

The changing relationship between civilian and military technologies is somewhat more difficult to specify, although it is usually characterized as a shift from "spin-off" to "spin-on". This describes the move from an environment in which military R&D was the driving engine of research in an advanced industrial economy, which "spun-off" civilian innovations (ranging from computers and micro-electronics, to composite materials); to an economy in which civilian innovation represents the leading edge, and military innovation is "spun-on" from such things as developments in computer software or electronics. Only anecdotal evidence for this is available, but it strongly confirms this argument national procurement programs are increasingly adopting "civilian" standards for production (in part to lower costs), and the vast array of research that the military subsidized in the past is being reduced. The implication of this is that investments in military R&D will increasingly be seen by governments as being "unproductive," unless they address immediate and pressing security threats or contribute directly to national competitiveness and economic security.

Finally, the response of some producers to the increased competitiveness of the global arms market has been to specialize in particular niches of the arms export market, and to develop global or international production networks that offer economies of scale and that increase the size of the market for the weapons system in question. The United States now dominates the market in advanced combat aircraft, and specific European producers are emerging as the major suppliers of short-range surface-to-air missiles, light armoured vehicles, fast attack craft and jet trainer aircraft. These emerging market specializations will make two or three states crucial for the control of certain advanced technologies or systems. The effort towards "internationalized" arms production has been most prominent among West European producers, who have launched a wide range of collaborative production efforts, both among themselves and with third tier states. Most significant among these are the *Tornado* (Germany, Britain and Italy) and *Eurofighter* (Britain, Spain and Italy) combat aircraft programs, the *AMX* fighter (Italy and Brazil), and various products of the *Euromissile* consortium (France and Germany). Projects for helicopters, frigates, radars and military electronics have also been undertaken.²⁷ The implications of collaborative production among first and second tier producers for controlling proliferation are mixed. On the negative side, export controls are weakened by the "lowest common denominator" principle: exports are made under the auspices of

²⁷ The literature on this is vast. See, *inter alia*, Elisabeth Sköns, "Western Europe: Internationalization of the Arms Industry," in Wulf, ed., 160-190; Ian Anthony, Agnès Courades Allebeck and Herbert Wulf, *West European Arms Production: Structural Changes in the New Political Environment* (Stockholm: Stockholm International Peace Research Institute, 1990); Moravcsik, 65-85; Michael Brzoska, *The Structure of Arms Production in Western Europe beyond 1992*, occasional paper 26 (Hamburg: Centre for the Study of Wars, Armaments and Development, 1989); Martyn Bittleston, *Co-operation or Competition? Defence Procurement Options for the 1990s*, Adelphi Paper 250 (London: International Institute for Strategic Studies, 1990); Peter Lock, *Towards a European Arms Industry*, occasional paper 27 (Hamburg: Centre for the Study of Wars, Armaments and Development, 1989); Terrell Covington et al., *A Review of European Arms Collaboration and Prospects for its Expansion under the Independent European Program Group*, RAND report N-2638-ACQ (Santa Monica: Rand Corporation, 1987).