3. The Symbiotic Interface Between Civilian and Military Technology

A fundamental feature of the R&D endeavour is the prevailing care and control over its working by governments, because of primacy of R&D in economy and development, with a special concern for security needs. Governments, federal and public institutions provide the lion's share for R&D. For 1982 - 1988 the average share of Gross Domestic Expenditure on R&D (GERD) from public funds was in the United States 50 %, in the US 44 %, in France 53 %, in FR Germany 37 %, in Italy 53 %, in Japan 23 %.[21]

There is a profound interaction between civilian and military R&D. The myth is widespread that military R&D provides civilian technology with large spinoffs of considerable economic utility. In part this hold true, though the general message is much of a public relations nature, aiming to win support for military R&D. Some spinoffs have indeed taken place, especially in dual-use technologies such as computer sciences, avionics, semi-conductor devices and electronics. However, the bulk of interaction between military and civilian R&D goes the other way: from civilian to military R&D, which is then called spin-on or spin-in. In the process, military R&D has gained a dominant and controlling position throughout R&D, civilian R&D included.

Military R&D is performed by a large network of laboratories, governments and private, permeating and interpenetrating industrial corporations and universities with parallel interests in civilian R&D. It is also keen to appropriate feats of civilian technology for its own military purposes. As emphasized by a study of the Office of Technology Assessment of the US Congress (OTA):

> increasingly, leading-edge technology is developed in the civilian sector and then finds its way into defense applications.[22]

In the interplay between the civilian and military R&D, military R&D is in many ways stronger: in available resources, tight structure, mission-orientation and government protection. Military R&D is a sealed establishment with rigid regulations, deep secrecy and special security directives, largely closed to civilian insight; by contrast, civilian R&D is more open, well studied - and is followed by military interests. Moreover, whereas military technology relies on specialized and highly sophisticated devices and is thus generally of low utility for civilian use, civilian technology is more consumer oriented and can be more easily adapted to military purposes. Military R&D is in perennial pursuit of exploits in civilian R&D which can be taken over for military needs. As stated by Thomas J. Welch, the Executive Director of the US Defense Science Board:

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[21] OECD, Main Science and Technology Indicators 1982 - 1988/2, table 5, p. 16.

[22] US Congress, Office of Technology Assessment, *Holding the Edge: Maintaining the Defense Technology Base*, OTA-ISC-420, Washington DC: US Government Printing Office, April 1989, p. 5,

> ... it is increasingly difficult to strictly differentiate between military and civilian technology... In the technology environment of today and tomorrow, civilian technology results in ever-more recognizable "spin-on" benefits for military use... Most sophisticated technologies are found increasingly in the civilian marketplace... Nations gain years of leadtime over adversaries and friendly competitors by way of spin-on...[23]

The OTA study focuses especially on "dual-use" technologies, of considerable civilian and military relevance, in three areas of critical importance for the military: (a) fiber optics and optoelectronics, (b) software, and (c) advanced polymer matrix composites (PMCs). In all these domains there is high potential for spin-on from civilian to military technology.

Fiber optics and related photonic technologies are today rapidly developing in most industrial countries, with exponential future growth probabilities. With their extensive civilian and military uses, especially in telecommunications, they are counted as an essential national capability. Also software technology has wide-ranging application in both civilian and military industries. It is seen as the heart of most defence systems, particularly command, control, communication and management systems. And advanced PCMs, though dominated by the military aerospace industry, are also crucial to civilian aerospace, construction and automotive industries. Too often, military absorption of these technologies relies on R&D, innovation and production in the civilian sector.

Competition is acute on the international civilian markets in all the above domains between the highly developed industrial countries, particularly the United States, Japan and the European Community countries. The commercial drive is especially conspicuous in the case of Japan, which has been conducting aggressive promotion of R&D and innovation in fiber optics and photonic technologies with a view to supplanting large portions of consumer electronics and computer industries. High-tech and exotic military systems are mainly developed in military laboratories; however, as the OTA study emphasizes,

> increasingly, building those systems depends on developments that take place in the civilian sector, a civilian sector that is driven by the international marketplace.[24]

There is both technological convergence and institutional business inhibition in the R&D and innovation processes of the above technologies. Part of the inhibitions stem from the momentum of these technologies, which cuts down the time between their arrival at top-capability and their obsolescence. This makes the very state-of-the-art of these technologies fluent, posing problems to the military, who are interested in long-term, mission-critical, robust applications. On the other hand, military and civilian technologies are not inherently different. The infrastructure, methodologies, capabilities and vast range of civilian R&D in the above domains are of immense utility for the military. In fiber optics, for instance, the civilian sector is generally far ahead of the military. Many of the optical sensors used by the military do not differ from those used in the civilian sector. Also large-scale software systems, such as avionics and telecommunications, are quite similar in both military and

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[23] Thomas J. Welch, "Technology Change and Security," *Washington Quarterly*, Vol. 13. No. 2, Spring 1990, p. 112.

[24] Ibid., p. 33.

civilian sectors. Convergence and divergence often boil down to cost and performance criteria - as is the case with aerospace PMC technology. Military specifications and performance characteristics involve, of course, higher costs.

The more we move into highly sophisticated technology, the greater is the potential for confluence and convergence of civilian-military R&D and innovation. In "dual-use" technologies the civilian sector is in most cases in the lead, while the military finds itself constrained to rely on innovations and R&D from the civilian sector.

The OTA study is emphatic about the signal role of civilian R&D for military technology:

> The trend appears to be to do research and exploratory development predominantly in civilian-oriented labs. Only in the advanced development stage would the work take on a military-oriented cast. The prevailing philosophy appears to be that science and technology policy should be integrated whenever possible with economic and industrial policies.[25]

This is the way in which Japan has become predominant and developing its military-industrial complex. Also in Europe, especially within European Community, research has begun taking this direction. Thus "in Japan, while military research budgets are growing modestly, the government is maintaining a close connection between this research and commercial applications."[26] And "in Europe, the bulk of publicity funded civil research is directed towards generic technologies, especially work conducted by universities and private research organizations," also of use for the military.[27] The OTA study, in this context, sees it as imperative for the United States "to foster greater symbiosis of civil and military technology."[28]

The emphasis is on "dual-use" technologies with multiple applications both for civilian industry and for military purposes. Japanese defence R&D is exemplary in this respect:

> Japanese defense technology strategies are intertwined with an extensive process of technology management within government and industry that emphasizes dual-use technologies to assure Japan's security in the broadest sense into the next century.[29]

Inherent in this approach is a future-oriented perspective: to preserve the efficacy of military R&D far beyond the flux in international relations that has come with the demise of the outer Soviet empire and the declined of the Cold War. At a time of an intermittent expansion of

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[25] US Congress, OTA, *Holding the Edge*, p. 26.

[26] Ibid. p. 113.

[27] Ibid., p. 99.

[28] Ibid., p. 13.

[29] Ibid., p. 98.

science-based technology, preserving military R&D is seen as providing reassurance for any possible future contingencies in new balance of power configurations. Military R&D is seen as possessing an importance far beyond the deployment of new weapon systems themselves. As noted by Joseph F. Pilat and Paul V. White of the Los Alamos National Laboratory:

> If one believes that the world is poised on the threshold of a military technological revolution, and that the prospect of East-West conflict in the next 10 years is low, than greater emphasis should be placed on R&D and modernization than on maintaining current active force levels. Traditional Western reliance on technology will grow, not diminish in the years ahead... Prudence dictates a shift in emphasis from deployed to deployable forces, entailing an R&D program designed to provide a range of rapidly producible and deployable weapons systems...[30]

Military R&D has indeed become the "sacred cow" of armaments as these are projected far into the future. Yet this course must not be taken as inevitable. Science and technology are still a human endeavour. It is up to society to change course. With the decline of the Cold War, we have an historical opportunity for converting military R&D for civilian purposes, for the benefit of all mankind.

Seen in this perspective, aiming at comprehensive disarmament and the demilitarization of international relations, it seems of prime importance to pay specific attention to the scientific-technological impulse of armaments, to restrain military R&D, and to try to bring it under some social and political control. This may be a tall order, but given political will, it is manageable.[31]

It may be worthwhile to recall that in 1962 successive US and Soviet draft proposals for a Treaty on General and Complete Disarmament (GCD) provided for control and conversion of military R&D for peaceful civilian purposes. Thus the US "Outline for Basic Provisions on a Treaty on GCD in a Peaceful World" of 18 April 1962 provided for the establishment of an International Disarmament Organization (IDO) within the framework of the United Nations which would:

(a) collect reports from the Parties to the Treaty on any basic scientific discovery and any technical invention having potential military significance and

(b) on the recommendation of expert study groups work out agreed arrangements for verification by the IDO that such discoveries and inventions were not utilized for military purposes.[32]

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[30] Joseph F. Pilat and Paul C. White, "Technology and Strategy in a Changing World", *Washington Quarterly*, Vol. 13, No. 2, Spring 1990, pp. 84 - 85.

[31] Mary Acland-Hood, "Restraining the Qualitative Arms Race", in Marek Thee (ed.), *Arms and Disarmament: SIPRI Findings*, Oxford University Press, 1986, pp. 427 - 436; and Marek Thee, "Military Technology, the Arms Race and Arms Control", Ibid., pp. 437 - 442.

[32] Text in *Documents on Disarmament 1962*, Vol. I, Washington DC: United States Arms Control and Disarmament Agency, Publication 19, Released November 1963, p. 379.

Furthermore the US Treaty Outline stipulated that

> The Parties to the Treaty would agree to support full international cooperation in all fields of scientific research and development, and to engage in full exchange of scientific and technical information and free interchange of views among scientific and technical personnel.[33]

Parallely the Soviet "Revised Draft Treaty on GCD Under Strict International Control" of 22 September 1962 provided also for the establishment of an IDO within the framework of the United Nations, and with concrete reference to military R&D stipulated that

> All scientific research in the military field at all scientific and research institutions and designing offices shall be discontinued and Inspectors of the IDO shall exercise control over these measures.[34]

Today, in order to curb the qualitative arms race and halt the modernization of nuclear weapons, of immediate salience is to achieve a comprehensive nuclear test ban. A ban needs also to be imposed on flight testing of missiles which are well observable, verifiable and controllable. In parallel, several complementary socio-political and economic measures can be undertaken. These could include budgetary restrictions on military R&D as well as the establishment of national and international technological assessment institutions for continuous monitoring and evaluation of the course of technological military innovation so as to develop early warning systems against the pursuit of new weapons. Of specific import would be the establishment of an International Satellite Monitoring Agency (ISMA) under UN auspices, as proposed by France in 1978.

Finally, it is imperative that we activate moral and ethical restraints against the pursuit of military R&D. As part of planning for the conversion of military R&D for civilian purposes, those scientists and engineers employed today by military R&D should be assured of alternative and rewarding work opportunities in civilian R&D to satisfy their professional and career ambitious. In general, we need to initiate a process away from secrecy in R&D which is detrimental to science, economy and human progress, and instead move towards openness of scientific pursuit to serve the cause of peace and the betterment of the human condition.

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[33] Ibid.

[34] *Documents on Disarmament 1962*, Vol. II, p. 931.

This is well reflected in government (federal) R&D appropriations of the leading world powers, by socio-economic objective, as given in *Table IX*.

Table IX:

Government R&D appropriations, by socio-economic objective, 1987, in %

Objective	France	FR Germany	Japan	UK	US	India
Total	100	100	100	100	100	100
Agriculture, forestry, fishing	3.6	2.0	4.0	4.2	2.3	9.2
Industrial development	10.6	15.3	4.8	8.7	0.2	12.4
Energy	6.7	8.7	23.2	3.5	3.6	9.5
Infrastructure	3.2	1.9	1.8	1.5	1.8	4.4
Environmental protection	0.4	3.3	0.5	1.0	0.5	5.1
Health	3.6	3.2	2.4	4.3	11.9	3.4
Social Development and services	2.7	2.3	1.0	1.5	1.0	0.8
Earth and atmosphere	1.4	1.9	1.0	1.7	0.7	2.3
Advancement of knowledge	26.6	43.8	50.8	20.2	3.6	6.7
Advancement of research	14.7	12.3	7.3	4.6	3.6	
General university funds	12.0	31.5	43.5	15.6	-	
Civil space	5.9	4.9	6.1	2.7	6.0	10.8
Defense	34.1	12.5	4.5	50.3	68.6	31.5
Not elsewhere classified	1.0	0.1	-	0.3	-	3.8

Source: US National Science Board, *Science and Engineering Indicators - 1989*, Washington, DC: US Government Printing Office, 1989, (NSB 89-1), tables 4-22, p. 289.
UNESCO Statistical Yearbook 1989, Statistics on science and technology, table 5.14, p. 5 - 72.

Note: No parallel data are available for countries with centrally-planned economies (USSR, China) or for a number of Third World countries such as Pakistan, Indonesia, Egypt, Algeria, Iran or Lybia.