arrow and AB-10). Technologically and militarily, these innovations have been very successful.

The foundation for Israel's nuclear capability was created in the 1950s under Ben-Gurion, who, like many other political leaders of the time, saw nuclear energy as the key to both economic development and national security. In the case of Israel, in particular, a nuclear weapons capability was and still is perceived by many military and political decision makers as the "ultimate guarantee" of national survival in the face of the overwhelming Arab demographic and economic advantage.22 The government has supported the growth of the Israeli nuclear program, including the reactor complex at Dimona in order to advance specific political and military objectives.

As a result, in Israel, as in other states with a heavy emphasis on military R&D, such as the U.S., government support for this sector, and related industries and fields, has skewed the national R&D system. Beginning in the late 1960s, support for military aircraft development led to greatly increased demand in this sector. When IAI, which is Israel's largest industrial employer, began to cut back its workforce in the late 1960s, the Israeli government supported the development of the Arava STOL aircraft primarily in order to prevent the loss of these workers and the infrastructure in this area. Given the very limited labor market in Israel, many skilled engineers would have left the country. The Lavi project was motivated, in part, by similar concerns.

While the government initially supported relatively large scale investment in civil nuclear research, applications, and facilities, economic limitations have led to subsequent reductions in these programs. (The facilities and personnel at the nuclear reactor complex at Nahal Sorek have been put on a commercial basis, and units that are not profitable have been reduced or even closed.) In 1987, the government ended the Lavi combat aircraft project due to a lack of funds for production, which led to an immediate reduction of 25% of IAI's workforce. Although some of the "slack" has been taken up in the Arrow ATBM program, this is much smaller in scope. Government "sheltering" of aeronautical engineers, was greatly reduced as the cost became to great.

At the same time, the large military-related R&D sector is largely separate from basic and civil R&D. Although the state is the main source of funding for basic research, as noted above, agendas and priorities are largely determined independently by the Israeli Academy of Sciences (through peer group evaluation of research proposals) and the university research system. Similarly, civil research priorities are set by industry (see above) and by the chief scientists in many government ministries. In contrast, the agenda of the much larger military R&D sector is determined by military contracts and requirements.

"Openness" and International Cooperation

In the introductory chapter of this volume, Solingen examines the impact of external factors on relations between the scientific community and the state. She suggests that a high degree of external conflict "leads to higher levels of investment in military-related scientific research, higher secrecy (including domestic), with respect to scientific research, and to lower levels of openness to international scientific interdependence."23

In Israel, the military R&D system is indeed highly secretive, particularly with respect to such areas as nuclear research, missiles and related technology. In contrast, however, basic science and civil R&D are very open. Israeli scientists publish extensively in international journals (among the highest rates per capita in the world). Basic research in areas that might seem sensitive, because of their relationship to military sectors, such as laser isotope enrichment research and electro-optics, are not generally subject to formal government censorship or other restrictions. In many cases, however, the scientific community exercises a high degree of self-censorship in "sensitive" areas.

Although the Israeli economy is far more integrated and dependent on the world economy than that of the U.S., the formal restrictions on the transfer of civil technology and knowledge that have developed in the U.S. have no counterpart in Israel. Indeed, some critics have warned against the relative freedom with which the Israel scientific community has "given away" new irrigation technology and agricultural developments, as well as innovations in the area of military and medical technologies. They argue that this process contributes to increased international competition that will, or in some cases, already has, led to reduced export earnings.

The percentage of joint research projects and publications with colleagues in other countries is very high. 27% of the papers written by Israeli scientists include international co-authors, compared with 10% for the U.S., and a range of 15 to 20% for most Western European states.24

Government institutions and policies encourage scientists to travel and to participate in international exchanges and cooperative projects. At any time, hundreds of Israeli scientists are on sabbatical leave in the U.S. alone.25 With a population of 5 million and a GNP of $52 billion in 1991, Israel is by all measures a small country with very limited absolute resources for science and technology. Israel cannot conceivably produce its own atomic particle accelerators or space-based instruments to provide access to the "frontiers of science" in these areas. Similarly, large scale funding for biomedical research and laboratories on the scale found in the U.S. or Western Europe is beyond the range of Israel's budgetary realities. Thus, in order to participate in the

major R&D activities of the modern era, Israeli scientists must join in cooperative ventures.26

Most of Israel's scientific and technological links are concentrated in Western Europe and North America. A very large portion of scientific exchanges involve individuals and institutions from these regions. Formal government-to- government exchange programs and frameworks for cooperative research have been signed with U.S., France, Holland, and other states.

A significant percentage of R&D funds in Israel is provided in cooperative frameworks such as the U.S.-Israel Binational Science Foundation. Between 1958 and 1972, the U.S. funded foreign educational and research projects under the PL 480 program.27 Since then, an endowment of $100 million was created for the BSF with additional funds in similar frameworks for agricultural and industrial research (BIRD-F and BARD-F). Support is also obtained from direct funding through contracts from U.S. agencies such as the NIH, AID, NASA, DOE and DOD. As of 1985, over one third ($26 million out of the $70 million) of the funds for basic research conducted in Israeli universities came from foreign sources.28

This basic condition is recognized by the government, which facilitates such cooperative activities through special travel funds and other arrangements and incentives. The NCRD publicizes and coordinates scientific exchanges and related agreements with other states and international bodies.

The dependence of the Israeli economy on imports and exports, and the technological based export strategy have further highlighted the importance of international technological links.29 As noted, over the past two decades, the percentage of technology-intensive exports, including defense and military products, has grown rapidly and the Israeli economy is now highly dependent on this sector. Exports center on computer industries, aeronautical equipment, electronics, pharmaceuticals, and communications systems. In many cases, Israeli firms have become subcontractors in major weapons systems developed by U.S. prime contractors. Given this structure, and the dependence on exports, the R&D community must necessarily be in close contact with its counterparts in the industrialized world.

The Effects of Regional Isolation

The emphasis on international links in the area of research and development is further heightened by the political and economic isolation of Israel in the Middle East. For most of its existence, Israel has not had diplomatic or economic links with any of the states in the region, although under the 1979 Peace Treaty, relations were established with Egypt. The economic boycott of Israel imposed by most of the Arab world

includes a secondary boycott, which limits trade with many industrialized states, and Japan in particular. Between 1967 and 1990, Israel was politically and economically isolated from Eastern Europe, the Soviet Union, much of Africa and parts of Asia.

However, as a result of the international prominence of Israeli scientists and their technological achievements, members of this community were generally far less isolated than other population groups. By virtue of their professional expertise and international contacts, scientists were often invited to participate in international conferences and exchanges in countries from which other Israelis were generally excluded, such as China, the Soviet Union and Eastern Europe, and even a few of the Arab states that have continued to maintain a state of war with Israel.

Science and technology, or more precisely, scientists and members of the technological community, became a channel for diplomacy and international acceptance for Israel. Scientists have often represented the state unofficially in international organizations and settings, and among scientists from states that do not have diplomatic relations with Israel. Professional meetings and conferences, as well as the activities of groups such as Pugwash, provided the setting for meetings between Israeli and Egyptian scientists, before the 1979 Peace Treaty. Prof. Michael Sela, from the Weizmann Institute, was among the first Israelis to be invited to the Soviet Union during the Gorbachev era. At the time, when few other channels existed, these scientists provided a means of communication for the government in meetings with political officials, including Gorbachev, and often carried diplomatic messages to and from Israeli political leaders. Similarly, the establishment of diplomatic and economic links with China and India began with scientific and technological exchanges and collaboration (in both the civil and military sectors).

To counter this political isolation, Israel is strongly represented in international scientific organizations, such as UNESCO, the scientific divisions of the IAEA, EMBO (the European Molecular Biology Organization, which Israeli scientists helped found), etc. Membership in such international organizations is seen as providing a form of international recognition when direct state-to-state relations have been absent.

Many scientists and political leaders see scientific and technological cooperation with neighboring Arab states, such as Egypt, Jordan, Syria, and Saudi Arabia as a basis for establishing cooperation and reducing the scope of the military and political conflict. Jordanian farmers have adapted many of the Israeli techniques for water conservation and drip irrigation, and this indirect contact is seen by Israelis as part of a broader "functionalist" approach to conflict reduction. Similarly, Yuval Neeman promoted the Mediterranean-Dead Sea Canal project as a means of establishing technical cooperation with Jordan. In the environment of the "cold peace" between Egypt and Israel, scientific exchanges and even some cooperation provide a means of increasing

contacts. These exchanges include joint research projects in public health, marine sciences, agriculture, and physics.30

While such open and frequent international exchanges might be a source of tension or even "subversion" in closed political systems, this is not the case for Israel. Given the open and highly pluralist political system, there is little that foreign travel and exposure to external concepts or to the "free marketplace of ideas" can provide that is not already found in Israel.

Far from being a source of subversion, exchanges are seen as source of political support for Israel. Visiting foreign scientists exposed to the realities of Israel, and those who meet Israeli scientists abroad are expected to develop an understanding of and sympathy for their Israeli colleagues. Thus, in the Israeli case, there is no contradiction between a high degree of international interdependence and the political impact of globalization. On the contrary, these are seen as synergistic and mutually reinforcing.

"Happy Convergence"

In Chapter 1 of this volume, Solingen uses the terms "happy convergence" to define a situation characterized by a high degree of consensus between state structures and the scientific community. "Happy convergence" allows scientists to operate with "broad measures of internal freedom of inquiry" and provides this community "with relatively comfortable material rewards". Efforts by the state to intervene and control of the direction of science are resisted.31

In the Israeli case, the evidence conforms closely with this model. The mutual dependence between science and the state has led to consensus and a high level of mutual cooperation. As discussed above, leaders of the scientific community form part of the ruling elite, and participate actively in the decision making processes in both the military and economic spheres. On a relative scale, the "material rewards" for scientists are high. Through various links, both informal and formal, these scientists determine policies, allocate funds, and set priorities on behalf of the state, while intervention by the state is very limited.

The close links between the scientific community and the military, and the unofficial diplomatic role of individual scientists in the face of Israel's formal isolation, tend to reinforce the situation of "happy convergence" between the state and the scientific community.32

This is a community of "insiders", using Gilpin's terminology; the "outsiders" are few in number and have very limited influence.33 With very few exceptions,34 the Israeli

scientific community forms a largely homogenous group, and it identifies strongly with the state and its overall policies. Although the community is divided, much as the broader polity is split, among "hawks" and "doves" with respect to policy options in the context of the Arab-Israeli conflict, scientists generally share the overall Israeli consensus regarding the centrality of Jewish sovereignty and national survival.35 In international organizations such as UNESCO, the IAEA, PUGWASH, Israeli scientists work closely with the government to oppose Arab-sponsored anti-Israel initiatives.

At the same time, there have been two significant exceptions to homogeneity and the convergence of views on issues of national security and technology. The first concerned the case of atomic weapons development. The Israeli nuclear research program was developed in the 1950s under the joint auspices of the Ministry of Defense and the Israel Atomic Energy Commission. In 1957, as the military potential of the program grew, (in response, in large part, to the Egyptian efforts to develop missiles and chemical weapons), all of the members of the IAEC resigned with the exception of Prof. E. D. Bergmann, who was known to have close links with the military.36 A few years later, as the military nature of this undertaking became more pronounced, a number of scientists created the Israel Committee for a Nuclear Free Zone. This group began a vigorous public discussion, but in 1963, when the development of the Dimona facility seemed to slow, and Prime Minister Eshkol announced that Israel had no plans to produce nuclear weapons, this political activity subsided.37

In 1966, the structure of the IAEC was altered and the Prime Minister replaced Prof. David Bergmann as chairman. A number of conflicting explanations have been presented for this move. According to Dowty, the reorganization was the result of conflict within the IAEC and the government regarding the development of a nuclear deterrent. Dowty argues that Prime Minister Eshkol had accepted U.S. pressure to "freeze" development of the Dimona facilities, prompting (or perhaps forcing) Bergmann to resign.38 At the same time, a group calling itself the Committee for the Nuclear Disarmament of the Arab-Israeli Region emerged.52 Members of this group, which included scientists from Israel's major research institutions such as the Weizmann Institute and the Technion (including two former members of the IAEC who had resigned in 1957), published a petition calling on "the Government of Israel to take the international political initiative in order to prevent the proliferation of nuclear weapons in the Middle Eastern land mass..."39

The level of conflict and protest within the scientific community regarding the development of a nuclear weapons option was limited and apparently ineffective. Since the period preceding the 1967 war, in which the conventional force of the combined Arab armies threatened the survival of the state, little criticism of the

maintenance of a nuclear option has emerged in the country in general, and in the scientific community in particular. The case of Mordechai Vannunu a former nuclear technician who provided detailed descriptions of the Dimona facility and operations to the Sunday Times of London, and was subsequently convicted for treason, failed to generate support among scientists, or any form of "collective action" as a professional community.

A second case of public dissent took place in 1992 around the issue of the Israeli military space program, and the development of reconnaissance satellites in particular. This effort was accelerated following the 1991 Gulf War, in which the threat of Iraqi missile and chemical weapons paralyzed Israel for 6 weeks. After the war, the Israeli military recognized the need for an independent source of real-time intelligence on military deployments in the Arab world, and this led to a dedicated satellite reconnaissance program.

The former head of the Israeli Space Agency, Prof. Dror Sadeh of Tel Aviv University, criticized this program, arguing that this technology was too expensive and not cost effective, given limited Israeli resources. He argued that this effort would divert scarce resources from the small-scale scientific research and development program, and could reduce cooperation in this area with other states, including the United States.40 However, Sadeh has been largely isolated in this debate, and most members of the scientific community seem to actively support and participate in the government policy. This criticism generated even less support or public discussion than the earlier protests over nuclear policy had, but both cases demonstrated the openness of the Israeli society, and the absence of formal legal or political limitations on policy debate.

Technological Enthusiasm

Given the high degree of interaction and interdependence, there is perhaps surprisingly little conflict within the scientific community, or between the state and the scientific community. In the military sphere, while there may be some disagreement about the means and appropriateness of some projects, active protests and opposition to policies is largely non-existent (with the exception of the nuclear case discussed above.) In Israel, there is no equivalent to groups such as the Union of Concerned Scientists (UCS) or the Federation of American Scientists (FAS). There are also no well-known individuals who serve as "opposition" scientists, and scientific meetings generally have no political content or debate.

The close relationship and interdependence between the state and the scientific community has increased the tendency in Israel for policy decisions based on "technological enthusiasm", as exhibited in the cases of the Lavi combat aircraft

project and the Mediterranean-Dead Sea Canal. The Israeli political leadership, as noted above, has a strong tendency to view science and technology without differentiation as a source of economic growth, social development, national security and national prestige. "Technological fixes" are often proposed for difficult social problems, and projects that are in some way linked to research and development tend to be endorsed enthusiastically without detailed cost-benefit assessments. Given the uncertainties involved, instead of assessments, such projects are rationalized under the assumption that all spending in R&D ultimately contributes to the national good, in some way. The concept of spillover is frequently used to rationalize decisions that do not seem to be cost effective. The allocation policies of the OCS and Israel Investment Center are based on a similar approach.

The Israeli scientific and technological community has generally reinforced this undifferentiated "technological enthusiasm". In part, this is a reflection of the shared values of this community; indeed, most are "technological enthusiasts" themselves so it is not surprising that opposition to such policies is rare. In addition, the scientists and engineers often depend directly on these policies and resulting allocations; since many members of this community receive subsidies from the OCS, ICC or other source, they are unlikely to criticize related policies.

While state-science relations may have been originally based on the sociological links between the individual scientists and the political leadership, the current relationship is clearly influenced, or perhaps dominated by political-economic issues.41 Both factors play a role in explaining the failure of the scientists to participate visibluy in the public debates on the Lavi, the Arrow missile, energy sources, and the environment. To some degree, the absence of national institutions or channels may be a contributing factor. In general, however, the shared values and perspectives would seem to provide the fundamental explanation for the absence of structural or ideological conflict.

A Comparative Perspective

The relationship between scientists and state, like many other aspects of Israeli society and political economy, is somewhat anomalous, if not unique. The Western European cultural and social structure, and the emphasis on the independence of the scientific endeavor, exists within a political-economic structure that is characteristic of the developing world, in which mobilization of scientific resources is the norm.

In addition, the extreme importance of national security and the continuing concern for the survival of the state is highly unusual among industrialized and most industrializing states. (The closest analogy is perhaps with Pakistan, but even here, the military/political threat to the survival of the nation is not as pronounced as the Israeli

case.) The resources that are devoted to defense and national security (over one-third of the GNP), and the importance of science and technology in Israeli strategy are scarcely matched anywhere. The degree of Israel's international and regional isolation is also highly unusual.

Economically, the availability of scientific and technological resources and the role of these factors in industrialization, economic development, and export sales are also extremely pronounced. Both Brazil and India have also placed an emphasis on technology-oriented development and industrialization, but not nearly to the extent as these are emphasized in the Israeli case.

As a result, the role of the scientific and technological community in Israeli society is more pronounced than in most other cases. As noted with respect to Arens and Neeman, Israeli scientists and engineers not only have access to the decision-making elite; they are a central component of this elite. These figures play a major role in technology-related issues including the development of new advanced weapons systems and technology-intensive economic investments, and they are also involved in all aspects of policy making in Israel. (As noted above, Neeman and Arens have held important positions in the government.)

In many other industrializing states, the scientific and technological enterprise is culturally alien. In contrast, in Jewish society in general, and Zionist ideology in particular, the scientific enterprise is widely valued and respected (which, as noted above, has contributed to the tendency towards "technological enthusiasm".) Even among the religious Israelis, who constitute some 20% of the society, there are few clashes between science and traditional values, and many physical scientists, engineers, computer experts, and physicians are members of the religious community.

The close links between scientists and the state and the general identity of interests and views has meant that there has been no conflict or perceived need for limitations or controls on scientists and their activities. The state generally sees its role as a resource provider for scientific and technological activities, rather than as a source of control and limits. In many cases, the close ties between the scientists and the military has allowed the former a great deal of freedom in new weapons projects and similar activities (as in the case of the Lavi, for example.) State involvement in agenda setting in the civil sector is also highly circumscribed, except to the extent that the scientific backers of specific projects seek to mobilize the state for support (as in the case of the Mediterranean-Dead Sea Canal, for example).

As a result of these close ties and common perceptions and interests, the Israeli case may perhaps be explained at least as well in terms of the sociological role of scientists in society, as in terms of the political-economy models that are useful in most other

cases.42 While the role of technology in the economy has been and will continue to be of central importance, the changing nature of the political economy and the evolution of a more decentralized, pluralistic, and market based system has not and is not likely to effect the close relationship between "scientists and the state".

Perhaps most importantly in a comparative context, Israel's position in the region and the international system continues to be highly anomalous. While peace talks began in Madrid in October 1991, Israel remains largely isolated from most of its neighbors. The threat of war continues, and has been reinforced by the Iraqi missile attacks during the Gulf War. The importance of technology in maintaining the military balance, and the contribution of this factor to the close convergence between the state and the scientific community is still prominent in the perceptions of both the political and scientific elite. As the technological arms race in the region accelerates, not only in the deployment of advanced conventional weapons, but also with the proliferation of ballistic missiles, chemical, biological and nuclear warheads in Iran, Iraq, Syria, Libya, and Algeria, the close cooperation between state and science is likely to grow even more pronounced.

Prospects for Change

In a broad sense, the relationship between science and the state in Israel can be explained by the particular factors that characterize the Israeli environment; the emphasis on the role of science and technology in Jewish and Zionist values and ideology, the central importance of technology to national security (which is by all measures, far greater than in other industrialized or industrializing state), the role of science and technology in the rapid transformation of the economy and society, and the role of science and technology in breaking Israel's diplomatic isolation in the international system.

As demonstrated above, the interactions between the political processes and the scientific community are generally consistent with the of the models and theories of state- science relationships. The openness of the Israeli political system, and close interdependence between the state and the scientific community have contributed to a relationship based on "happy convergence". The scientific community is part of the Israeli elite, and as part of that elite, plays an important role in determining economic and security policy. Scientists are involved in determining both "policy for science" and the role of science in policy.

As a result of the close links between science and thestate, sharp conflicts have been avoided, and Israeli scientists are able to function internationally with minimal restrictions. Despite the importance of military technology and the role of scientists in the national security structure, the activities and international links of this community

have generally not been subject to government-imposed limitations. On the contrary, the state has supported the international activities of scientists.

There are no indications that would point to changes in the elite role of scientists, or in the homogeneity and consensus approach to science and technology that have prevailed for over four decades. As long as the basic political and economic constraints that shape the structure of the Israeli political economy are constant, the interaction between science and the state are unlikely to change radically.

NOTES:

0- E. Tal and E. Katzir, "The Case of Israel" in Worldwide Science and Technology Advice to the Highest Levels of Government, William Golden, editor, (Oxford: Pergamon Press, 1990)

1- The high level of R&D in the period 1988-1990 reflected the major investment in the Lavi combat aircraft project. Prior to this period, R&D consumed approximately 3.5% of the GNP. See A. Keynan, Science and Israel's Future. A Blueprint for Revitalizing Basic Research and Strengthening Science Based Industry. (Jerusalem: The Jerusalem Institute for Israel Studies, 1988), 22

2- T. Herzl, Altneuland (Old-New Land), Reissued (Jerusalem: M. Newman, 1960); see also Baruch Kimmerling, Zionism and Economy, (Cambridge, Mass.: Schenkman, 1982)

3- In most accounts of the Balfour Declaration, the role of Weizmann's achievements as a chemist are exaggerated. This exaggeration is, in itself, an indication of the perception that scientists, by virtue of their achievements, are able to wield power in the international political system. For a detailed analysis of the perception of Weizmann's role in the formulation of the Balfour Declaration see David Vital, Zionism: The Crucial Phase, (Oxford, Oxford University Press, 1987).

4- The perceived importance of scientific and technological activity in economic and social development is demonstrate in government policy. See, for example, Council for National Planning, International Developments and Their Impact on Israel and the Middle East in the Next Decade, Jerusalem: Ministry of Economy and Planning, 1988; Council for National Planning, Technological Culture as a Condition for Economic Growth, (Jerusalem: Ministry of Economy and Planning, 1988); and J. Jortner, Scientific Research in Israel, Perils and Challenges (Jerusalem: The Israel Academy of Sciences and Humanities, 1988).

5- See Eugene Skolnikoff, "Science, Technology, and the International System", in Science, Technology, and Society -A Cross Disciplinary Perspective edited by Ina Speigel-Rosing and Derek De Solla Price, (Beverly Hills, Sage, 1977).

6- See Sanford Lakoff, "Scientists, Technologists, and Political Power", in Science, Technology, and Society: A Cross Disciplinary Perspective, edited by Ina Spegiel-Rosing and Derek de Solla Price, (Beverly Hills, Sage, 1977); and R. C. Wood, "Science and Politics: The Rise of an Apolitical Elite" in R. Gilpin and C. Wright, editors, Scientists and National Policy Making, (New York, Columbia University Press, 1964).

7- Scientists and analysts of research and development in Israel have generally ignored the relationship between the Israeli political and social structure and the scientific community. See, for example, E. Tal and Y. Ezrachi, Science Policy and Development: The Case of Israel (Jerusalem: National Council for Research and Development, 1972); Tal and Katzir; and Keynan.

8- Etel Solingen, Chapter 1, this volume, (p.10 of manuscript)

9- Tal and Katzir

10- Keynan, p.22

11- Keynan, p.16

12- See, for example, David Ben Gurion, B'Maarakhah (Tel Aviv: Am Oved, 1957), and Zikhronot, (Tel Aviv: Am Oved, 1971-73). For empirical evidence of the role of technology in Israeli economic development, see Tuvia Blumenthal, "R&D in Israeli Industry", Research Policy 7 (1978): 62-87.

13- Estimated on the basis of date from the Statistical Abstract of Israel -1989 (Jerusalem: Central Bureau of Statistics, 1989), 249-50; and Annual Report, Bank of Israel, 1991, (Jerusalem: Bank of Israel, 1992), 330. Official statistics regarding defense and military exports are widely believed to be less than the actual sales and transfers, and many reports of major multi-billion transactions with China and other states have been published.

14- See Solingen, the Chapter 1 of this volume, (p.10 of manuscript)

15- Tal and Katzir, p.5

16- Tal and Katzir; see also Committee to Inquire into the Organization and Administration of Governmental Research, Report of the Committee, E. Katchalski (Katzir), Chairman, (Jerusalem, 1968).

17- See Sanford A. Lakoff, editor, Knowledge and Power: Essays on Science and Government, (New York, Free Press, 1966).

18- Weizmann was chosen as Israel's first President primarily in recognition of his role as the leader of the Zionist movement for many years. In this sense, his scientific achievements were secondary.

19- Yael Yishai, Kocha Shel Mumchiut: HaHistadrut Harefuit Biyisrael (The Power of Expertise: The Israeli Medical Association), (Jerusalem: The Jerusalem Institute for Israel Studies, 1990).

20- For an analysis of the development of the scientific advisory structure in the United States, see Robert Gilpin and Christopher Wright, Scientists and National Policy-Making, (New York: Columbia University Press, 1964), and William T. Golden, editor, Science and Technology Advice to the President, Congress, and Judiciary, (New York: Pergamon, 1988).

21- Gerald M. Steinberg, "Large Scale National Projects as Political Symbols: The Case of Israel," Comparative Politics 19, No. 3 (April 1987): 331-346.

22- For a detailed discussion of the Israeli nuclear program, see Shai Feldman, Israeli Nuclear Deterrence, (New York, Columbia University Press, 1982).

23- Solingen, Chapter 1, this volume, (manuscript p.7)

24- Shlomo Hershkowitz, editor, Scientific Research in Israel - 1988, (Jerusalem: National Research and Development Council, 1989)

25- Keynan, p.47

26- M. Carmi, Research and Development Systems in Small Countries with Special Reference to Israel. (Jerusalem: National Council for Research and Development, 1979).

27- Under United States Public Law 480, the income derived from the sale of U.S. surplus food supplies to non-industrialized countries was made available to the recipient country to support research.

28- Keynan, pp.49-50; see also Foundation for Basic Research, Annual Report Number 12, 1986-7; (Jerusalem: Israel National Academy of Sciences, 1987); and Foundation for Basic Research, Annual Report Number 14, 1988-9; Israel National Academy of Science, Activities of Scientific Research in Israel (Jerusalem: Israel National Academy of Science, 1986).

29- For a theoretical discussion of this point, see Solingen, Chapter 1 in this volume, (manuscript p. 9)

30- In a publication appearing in Physical Review Letters, two Egyptian physicists acknowledged the assistance of a member of the faculty of the Weizmann Institute. (M. El-Nadi and O.E. Badawy, PRL 61, No. 11, (12 September 1988), 1271-2.

31- Solingen, Chapter 1, this volume, p.11 (manuscript)

32- See Solingen, Chapter 1 of this volume, p.11 (manuscript)

33- R. Gilpin, American Scientists and Nuclear Weapons Policy, (Princeton, New Jersey: Princeton University Press, 1962).

34- A few individuals scientists, such as Israel Shahak, are active opponents of government policies. They lack any form of organizational support, and their political influence in the scientific community is essentially nil. Their political activities are generally outside the broad framework of Israeli politics and protest movements.

35- It should be noted that overall, the natural scientists (physics, biology, chemistry) tend to be more "hawkish" with respect to the Arab-Israeli conflict and the debate over policy options, while those from the social science and humanities tend to be more identified with the "left" and groups such as Peace Now. During the 1988 general elections, academic signatories of Peace Now advertisements in newspapers were overwhelming from the social science and humanities faculties, while natural scientists formed the majority of signatories in advertisements for the right-wing Likud and Tehiya parties.

36- Alan Dowty, Israel and Nuclear Weapons", Midstream, 26, (November 1976), 10.

37- Ephraim Inbar, "Israel and Nuclear Weapons since October 1973", in Security or Armageddon: Israel's Nuclear Strategy, edited by Louis Rene Beres, (Lexington, Mass.: Lexington Books, 1988), 62

38- Alan Dowty, "Nuclear Proliferation: The Israeli Case" International Studies Quarterly, 22, No. 1, (March 1978), 79- 120.

39- Committee for Nuclear Disarmament of the Arab-Israeli Region, "Keep Nuclear Weapons Out of Our Region" New Outlook, (July- August 1966) 64-5. (New Outlook is a small publication which serves as a protest vehicle against government policies.) Additional articles on the question of nuclear weapons were published in the mid-1960s. See E. Livneh, "Israel Must Come Out for Denuclearization", in New Outlook, (June 1966), 44-47; Nimrod, Y. & Korczyn A., "Suggested Patterns for Israeli-Egyptian Agreement to Avoid Nuclear Proliferation", New Outlook, (March 1966), 9-20; and V., Y. "Atoms and a Middle East Tashkent", in New Outlook, (March 1966), 3-6.

40- Ha'aretz, (Israeli daily) 21 May 1992

41- See Sanford A. Lakoff, Knowledge and Power: Essays on Science and Government, (New York, Free Press, 1966); Don K. Price, The Scientific Estate, (Cambridge, Mass.: Harvard University Press, 1965); Dorothy Nelkin, "Technology and Public Policy" in Spiegel-Rosing and Price.

42- Joseph Ben-David, The Scientist's Role in Society: A Comparative Study (New Jersey: Prentice Hall, 1971).