Innovation in a Cold [War] Climate: Engineering Peace with the American Military–Industrial Complex

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On January 8, 2008, executives at MacDonald, Dettwiler and Associates (MDA), a systems engineering firm centered in Vancouver, British Columbia, triggered a political firestorm by announcing that, subject to regulatory approval by the governments of Canada and the United States, shareholders had approved the sale of the firm's space business to Alliant Techsystems (ATK), an aerospace company and manufacturer of land mines, cluster bombs, and missiles headquartered in Minneapolis, Minnesota. Daniel Friedmann, MDA's chief executive since 1995, argued the sale would "allow the company to focus management and financial resources exclusively on its rapidly growing information products business," particularly the firm's property-information systems for those "involved in real estate-related transactions such as the buying, selling, conveyancing, mortgage financing, and insurance of properties."[1]

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1. Friedmann qtd, Wong, "MDA Sells Space, Satellite Business to ATK"; McDonald, "Keeping Canada's Space Business in Business"; www.mdacorporation.com/information_products/overview (accessed November 28, 2010).

In a press release, ATK announced that the $1.325 billion acquisition of the "Information Systems and Geospatial Businesses of MDA . . . a global leader in space-based radar systems, space robotics, satellite systems, and imaging satellite ground stations and processing; with additional world-class capabilities in satellite payloads, C4ISR [also known as *Battle Command*], and geospatial services," promised to establish ATK as a "full-spectrum international space company." Canadian protesters argued that ATK's gain seemed like a pretty bad deal for Canada. They therefore demanded a national conversation about the "morality" of selling to an American weapons manufacturer MDA's satellite and space division (including both the International Space Station's robotic "Canadarm2" as well as Radarsat-2, the earth observation satellite MDA had developed, into which Canadians had invested $430 million, and MDA has operated following the satellite's launch in December 2007).[2]

As the debate over the sale unfolded, the national press reminded Canadians that MDA had become one of their country's preeminent systems engineering firms. From the 1970s forward, local reporters noted, the company had also served as an anchor for developing Vancouver's high-tech community, specifically its expertise in information systems, robotics, and telecommunications. The press also revealed that several of MDA's engineers had resigned in protest over the proposed deal, complete with ethical objections to working for a company that "produces weaponry that kills people indiscriminately—soldiers and civilians alike." Underscoring the fact that Canada had signed the Mine Ban Treaty and the United States had not done so, one American-born engineer who resigned told reporters that he had moved to Canada, in part, to "avoid having my tax dollars go to support companies like ATK." Moreover, he argued, selling a Canadian company to an arms manufacturer violated the Mine Ban Treaty. Another engineer who quit MDA in protest claimed that he had wanted to work on Radarsat-2 because he and others had assumed that the satellite "would be used for good," for civilian purposes and peaceful Arctic observation. Together, these critics outlined their own moral dilemma, and the ethical dilemma of

2. Alliant Techsystems, "Press Release"; "Despite Canadarm"; "25 Breakout Companies"; McClearn, "The Long Arm of MDA," 11–12; Gainor, "Canada's Space Program in Crisis."

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a nation's people who like to see themselves as more peaceful than their southern neighbors.[3]

Very soon, other sources reported that the federal government had decided—for the first time in the twenty-three-year history of the Investment Canada Act—to block the sale of a Canadian firm to a foreign entity as "not in the national interest." Federal Industry Minister Jim Prentice announced the Canadian government's decision to prevent the MDA sale under pressure from critics who argued that such a deal "handed over taxpayer-funded technology and, in the case of Radarsat-2, gave away technology designed to protect Canada's sovereignty."[4]

With MDA recognized globally for its pioneering work in remote sensing (the gathering of information about the earth and its environment from aerial photographs, satellite images, and earth observation systems) and synthetic aperture radar (SAR; a high-resolution technique that provides surface mapping no matter weather conditions, cloud cover, or levels of darkness), its founders decided to weigh in on the debate. Retired in 1998 and living in Switzerland, Werner (Vern) Dettwiler argued that "When I was still working [at MDA], I and most of my fellow workers believed quite strongly that we would not like to work for a defense (or offense) based company, particularly a foreign" one. Retired the same year and involved in another Vancouver company he had co-founded, John Spencer MacDonald defended the proposed sale, arguing that shareholders had no choice. "If the company wants to fulfill its destiny, it has to do this," MacDonald claimed. "None of us likes it, but the market for the space side of MDA isn't really in Canada. We had a good 40-year run at building one hell of a space program on the West Coast," MacDonald boasted, but "the government will be responsible for creating a new Avro Arrow disaster [a Canadian interceptor/fighter aircraft project suddenly terminated in 1958], unless it either reverses the decision [to block the sale] or rapidly increases

3. Cottle qtd, "MDA Engineer Quits Over Sale to U.S. Weapons Company," and in "Sale of Canada's Leading Satellite Developer Not Ethical"; Williams qtd, "Second Employee Leaves Job Over Sale of Space Contractor." In addition, see Eiko, "ATK's WMDs Ignite Protest Over Canadian Acquisition"; "Canada Shoots Down Alliant Space Deal"; Gainor, "Blocked Sale Exposes the Neglect of Canada's Space Program"; "Ruling on Sale of Canadarm Delayed"; "Our New Satellite Surveillance Capability." According to Chodos, Murphy, and Hamovitch, *Lost in Cyberspace?,* 12, "Canada's cultural sovereignty is protected by a variety of federal policies. However, the new technologies [particularly satellites] make it possible to circumvent many of them."

4. Prentice, qtd, "Govt. Confirms Decision to Block Sale of MDA Space Division." In addition, see "Credit Crunch Puts End to Merger Boom"; McQueen, "Is the MacDonald Dettwiler/Alliant Space Deal Dead?"; "Federal Government Blocks Sale of MDA Space Division"; "Foreign Takeovers"; McDonald, "MDA Deal"; "Canada and the Space Shuttle"; "Block Sale of Canadian Space Firm."

funding for Canada's space program." In his view, the government should double the Canadian Space Agency's budget "immediately," if it wanted to save Canada's space industry.[5]

Most critics failed to mention that MDA already had a long-term "strategic partnership" with ATK. Nor did they stress that, with the assistance of the Canadian government, MDA had long participated in the expansion of the United States' military–industrial complex, worked with foreign governments on global surveillance, helped to erode Canadian sovereignty, and collaborated with companies and governments to produce weaponry that has killed both soldiers and civilians. To be sure, prior to the proposed deal, MDA had not asked its employees to work directly for a military technology company. Perhaps the benefits of Radarsat-2's higher resolution and positional accuracy (for detecting icebergs, pollution, and ships) far outweighed its potential costs (including those associated with increased surveillance and targeting). But "killing" the billion-plus-dollar deal, whether permanently or as a temporary expedient, does not change MDA's historic role as a government contractor assisting the American-centered military–industrial academic complex's expansion. Indeed, as Daniel Friedmann had noted fifteen years earlier: "defense budgets are still larger than anything else in the world. And, we're heavily involved in stuff that has nothing to do with [the] pointed end." The decision to pursue space and defense contracts flowed from MDA's work in remote sensing during the 1970s, the experience the firm gained in managing large complex software development projects and the military specification environment during the 1980s, and an aggressive corporate strategy implemented fully during the 1990s.[6]

5. Dettwiler qtd, Stueck, "MDA Deal on Life Support"; MacDonald qtd, "Canadarm Heads South as MDA Sells Units for $1.3 Billion," and in "Last Chance for Salvaging the MDA Sale." In addition, see "CAW Calls for $1.5B in Funding for Space Industry"; Vanderklippe, "Ottawa Could Face Lawsuit if It Blocks MDA Sale"; Gainor, "Crash of Canada's Space Biz."

6. Interview with Friedmann, 2. This article, and a larger project on which it is based, supplements available business records, government documents, and other sources with nearly five-hundred hours worth of oral history (contained in transcripts from interviews conducted with more than forty people associated with MDA's first quarter century in business (1969–93). Conducted during 1992 and 1993, on the eve of the firm's initial public offering in the summer of 1993, the interviews include conversations with MDA's principal founders, the chief executive officer and venture capitalists who saved the company from bankruptcy during 1982, business people and government agents who contracted with MDA, and employees who participated in the development of the firm and the evolution of Vancouver's place in the global economy. MDA interview transcripts, permissions from interviewees, and unpublished documents are currently in the possession of the author.

MDA's surveillance work long played a critical, albeit indirect, role in providing intelligence systems for the global arms race and in developing and deploying technologies for noble as well as unsavory purposes. From the 1970s forward, the same expertise that drew young engineers and government officials to MDA and its technologies also made it a potentially excellent acquisition for a variety of global surveillance firms and arms manufacturers, particularly American ones. To survive in the competitive technology sector ("to fulfill its destiny" as a systems integrator), MDA also had to acknowledge the ultimate discipline and power of the capitalist marketplace, the military–industrial complex, and the surveillance state. In an article reporting the recent sale of the firm's property information products business, Friedmann maintained that MDA's "objective is to create shareholder value." With the Canadian government pumping more money into the Canadian Space Agency's budget, that "value" seems to have shifted again, to the once "stalled" space and defense business shareholders had hoped to sell just three years earlier. Indeed, the government's long support for MDA's evolving expertise in space and defense continues, not because the firm is an investment bonanza, not because MacDonald and other engineers convinced members of Parliament to "save" the industry, but rather because MDA has long served the "national interest"—as an important regional development tool, as part of an antidote to the brain drain of Canadian engineering talent, and as a vehicle for Canada's participation in the global political economy of surveillance.[7]

Rationalizations of the present and selective memories of the past are hardly confined to Canada. Chandra Mukerji has argued that the "intelligence of engineering is not just pragmatic, but also deeply invested in social, legal, and moral conceptions of power . . . [thus] science and engineering . . . produce an engineered world that shapes our lives—in ways we systematically ignore." Vincent Mosco also confirms that we have neither learned many lessons from that engineered world, nor become more adept at recognizing the ambiguities of technological "progress" or the staying power of self-flattering myths about human accomplishments. For Mosco, our current faith in computing resembles, rather than radically departs

7. Friedmann qtd in Ebner, "MDA Sells Real Estate Arm Once Seen as Key to Growth." For discussions about the long arm of surveillance-centered firms and networks, see the important collection of essays in Graham, ed., *Cities, War, and Terrorism;* and Graham and Wood, "Digitizing Surveillance: Categorization, Space, Inequality," 227–48.

from, earlier periods, when technology enthusiasts pinned their hopes on steam, railroads, and telegraphs, then electricity, automobiles, and radios, confident these would either open the curtain on a new and better world, or, at the very least, correct the unwelcome failures, adverse economic effects, and social problems previous innovations delivered.[8]

Despite scattered protests, Vincent Mosco has argued that sustained beliefs in engineering intelligence and technology demonstrate a "remarkable, almost willful, historical amnesia. One generation after another has renewed the belief that, whatever was said about earlier technologies, the latest one will fulfill a radical and revolutionary promise . . . [to satisfy an] intense longing for a promised community" somewhere just beyond reach. Such historical erasures and yearnings also reveal both a profound misunderstanding about the multiple paths that innovations actually take, as well as a conspicuous and continuing disregard for the political, social, and moral dimensions of scientific research *and* technological development, among "amateur" populations and within the technical professions.[9]

Willful ignorance and historical amnesia have allowed public officials to create legal environments for military–industrial entrepreneurship, and to expend taxpayer dollars on the nourishment of budding technological "family trees" among and between global surveillance experts at universities and in industry and government. Indeed, as Rebecca Lowen has argued, the services that Cold War universities provided to the American government include "a pervasive scientism, the triumph of the ideal of apolitical expertise, and the popularization of psychotherapeutic ideas and techniques. As one of the top recipients of Defense Department patronage [Stanford] was one of the first universities to forge close relationships to private industrial concerns, many of which were developing war-related technologies." Stanford was far from alone.[10]

8. Mukerji, "Intelligent Uses of Engineering and the Legitimacy of State Power," 657; Mosco, *The Digital Sublime,* 8–15.

9. Mosco, 8, 15. On the abiding faith that map-making technologies and internet platforms (such as *Google Maps*) can transform the world for the better, see, for example, Helft, "With Tools on Web, Amateurs Reshape Mapmaking." For more critical assessments, see Pursell, "Government and Technology," and Roger D. Launius, "Technology in Space," in Pursell, ed., *A Companion to American Technology*, 4–5, 8–19, 132–55, and 275–95; Vinck, ed., *Everyday Engineering;* Slotten, "Satellite Communications, Globalization, and the Cold War," 315–50; Williams, *Retooling*, and "'All That is Solid Melts into Air'," 641–68.

10. Lowen, *Creating the Cold War University*, 6. On the importance of creating a legal environment for military–industrial entrepreneurship and the creation of technological "family trees" between universities, industries, and the government,

Although the literature on the history of computing has expanded dramatically, satellite and surveillance technologies still remain understudied topics. In the wake of the September 11, 2001 attacks and the American invasion of Iraq (March 2003), geographers, journalists, public policy experts, and social critics have argued that we need to know much more about the historical roots of "spy capitalism" and the "soft cage" of surveillance, much of it initially developed during the Cold War by businesses, universities, and nations linked to the U.S. military–industrial complex. This expanding work on surveillance has demonstrated that users of remote sensing data have immense power to distort reality, including the ability to manipulate "intelligence," fear, the media, politics, and desires for revenge. The expansion of the Internet since 1994 has merely blurred and extended that power.[11]

In addition, and in ways made poignantly clear in Dwight D. Eisenhower's warning to "guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex," totalitarian nightmares threaten to unfold not from the activities of a rogue few, but rather from the passivity of the governed, particularly when the latter maintain an uncritical faith in technological "advances." High-resolution images from earth observation satellites do, of course, hold the promise of safeguarding the environment, sustaining human life, reducing poverty, and thwarting the ambitions of despots. As many have argued over the past four decades, concerns about global environmental change, natural disasters, sustainable development, and human rights violations initially fueled worldwide demand for remote sensing

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see Mark C. Suchman, Daniel J. Steward, and Clifford A. Westfall, "The Legal Environment of Entrepreneurship," in Schoonhoven and Romanelli, eds, *The Entrepreneurship Dynamic*, 349–82. In addition, see Sinclair, "The Profession of Engineering in America," in Pursell, ed, 36–84; Nye, *American Technological Sublime;* Adas, *Machines as the Measure of Men;* McMahon, *The Making of a Profession;* Noble, *America By Design.* On the ways in which corporations shape social and moral consciousness, see Jackall, *Moral Mazes.*

11. See Lewis, *Spy Capitalism;* Lyon, *Surveillance Society,* and *The Electronic Eye;* Monmonier, *Spying with Maps;* Parenti, *The Soft Cage;* and Niedzviecki, "The Spy Who Blogged Me," 36–42. Other important work on "spy capitalism" and the surveillance state includes Paglen, *Blank Spots on the Map;* Andrejevic, *iSpy*; Graham Jr. and Hanson, *Spy Satellites and Other Intelligence Technologies that Changed History;* Bille and Lishock, *The First Space Race;* Launius, Logsdon, and Smith, eds, *Reconsidering Sputnik*; Gavaghan, *Something New Under the Sun;* Bulkeley, *Sputnik's Crisis and Early United States Space Policy;* Richelson, *American Espionage and the Soviet Target*; and Newhouse, *Cold Dawn*, particularly 40–79.

applications. Nonetheless, remote sensing capabilities have also created new problems, including rationalizations for military invasions, unauthorized eavesdropping, infringements on human and civil rights, and other abuses.[12]

Occupying one of the globe's publicly nurtured remote sensing "family trees," MDA's founders and followers provide a window into several histories: engineering as practiced during the Cold War, the commercial development of surveillance technologies, the expansion of government contracting for business and armed forces, and technological enthusiasts and "peaceful" nations rationalizing links to the American-centered military–industrial complex. MDA evolved within the larger context of that complex, through projects that carried the firm from its founding in 1969 through its first public offering in 1993. During that era, it matured from a small consultancy focused on the acquisition, processing, and distribution of data into a full-scale systems integrator, catering to the expanding global surveillance state.[13]

Setting the Stage: Entangling Alliances, Government Agencies, and Cold War "Mental Models" for Engineering Peace with the Military–Industrial Complex, 1957–72

On October 4, 1957, the Soviet Union launched *Sputnik*, the world's first artificial satellite. Surprised and embarrassed by the Soviets, Americans quickly countered, in a flurry of activity that dispatched their own *Explorer* satellite to the heavens on January 31, 1958. *Sputnik* and *Explorer* not only captured the imagination of

12. See Haggerty and Ericson, "The New Politics of Surveillance," David Lyon, "9/11, Synopticon, and Scopophilia: Watching and Being Watched," Christopher Dandeker, "Surveillance and Military Transformation: Organizational Trends in Twenty-First Century Armed Services," and Oscar Gandy, Jr., "Data Mining, Surveillance, and Discrimination in the Post-9/11 Environment," in Haggerty and Ericson, eds, *The New Politics of Surveillance and Visibility,* 3–25, 35–54, 225–49, 363–84; Le Heron and Harrington, eds, *New Economic Spaces*; Kirkwood, "Urban Real Estate Information Systems," 29–42; Mussio, *Telecom Nation,* 65–68, 92–93, 97–114, 222–7; Abbate, *Inventing the Internet;* Kay, "Space Policy Redefined," 237–47; Sirois and Forget, *The Medium and the Muse;* Knapp, "Masters of the Universe," 119–22; Fotos, "Commercial Remote Sensing Satellites Generate Debate, Foreign Competition"; and Orwell, *Nineteen Eighty-Four.*

13. The company's public-facing vision of itself appears at http://www.mdacorporation.com (accessed January 5, 2011).

technological enthusiasts across the globe but also officially inaugurated a global space race, accelerated the arms race, and encouraged other nations to compete for the commercial and military spoils of earth observation. As the third country to announce a space program, Canada sent the *Alouette* into orbit on September 29, 1962. This launch helped put the country on the competitive map and sent its citizens into heavenly orbit. With a stake in the commercial promises of remote sensing, Canadians actively tied themselves to the American surveillance community, took their place among the industrialized nations vigorously promoting space exploration and the engineering disciplines, and helped craft government policies to extend remote sensing's reach.[14]

The voyages of *Sputnik*, *Explorer,* and *Alouette* were conspicuous political acts performed on a global stage. The United States led the North American effort to employ earth observation for both military and commercial purposes, whereas Canadians preferred to celebrate their role as purveyors of peaceful space applications. Even so, Canada has long played a central role in the American-centered military economy and the creation of global surveillance networks, as a political ally and as the United States' largest trading partner. According to Laurence Mussio, between 1945 and 1975, "Canada was enmeshed in a series of international arrangements and alliances in which it had to define and articulate its interests as a middle power." Expertise in remote sensing surfaced as one of those interests; and, although not widely appreciated at home or abroad, Canadians stood in the vanguard of the industry's military and commercial development. With promises of lucrative international cooperation, and government policies supporting remote sensing's development, interested Canadians vigorously promoted its expansion during the 1960s and 1970s. The Federal government, for example, established programs within the science procurement division of the Department of Supply and Services (DSS) that allowed small firms to bid on contracts to

14. American Institute of Aeronautics and Astronautics (AIAA), *Collection of Technical Papers*; "At Long Last," 98–104. On developments in the United States, and the long arm of the government in promoting post-World War II's emphasis on building a military–industrial complex and the technology-related industries to support it, see, for example, Heinrich, "Cold War Armory," 247–84; Abbate, "Government, Business, and the Making of the Internet," 147–76; Hughes and Hughes, eds, *Systems, Experts, Computers*; Edwards, *The Closed World;* Norberg and O'Neill, *Transforming Computer Technology Information Processing for the Pentagon;* Saxenian, *Regional Advantage*; DeVorkin, *Science with a Vengeance*; Leslie, *The Cold War and American Science*; Smith, ed., *Military Enterprise and Technological Change*.

extend Canada's expertise in data acquisition, SAR, computing, and other space-based applications.[15]

Even as scientists started to investigate remote sensing's possible applications, the Canadian federal government had already spun agencies and programs to help organize and underwrite a Canadian surveillance industry to service the American market. Following World War II, Lawrence Morley, chief geophysicist for the Canadian Department of Energy, Mines, and Resources, organized Canada's airborne survey industry through government procurement contracts that transferred much of the government's aerial reconnaissance business to the private sector. With remote sensing satellites' potential in the mid-1960s, Morley championed a Canadian aerospace industry similar to the airborne survey business he had helped to create. When the eminent geophysicist, Philip Lapp, finished his consulting work for

15. Mussio, 222. Despite revisionist historiography on the Canadian economy, many continue to embrace the arguments in Bliss, *Northern Enterprise*, that the Canadian government did little to encourage entrepreneurship. Along with Mussio's work, other case studies have recently called such assertions into question. See, for example, Vardalas, *The Computer Revolution in Canada,* 1, 92, 102, 276–78, 295, 302; Chodos, Murphy, and Hamovitch, 19–26, 86–87; Board, *A Brief History of the Defence Research Establishment Ottawa*. Canadian Tory polemicists such as J. L. Granatstein have bemoaned Canada's military decay, seeking increased funding for its resurgence; however, they might take heart in the historical evidence confirming that Canada has long served as a crucial American commercial and military ally. Indeed, *Lost in Cyberspace?* argued over a decade ago that the "Cold War worked towards turning all the countries of the West, and for that matter the East, into American satellites—military, economic, and cultural." Given its "satellite" status within the American military–industrial web, the "Canadian government has been part of this creation just as the American government has. And we have always stuck to our role as component manufacturer despite expertise developed in aerospace, electronics, and communications." John Vardalas's work on Canada's computer industry has demonstrated that, "Without a doubt, military enterprise was the primary force behind Canada's early participation in the digital electronics revolution" and the development of earth observation industries. See Granatstein, *Who Killed the Canadian Military?*, 202; Chodos, Murphy, and Hamovitch, 24–26; and Vardalas, 278. In addition, see Donaghy, *Tolerant Allies*; Godefroy, "Canada's Early Space Policy Development," 137–41. For earlier arguments about Canada's strategic role in American military planning and execution, see Surtees, *Pa Bell*; Littleton, *Target Nation*; Tupper and Doern, eds, *Public Corporations and Public Policy in Canada*. For a general overview of the effort to map Canada, see McGrath and Sebert, eds, *Mapping a North Land*. And, for differing interpretations of Canadian-style capitalism and the factors that have influenced Canadian nationalism and the country's economic, political, and cultural objectives, see Clement and Williams, eds., *The New Canadian Political Economy*; Innis, *Staples, Markets, and Cultural Change*, and *Empire and Communications*; Watkins, *Canadian Economic History*; Urmetzer, *From Free Trade to Forced Trade*; Hart, *A Trading Nation*; Norrie. Owram, and Emery, *A History of the Canadian Economy*; Easterbrook and Watkins, *Approaches to Canadian Economic History*; McCalla, ed, *The Development of Canadian Capitalism*.

Canada's Chapman Commission on space technology research, Morley approached him about creating the Canada Centre for Remote Sensing (CCRS), to promote the Commission's recommendations. Along with other supporters, they commenced boosting Canada's space industry, not only encouraging the 1967 formation and then expansion of Special Products and Applied Research (SPAR) Aerospace, once Canada's largest space contractor, but also officially forming the CCRS in 1970.[16]

As a government department, the CCRS put Canadian companies in a unique position to work on and profit from remote sensing. For the next fifteen years, no other nation had a CCRS equivalent or any endeavor capable of receiving and processing satellite information on the ground. Such agencies appeared in 1984, with the formation of Earth Observation Satellite Corporation (EOSAT, a private joint venture formed by Hughes Aircraft and RCA to support the Landsat program), and in 1985, with the launch of SPOT-Image (a French government-owned satellite support firm).[17]

The CCRS derived from earlier space programs, particularly the U.S. National Aeronautics and Space Administration (NASA), formed in *Sputnik*'s wake. Created to conduct all nonmilitary activity in space but also incorporating elements of the Army Ballistic Missile Agency and Naval Research Laboratory, NASA soon embarked on launches of its own. NASA's leaders and champions soon envisioned an all-encompassing space program, including weather, communications, earth resources, and surveillance satellites. From the start, NASA also encouraged other nations to use its satellite data. Knowing that satellite photographs depicted countries other than the United States, NASA swiftly entered into cooperative agreements with its allies and

16. Special Products and Applied Research (SPAR) Aerospace Ltd. was formed by a merger of De Havilland Canada's Special Products Division (*Alouette 1*) and Avro Canada's Applied Research unit (CF-105 Arrow). In 1967, SPAR's senior management team bought out the division and issued its shares to the public. Interview with Lapp, 1–4. The Chapman Commission's 1967 report not only recommended that Canadians focus their space technology research on communications and remote sensing, but also capitalize on the country's expertise in the international market. The report's recommendations also led to the formation of Canada's Department of Communications and Telsat Canada in 1969. According to Vardalas, 278, these events flowed from World War II, which "thrust Canada into a position of geopolitical prominence that otherwise would have been inaccessible to it." See also Mack, *Viewing the Earth*, 3–10, 15–16, 20–23, 34, 37, 183–94; "The Long View From Space," 24–29; "Remote Sensing Sparks a Row," 75–76; AIAA, *Collection of Technical Papers;* "At Long Last," 98–104.

17. Interviews with Morley, 2–3, and Lapp, 1–4; Mack, 189–95; Morley, *Remote Sensing Then and Now*.

established an "International Participation Program." The "pre-launch" program not only assured other nations that the NASA program had peaceful intentions; it also encouraged participants to build their own ground stations to receive the data. Early NASA activity thus sparked enthusiasm among scientists, engineers, business leaders, government agents, and technological devotees around the globe. As Morley later recalled, "there was a lot of international interest in [NASA's] read-outs, this semi-secret information about all the various countries' resources." Canadians wanted a piece of this action. Hence, when a pivotal meeting on remote sensing took place in Annapolis, Maryland (March 1970), Morley and other Canadians positioned themselves to play a strategic role following the launch of NASA's first Earth Resources Technology Satellite (ERTS, renamed Landsat in 1975). Soon thereafter, MacDonald, Dettwiler and their young associates stepped on to the remote sensing stage.[18]

The engineering profession prepared John MacDonald, Vern Dettwiler, and other technological enthusiasts for their roles in the expanding surveillance state. During the 1950s, MacDonald and Dettwiler attended universities anxious to train them in electrical engineering, physics, applied mathematics, and later, computing, so that they could support a military–industrial complex centered on the United States but with ripple effects across the globe. Other governments, including Canada's, reacted by funding research and development programs at the University of Toronto and elsewhere, and by providing offers of employment and summer internships in agencies such as Atomic Energy and the National Research Council of Canada. Through such efforts, the Federal government hoped to stimulate business development "in the national interest." Tied to their southern neighbors by agreements and cultural understandings, Canadians also encouraged border crossings for those who wanted to apply to graduate programs in the United States, facilitating the transfer of experiences and know-how from American cities and universities, such as Boston and the Massachusetts Institute of

18. Interviews with Morley, 2–3, and Sloan, 3–4. For background information, see Slotten, 315–50; McCurdy, *Faster, Better, Cheaper*, and *Inside NASA*; Bromberg, *NASA and the Space Industry;* Kay, "Review Essay: NASA and Space History," 120–7; Leclerc and Lessard, "Canada and ESA"; Krige and Russo, eds, *Reflections on Europe in Space*; Launius, *NASA*; Mack, 1–17, 183–95; Bruce Mazlich, "The Idea of Space Exploration," in National Aeronautics and Space Administration, *A Spacefaring People*, 137–46; McDougall, *The Heavens and the Earth*; Large, "Eyes in the Sky," 46ff; United States House of Representatives Committee on Science and Astronauts, *A Compilation of Papers.*

Technology (MIT), to once-unlikely places, such as Vancouver and the University of British Columbia (UBC). The technological commitment of the two governments and their research institutions thus provided the "mental models" for university departments' expansion, and training the young men who formed many technology companies.[19]

Those "mental models" included an engineering profession conceived as broadly individualistic, capitalistic, and status conscious. Many post-World War II engineers hailed from small towns and farms, or emerged in cities as outsiders — from immigrant enclaves, first in Northern and Western Europe, and later from other parts of the globe. Many arrived from less well-off and less-educated segments of the middle class, with fathers who had tended farms or small and localized businesses, or who had worked in blue-collar or clerical jobs. As a result, engineers in training hoped to scale the ladder of middle-class respectability by capitalizing on their technical abilities and knowledge. According to Edwin Layton, they also prided "themselves on being hard-headed practical men concerned only with facts." Moreover, engineers tended to share ideological preconceptions, including the belief that scientific methods and technological advances lead to a better world, that "material achievements . . benefit humanity and advance civilization," that "technological progress . . lead[s] toward universal peace and the brotherhood of man." Engineers often assumed that, as "professionals," they had a "unique and vital role to play in social progress," utilizing the leadership and "creative role of the technical expert" for capitalist growth. Still, engineers perceived themselves as undervalued in status terms: "if only the public were properly informed of the engineer's merits, he would be accorded the deference that was his just due."[20]

19. See, for example, Simpson, *NATO and the Bomb*; M. Diane Burton, "The Company They Keep," and Romanelli and Schoonhoven, "The Local Origins of New Firms," in Schoonhoven and Romanelli, eds, 13, 15, 27, 41–43; Horowitz, ed., *Boys and Their Toys,* 1–10; Goldman, "National Science in the Nation's Heartland," 435–59; White, *The Skule Story,* 175–84, 189–200, 205–14; Lowen, 1–6, 9–14, 44, 104–5, 118, 140–7, 237; Zachary, *Endless Frontier*; Nichols, "Federal Science Policy and Universities," 197–224; Hannan and Freeman, *Organizational Ecology*; Boeker and Karichalil, "Entrepreneurial Transitions," 818–26; Boeker, "Organizational Origins," in Carroll, ed., *Ecological Models of Organizations,* 33–51; Wiebe, Hughes, and Pinch, eds., *The Social Construction of Technological Systems*.

20. Layton, *The Revolt of the Engineers*, 8–13, 53, 58–59, 65, and 120.

Similar social profiles and worldviews grounded and guided MDA's founders and followers, as well as those working inside the CCRS and other government agencies. Both John MacDonald and Vern Dettwiler grew up in modest British Columbia households. They both traveled to Vancouver during 1954 to attend UBC. Neither could have failed to notice university departments interested in Cold War technologies and business speculation focused on the emerging knowledge industry, and research pulling bright young men into software and hardware development, systems engineering, optics, space exploration, and earth observation.[21]

Sputnik's launch in 1957 captured their imagination and attention. In that year, the United States also introduced the world's first nuclear-powered submarine, while International Business Machines (IBM) sold its first compiler for the FORTRAN scientific programming language. The year 1958 brought NASA's first launch, Canada's Avro Arrow debut flight, the signing of the U.S.–Canada North American Defense Command agreement, and the first international protest march demanding a ban on nuclear weapons. By 1959, however, the Canadian government canceled the CF-105 Arrow project, even as NASA selected seven military pilots to become the first American astronauts and the Soviets' Luna 2 crashed into the moon, making Russia's spacecraft the first to make contact with an extra-terrestrial body. Both young men also graduated from UBC that year, MacDonald in Electrical Engineering, and Dettwiler in Mathematics and Physics. They then traveled in different directions.[22]

Vern Dettwiler followed the computer's electrical current into consulting and systems engineering, gravitating toward UBC's embryonic Computing Center and spending the next decade there. Demand for his abilities also resulted in opportunities to moonlight. Over time, Dettwiler began to believe that, with a little luck, and the

21. Interviews with MacDonald (January 7, 1993), 1–30, and Dettwiler, 1–15. MacDonald came from Prince Rupert, a fishing and logging port on Kaien Island, some 30 miles southeast of Alaska, just north of the mouth of the Skeena River; and Swiss-born Dettwiler from Smithers, a small farming community on the banks of the Bulkley River in the province's northern interior.

22. Interviews with MacDonald (January 7, 1993), 15–27, and Dettwiler, 1–8; Paglen, 56–61, 86–95, 184–5; Pursell, in Pursell, ed., 132–55; Mukerji, 655–76; Nathan Rosenberg, "America's Entrepreneurial Universities," in Hart, ed., *The Emergence of Entrepreneurship Policy,* 113–37; Brate, 2–7, 33–52; Heinrich, "Cold War Armory," 247–84; Collins, *Cold War Laboratory*, vii–xviii, 224; Mindell, *Between Human and Machine*, 2–5, 11–13, 18; Zimmerman, *Top Secret Exchange;* Bix, "Backing Into Sponsored Research," 9–53; McCurdy, *Inside NASA,* 173; and Wildes and Lindgren, *A Century of Electrical Engineering and Computer Science at MIT.*

right partner, he might be able to form a company of his own, allowing him to spend all of his time doing precisely what he wanted to do: get "paid to do jigsaw puzzles," make enough money to "do neat things" in software and hardware development, and work on new and exciting data acquisition projects while simultaneously enjoying the status his technical expertise promised. Indeed, among the highlights from his long career, Dettwiler reminisced most fondly about "the first time that I phoned the company, and there was this voice saying, "Good afternoon, MDA," and visiting the company's new building in the 1990s, "because it has our name on it. It's not something we just moved into. . . It was designed to our specifications."[23]

According to colleagues, Dettwiler not only became a master technical troubleshooter between 1957 and 1968, but also matured into an accessible and unassuming man. For many young technical enthusiasts, he also emerged as an ideal mentor: a generous sage who enjoyed explaining technical concepts, no matter the hour or the time involved. According to MDA lore, he also displayed some of the classic attributes of the creative genius. Solitary in many ways, often disorganized in his work habits, and preoccupied with technical problems, Dettwiler knew he needed a different kind of visionary if he wanted to realize his expanding dream about launching a company. He found that someone in UBC alumnus John Spencer MacDonald.[24]

In a land of introverts, the extrovert is king, and in contrast to Dettwiler, John MacDonald casts an impressive shadow. At six feet, five inches (1.96 m), MacDonald has towered above the crowd since his teens, grabbing people's attention with his probing gaze, booming voice, boisterous laugh, boundless enthusiasm, and an unmatched confidence in his own abilities and ideas. Pursuing an academic career with determination, MacDonald gained admission to MIT. The technical excitement he encountered there then catapulted him into worlds far beyond Western Canada.[25]

Upon entering MIT, MacDonald found himself at the center of the U.S. military–industrial complex, in buildings and an environment

23. Interview with Dettwiler, 14, 18, 21–22, and 31.

24. MDA, "Personnel Profile, Werner (Vern) Dettwiler," and *Our Knowledge is in the Holes*; Interviews with Druce, 1–4, MacDonald (January 14, 1993), 5–10, Maxwell, 30–37, and Semrau, 8–12.

25. Interview with MacDonald (January 7, 1993), 1–20; Faustmann, "John MacDonald Had a Firm," 60–66; John S. MacDonald, "Science and Technology Policy," in Doern and Purchase, eds, *Canada at Risk*, 199–200; Canadian Space Agency, "Dr. John S. MacDonald Receives First Ever John H. Chapman Excellence Award from the Canadian Space Agency"; "Management," at www.day4energy.com/EN/jmacdonald.htm (accessed January 5, 2011).

that Vannevar Bush and others had already turned into the United States' largest academic defense contractor. Thus, MacDonald joined the globe's most significant "war technology think tank," with advocates emphasizing various forms of surveillance as important for future research and military–commercial development. Undertaking much of his doctoral work at MIT's interdepartmental Research Laboratory of Electronics, MacDonald also found ample funds for his dissertation research, particularly in grants and contracts from the United States' military. In his study of high-tech firms in the United States, Stuart Leslie has argued that absent from "virtually every account of freewheeling entrepreneurs and visionary venture capitalists is the military's role, intentional and otherwise, in creating and sustaining Silicon Valley." That role is also missing from most accounts of high-tech firms in Canada, Switzerland, Scandinavia, and other peaceful nations that helped to bolster American-centered expansion.[26]

26. Leslie, "The Biggest 'Angel' of Them All," in Kenney, ed., *Understanding Silicon Valley,* 49; Interview with MacDonald (January 7, 1993), 10–15; MacDonald, "Experimental Studies of Handwriting Signals"; Savage, *Funding Science in America*; and Brate, *Technomanifestos,* 33–36. For background materials on MIT and Vannevar Bush, Silicon Valley and Frederick Terman, and developments contributing to the Cold War university, see Berlin, *The Man Behind the Microchip*, and "Robert Noyce and Fairchild Semiconductor," 63–101; Pursell, ed., 140–8. For additional discussions about the MIT connection to laboratories and new technology start-ups, including Laboratory for Computer Science, Laboratory Instrument Computer, Lincoln Laboratory, Whirlwind, Digital Equipment Corporation (through Ken Olsen and Harlan Anderson), Texas Instruments (and Jack Kilby), and Fairchild Semiconductor (and Robert Noyce), see Yost, *The Computer Industry*, 28–42, 55–56, 90–110, 131–49, 168–72, 197–9, 223–4; Goldman and Eliason, eds, *The Diffusion of Military Technology and Ideas*; Rosenberg in Hart, ed., 113–37; Bassett, *To the Digital Age*; Brown and Duguid, *The Social Life of Information*; Redmond and Smith, *From Whirlwind to MITRE*; White, *The Skule Story,* particularly on connections created by James M. Ham, the MIT-trained engineer who became the chair of the University of Toronto's electrical engineering department during the early 1960s, its engineering dean from 1967 to 1973, and its president in 1978; Richard Langlois and Edward Steinmueller, "The Evolution of Competitive Advantage in the Worldwide Semiconductor Industry, 1947–96," in Mowery and Nelson, eds, *Sources of Industrial Leadership*, 19–78; Leslie and Kargon, "Selling Silicon Valley," 435–71; and Wildes and Lindgren. Important works on Silicon Valley and regional clusters of entrepreneurial activity include Lowen; Lee, Miller, Hancock, and Rowen, eds, *The Silicon Valley Edge*; Boyne, *Beyond the Horizon*; Seitz and Einspruch, *Electronic Genie*; and Saxenain. Following the major players in Santa Clara County, California, who participated in Stanford's university research and the military–industrial complex in *Silicon Valley, Women, and the California Dream*, 112–46, Glenna Matthews listed, among those who arrived in 1977 alone, Lockheed Martin, Ford Aerospace, Westinghouse, United Technologies, GTE Sylvania, ITEK, ESI, Inc., Hewlett-Packard, Varian, Watkins-Johnson, Teledyne, and California Microwave. Despite revisionist historiography, however, success stories abound, particularly in the United States.

Completing his PhD in 1964, MacDonald quickly accepted a tenure-track position in the electrical engineering department of his alma mater, UBC. He then returned to Vancouver in 1965 with a grand vision: transferring his experience from MIT to UBC and reengineering Vancouver from a city dominated by fish, lumber, and tourism into a high-tech hub. But circumstances along Vancouver's Trans-Canada highway differed markedly from Boston's Route 128. UBC was no MIT, and Vancouver was not yet a world-class city like Boston. Neither school nor city had the infrastructure to advance such a vision, and both lacked the military contracts to bolster technological development and the critical mass of engineers, venture capitalists, and expansionists to drive economic expansion. UBC had not yet captured much of Canada's resources for advanced research. Equally important, MacDonald lacked the experience and networks to pull resources, people, and ideas together. Like many idealists, he was impatient for results, often alienating some of the people he thought should help him. Finding few resources to realize his research agenda, never mind his more expansive dreams, MacDonald satisfied himself in the classroom, at least for a short time.[27]

Like Dettwiler, MacDonald found academic life increasingly frustrating and also began to moonlight as a consultant. While teaching, MacDonald also observed that he had many gifted students at UBC. Yet, once they graduated, they had but two choices: either leave Vancouver (often British Columbia, and sometimes even Canada) for want of challenging work; or vanish into the province's utility companies, never to emerge again. Knowing the talent existed and that engineers wanted to remain in Vancouver, MacDonald considered starting a business where his able students could take on imaginative and challenging work. Seed capital, in the form of

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See, for example, Kidder's classic, *The Soul of a New Machine* and the more recent Dorsey, *Silicon Sky*. Within the Canadian realm, see Brody, Grant, and Holland, *Innovation Nation*. For a collection of important theoretical essays on entrepreneurial networks, geographical factors, and state support for business start-ups, see Schoonhoven and Romanelli, eds. And, for other comparisons, see Niosi, *Canada's Regional Innovation System*; Wolfe and Lucas, *Clusters in a Cold Climate*; Castells and Hall, *Technopoles of the World*; Abbott, *The Metropolitan Frontier*; Malone, *The Big Score*. On the European Space Agency's entrance into the space race, see Madders, *A New Force at a New Frontier;* Suzuki, *Policy Logics and Institutions of European Space Collaboration*; Zabusky, *Launching Europe*; Bonnet and Manno, *International Cooperation in Space*; Sandholtz, *High-tech Europe*.

27. Interviews with Connor, 2, MacDonald (January 7, 1993), 15–21, Renwick and Seymour, 5–8, Semrau, 8–9, and Spencer, 1–5; Davis, *The History of Metropolitan Vancouver.*

government (and particularly military) contracting work did not seem to enter into his calculations during 1968, but he soon decided that, if he started a firm of his own, he might realize his MIT-centered dream after all. His ideas also meshed with brain-drain concerns percolating throughout Canadian society and all levels of government.[28]

During 1968, MacDonald sat in on Dettwiler's course, and the two lunched together now and again. As MacDonald's frustration increased, so did his lunches with Dettwiler. The idea of forming a consulting engineering firm received more attention as well; and by and by, it seemed they talked of little else. Then, on one summer's evening, MacDonald found himself in Dettwiler's living room, visiting with two friends, each of whom ran a small company. After much back-and-forthing between MacDonald and Dettilwer, one friend could take it no more. "Well for god's sake," he roared, "why don't you guys get off top-dead center and do it!" Why not indeed? They could get some business advice, start a small company, do exciting computer work, and maybe even make some money. After all, they had secure jobs, could start part-time, include UBC students, and see what happened. "The objective was to do the kind of work we wanted to do," MacDonald recalled, "and I knew there was all this horse power that wanted to stay here. . . So, I thought we could hire these bright kids to join us, we could do work at a world-class level, and that was really all there was to it in the beginning stages."[29]

MacDonald and Dettwiler soon busied themselves with recruiting like-minded spirits among MacDonald's students and others who later described the firm's engineers as "extremely bright, wide-eyed innocents, without an ounce of business experience," but also "very genuine," "eager to please," and "high energy" individualists who saw themselves as "horizon gazers." Throughout the 1970s, MDA also took on "whatever came through the door, as long as it did not require large initial capital." This flow included a great deal of software work, such as supervisory control systems for the oil and gas industry, flight operations computer systems (FOCUSs), mobile data communications terminals, and anything else a bright and able employee suggested. The deliberately unstructured environment MDA's leaders created also allowed the firm's engineers and technological enthusiasts to see themselves as "pragmatic problem-solvers" and "pioneering"

28. Interviews with MacDonald (January 7, 1993), 8–21, and Connor, 2–5. For a discussion of the dual Canadian fears of brain drain and American cultural annexation at Canadian universities and businesses, see, for example, Cormier, *The Canadianization Movement*, 29–31.

29. Interview with MacDonald (January 7, 1993), 10–11 and 17.

champions of progress in remote sensing and SAR work. They also described themselves "entrepreneurial," "extremely committed," "self-confident," "loyal," and a "desperate-to-deliver" bunch of "shoot-from-the-hip cowboys" who "embraced problems" and "never really believed that anything was truly impossible." Living on the West Coast, MDA's engineers also tended to decry the establishment (meaning Toronto and Ottawa, and Ontario-centered government contractors such as the firm's long-time rival, SPAR Aerospace), while generally conforming to the engineering creed. As company president from 1969 through 1982, MacDonald nurtured that creed, in an environment obsessed with individualism, professional status, and technological firsts but not necessarily the financial bottom line.[30]

Forced to relinquish control during a 1982 financial crisis, MacDonald passed the torch to a seasoned businessman and new chief executive, John W. Pitts. A Harvard MBA with a background in mechanical engineering, Pitts positioned the firm to profit from its technologies, but left the company's original culture largely intact. In 1995, Pitts passed MDA to Daniel Friedmann, an engineer who joined MDA in 1979, declaring in his first annual evaluation that he wanted to be the firm's president. Friedmann later developed and executed a new strategic and marketing plan, as chief operating officer in the early 1990s and then as chief executive. MDA's third president, Friedmann married the firm's original research and development culture, Pitts' focus on cost controls and business structures, and his own global marketing strategy aimed at realizing larger-scale returns from systems integration.

Focused on individualism, professional status, and enterprise expansion in the service of technological development, engineers at MDA also expressed conservative assumptions about labor and other challenges to the status quo, with both MacDonald and Pitts declaring that "a union would ruin the whole thing," and "if you were to take a poll, 95% of [us] would say, 'I quit' if you brought a union here." No matter the leadership style, most who remained at MDA shared that view. They also learned to make peace with the military–industrial complex, agreeing with MacDonald's philosophy that MDA should and would not involve itself in the "pointy end of defense . . . it's all

30. Interview with Dettwiler, 2. Adjectives and attributes describing MDA's personnel (in this and following paragraphs) from Interviews with Connor, 3–4, Lennox, 23–5, Lennox and Price, 28, MacDonald (January 7, 1993), 33 and (January 18, 1993), 14, Maxwell, 32, McConnell, 14, Morris, 19–20, Murray, 25, Pitts, 18, Prentice, 36 and 40, Renwick and Seymour, 30, and Spencer, 2.

reconnaissance." Indeed, in 1993, MacDonald argued that MDA staff had never been "very enthusiastic about getting involved in things that destroy equipment and people [because we have] always had the view that good reconnaissance sold to both sides is one of the great preventers of conflict." That "good reconnaissance" commenced in earnest during 1971, just two years after the firm opened its doors for "whatever came through." In that year, a young radio astronomer named Dave Sloan arrived, carrying with him opportunities to undertake remote sensing and hardware work, as well as a promise of government contracts on which to build MacDonald's larger dreams.[31]

Innovation in a Cold Climate: Government Contracts and the International Marketplace for Surveillance, 1972–82

Founded in 1969 as a small software consulting firm, MDA moved into hardware during 1971, built its first satellite ground receiving station in 1972, emerged as the first commercial firm to process a SAR image in digital form six years later, and debuted a film image recorder for remote sensing in 1981, setting the global standard for such work. These feats ensured MDA's long-term future. Throughout the firm's first decade, MDA engineers willingly worked with anyone who promised to pay them to acquire expertise in the remote sensing field, learned how to work and negotiate with the Canadian government, and developed a business paradigm based on procuring government contracts to build systems—including satellite ground stations and other surveillance-related work—for Canada, thereafter exporting the company's (and, by extension, the country's) expertise across the globe.[32]

At the same time, MDA executives feared a limited market for global ground station work. The firm thus attempted to execute various diversification plans on exciting but potentially risky and costly work in flight information computer systems, mobile data terminals, business computer systems, airborne-radar work, and electro-optical products. To enter those markets, and to build

31. MacDonald's guiding philosophy is contained in Interview with MacDonald (January 18, 1993), 34 and echoed in Interviews with Beattie, 5, Bennett, 12–13, Caddey, 3–4, Connor, 21–22, Friedmann, 5, 10–11, and 21–24, George, 31 and 33, McDonald, 21–22, and Prentice, 14–15.

32. Interviews with Connor, 3–4, Lennox, 23–25, Lennox and Price, 28, MacDonald (January 7, 1993), 33 and (January 18, 1993), 14, Maxwell, 32, McConnell, 14, Morris, 19–20, Murray, 25, Pitts, 18, Prentice, 36 and 40, Renwick and Seymour, 30, and Spencer, 2; "Industrial Award to Satellite Image-Mapping System," 1.

customized solutions for their various clients, MDA's technocrats also tended to underestimate (and hence to underbid) the effort required to complete projects, which meant that the firm fueled much of its early expansion on the sweat equity of its young engineers, many of whom later recalled that they had worked sixteen or twenty-hour days, nearly year round. They undertook these herculean efforts because the exciting technical work consumed them, because, as one of them put it, "I thought we were building something for the future, that we were putting in all this effort to achieve something. I didn't know what it was, but I wasn't just working for a firm. I was putting part of my soul into that company in exchange for something in the future that wasn't really defined." Working those kinds of hours, in an exciting technical environment, few at MDA had the time or the inclination to think about the political and moral implications of their work. Meanwhile, MDA's innovations not only earned the firm an international reputation in surveillance capabilities, but also drew interest from the American military.[33]

Dave Sloan provided MDA with its first opportunity to undertake remote sensing work. He also gave John MacDonald the incentive he needed to give up his tenure-track position at UBC and become MDA's full-time president. Sloan originally caught space fever during the 1960s, while he worked on a physics degree at UBC. During those years, NASA launched Tiros and Nimbus, the agency's first weather satellites. Intended to fly ahead of reconnaissance satellites to identify cloud-free areas for high-resolution photography, both Tiros and Nimbus transmitted weather pictures to remote locations. Sloan and his best friend Peter Kuijt realized that anyone could build a ground station to receive weather satellite transmissions. They thus constructed one. Although the Canadian government had a weather office in Toronto, Sloan's and Kuijt's 1966 ground station emerged as both Canada's first amateur station as well as the first commercial weather-receiving office in Western Canada.[34]

Sloan and Kuijt left UBC during 1967. Receiving a master's degree in radio astronomy, Sloan quickly gravitated toward TRIUMF, a university-affiliated research institute, where he participated in designing a computer data acquisition and control system for UBC's Cyclotron (a particle accelerator, or "atom smasher"). Kuijt took a job as a draftsman for a local engineering company. When a 1969 article

33. Interview with Thompson, 7; Faustmann, 60–66.

34. Interview with Sloan, 1–2; Mack, 20–22; "Sciencemen Plan Monitor of Satellite," 2.

announced, "At Long Last, ERTS Is On The Way," Sloan and Kuijt looked for ways to connect themselves to NASA's first ERTS. Convincing Kuijt's manager at Wright Engineering that the company should send them to the technical kick-off meeting in Annapolis, Sloan argued that mining companies had an interest in the commercial applications of space exploration. Kuijt's boss, P.F. O'Sullivan concurred. As a result, they headed for Annapolis, and learned that the Canadian government had come to an agreement with NASA to build a ground station and some other unspecified components. Moreover, during a plenary session, O'Sullivan declared, "I'm representing a group of Canadian mining companies that would like to build a ground station, and what's NASA doing to allow private companies to get this data?" NASA representatives explained that while O'Sullivan's question had merit, technical reasons precluded such involvement. Perhaps that was the case for NASA, but no sooner had the meeting closed than Canadian government representatives approached O'Sullivan and his two young colleagues. Impressing Morley and other Canadian officials, Sloan soon found himself attending CCRS planning meetings in Ottawa.[35]

From Morley, Sloan learned that the CCRS planned to contract the work for Ottawa's main processing center with the University of Toronto, but the young radio astronomer also met Ron Barrington of Canada's other Federal agency involved in remote sensing work, the Communications Research Centre (CRC, now Canada's Department of National Defense). Barrington had participated with the CRC team that had built and launched the *Alouette* satellite, and soon decided that he wanted to work with Sloan. As a result, when the CRC won subcontracts for Canada's ground station work, Barrington approached Sloan with a proposal.[36]

The CRC team first searched for a place to build a receiving station, selecting an abandoned radar laboratory in Prince Albert, Saskatchewan. As part of the government's plan to seed western regional development, Barrington contracted with the University of Saskatchewan's Space Engineering Division (SED, later privatized as SED Systems), to convert the radar laboratory into a satellite receiving

35. Interviews with Sloan, 2–5, Collins, 1–8, Lennox, 7–8, Lennox and Price, 5–6, Morley, 1–4; Butrica, *Beyond the Ionosphere*, 29–31, 173; Mack, 3–4, 9–10, 15–16, 27–42, 183–4, 186, 189–94; AIAA, *Collection of Technical Papers*; "At Long Last," 98–104.

36. Interviews with Sloan, 4–5 and 11–12, Bennett, 3–4, Lennox, 7–8, and Lennox and Price, 5.

station. He also explained to Sloan that the government had an official "make or buy" policy in place, and that the CRC could buy equipment for the Prince Albert station from the private sector. Additionally, he revealed that the CRC would seek products similar to those employed by NASA. Importantly, one piece of equipment, the demultiplexer (a mechanical system used to scan the earth's surface on a continuous basis), was only available through Hughes Aircraft, but Hughes charged a then-exorbitant $500,000 for it. Barrington thus encouraged Sloan to make a much lower bid for this subcontract.[37]

Sloan knew that, as just one person working at TRIUMF, he needed a patron. He therefore visited MDA. MacDonald already knew him by reputation and wanted to hire the ground station enthusiast. But MacDonald also revealed that Sloan's proposal presented a problem for MDA. Given its other projects, and several cost overruns flowing from software work, MacDonald could ill-afford to hire Sloan on the spot. Instead, he suggested an alternative, that "MDA bid on the two opportunities" Sloan identified. "You help us write the proposals, and if we win even one of them, you and Kuijt can join us and we'll do it, we'll play!" MacDonald boomed.[38]

Sloan wrote the two proposals and MDA lost one straightaway, but Barrington pushed the CRC to award the demultiplexer work to the young Vancouver firm. Only one other thing stood in the way: MDA's size. Representatives from the DSS had reservations about giving a small unknown firm such a large government contract. After much discussion in Ottawa, however, Barrington finally convinced the DSS that it should at least investigate MDA's operation. During July 1971, a skeptical DSS auditor arrived in Vancouver, but a local, more established electronics component manufacturer with hardware experience helped to alleviate his concerns. It offered to serve as MDA's quality assurance group, cementing CRC's willingness to give the small firm its first major contract. Worth $68,000, that contract trained MDA in ground station hardware and gave the company a foothold in Canada's infant remote sensing industry and the global surveillance community. In addition, MDA's demultiplexer made a splash. It not only matched the quality of Hughes Aircraft's equipment,

37. Interviews with Sloan, 5–6, Bennett, 2–3, Collins, 1–3, 5–8, MacDonald (January 7, 1993), 39-41 and 66, Maxwell, 30, and Renwick and Seymour, 17; Synaptic Systems, *ERTS*.

38. Interviews with MacDonald (January 7, 1993), 26–29, and Sloan, 3–10, 20, and 27. For comparative purposes, see Berlin, "Robert Noyce," 63–101.

delivering the device at nearly one-eighth of Hughes' price, but also created high-tech jobs in Vancouver and promised more of them.[39]

Seeing Vancouver engineers hungry for a piece of the action and willing to work day and night for little financial return, Barrington approached Sloan about negotiating a second contract with the CRC, this time for a ground station "Quicklook" device. Because the CRC had placed the ground station in central Canada, Barrington worried that he had no way of knowing whether he had received valuable data. Moreover, data processing, 1,800 miles away in Ottawa, promised to take months, so Barrington wanted a device located at the ground station that could give him instant results. During fall 1971, he announced that the CRC had decided to give MDA a second federal contract. Valued at $111,000, it commissioned MDA to build a "Quicklook" display system, complete with a Polaroid camera that converted the raw data into a quasitelevision image that they could then photograph. Again, the Canadian government purchased the device at a much lower cost than an American firm would have charged, while MDA's expanding team of engineers gladly put in uncompensated overtime as the badges "western mavericks" wore to celebrate technical challenges. This government contracting and sweat-equity formula then became one of the firm's central paradigms: to work on the cutting edge, produce value for the money spent, "learn to do things and then build businesses around them." Such a paradigm also served those in the government with ambitions for Canada.[40]

While the MDA team worked on the "Quicklook" display system, MacDonald received a Science Council of Canada report entitled, *Innovation in a Cold Climate*, which declared that Canadian research and development had fallen far below that of other industrial nations. Moreover, it warned, without some form of government–industry collaboration, Canada's ability to compete in international trade would decline further. MacDonald found the report inspiring and

39. Interviews with Dettwiler, 12–14, Lennox, 5–7 and 12–15, MacDonald (January 7, 1993), 26–29, 42–44 and 61, (January 14, 1993), 6, and (January 18, 1993), 11, Morley, 3–11, Sloan, 3–15, 20 and 27–28, Spencer, 13–18, and Thomspon, 6; MDA, "1969–89," *1989 Annual Report,* 4; "The Long View From Space," 25–26; Seymour, *A Study of MacDonald, Dettwiler & Associates Ltd.*, Insert A, Table 2; MacDonald to Meyboom; and L.A. Varah, "Innovation is the Business of This Man's Team at MDA," 2.

40. Interviews with MacDonald (January 7, 1993), 42–44 and 61, Connor, 3–6, Dettwiler, 15–18, Lennox, 5, 9, and 15, Sloan, 3–10, and Spencer, 17–18; Thompson, "An Investigation Into the Extent and Cause of the Sagging Morale Within MDA," *Company Confidential Report.*

determined that MDA could help reverse the trend. On the strength of the company's recent success with the Federal government's "make or buy" policy, MacDonald declared that this was the formula on which to expand his vision, MDA's business opportunities, and Canada's industrial expertise. With governments (at home and abroad) funding initial development, MDA could take on all the interesting work it could find, and perhaps even start to incubate Vancouver's high-tech community by offering more employment to engineering graduates, first from UBC and Simon Fraser University, and then from elsewhere. With that future as his backdrop and conversational prop, MacDonald began to talk and travel. He spoke in Vancouver and spent time in Ottawa, giving "lectures" at CCRS, the CRC, and Bell Northern Research and also to Federal Ministers and other Ontario luminaries. He offered interviews and encouraged Sloan to convince their friend at the CRC to give MDA more work. Barrington and others needed little convincing. Although MacDonald and other self-proclaimed western mavericks remain loath to admit it, MDA and other high-tech firms in British Columbia, Alberta, and Saskatchewan survived thanks to nationalist policies in Ottawa and the "eastern establishment."[41]

NASA launched Landsat-1 on July 23, 1972. When it orbited over Canada, completion of the Ottawa CCRS processing center still remained months away; however, the "Quicklook" device set up at the Prince Albert station provided Canadians with real pictures from space. As the first to achieve instant results, Canada made history, MacDonald and Sloan became engineering celebrities, and, within the year, MacDonald tendered his resignation at UBC. Moreover, "Quicklook" publicity within the international remote sensing community ensured that MDA had all the follow-on work its team could handle. The third contract from CRC arrived by 1973's end.[42]

With MDA's young enthusiasts turning their attention to hardware, the company needed an assembly facility, even though MacDonald

41. L.A. Varah, 1–3; Science Council of Canada, *Innovation in a Cold Climate*; Interviews with Collins, 6–7, Gelbart, 4, George, 15, 17, and 34, Immega, 2 and 6–7, Lennox, 15, and MacDonald (January 7, 1993), 38–39 and (January 18, 1993), 1–2, Maxwell, 30–34, Prentice, 40, and Renwick and Seymour, 5; Gordon, "Canadian Firm Leads the Way to Making 21st-Century Maps," 3; Grescoe and Cruise, *The Money Rustlers;* Newman, *The Canadian Establishment;* Cormier, 29–31.

42. W.M. (Mac) Evans, "The Canadian Space Programme," in Battrick and Conroy, eds., *Proceedings of the Concluding Workshop*, 133–55; Interviews with Collins, 1–8, Dettwiler, 4–6, Lapp, 1–5, Lennox, 5–7, MacDonald (January 7, 1993), 26–29, and Sloan, 14–15 and 20; Mack, 191–2; United States Congress, Office of Technology Assessment, *Remote Sensing and the Private Sector;* L.A. Varah, 2.

asserted that MDA had no intention of competing in the manufacturing world. In May 1972, he declared: "A large portion of our business is with manufacturers. We never want to be taken for one. So at MDA we don't make anything. We buy everything, put it together and make it work." This declaration marked the first public statement that MDA intended to build systems in a research and development environment focused on government contracts that attracted bright, young, technical people from British Columbia and beyond.[43]

By December 1972, the CCRS had also awarded MDA another contract, this time to build an airborne data acquisition system (ADAS), integrating new hardware, new software, and digital tape recorders. MDA designed a successful system; unfortunately, ADAS cost twice as much as the company had estimated, and once again MDA had to absorb the overrun, a trend that continued on most 1970s' contracts. Nevertheless, that project led to more work, including a Federal contract to build a data acquisition system for a Canadian research submarine. The submarine contract also solidified MDA's position as serving both sky and sea.[44] Delivering the submersible data acquisition system (1975) also led to MDA's first direct, foreign contract negotiation, with the Institute of Oceanology of the Soviet Academy of Sciences. The USSR had already decided to purchase a submersible, but MDA's successful prototype convinced Canadian officials to approach the Soviets about investigating MDA as a possible supplier. Adhering to MacDonald's principle, that MDA should work with any client who promised to spread the company's name and influence globally, the MDA team drafted a proposal. By July 1975, with the assistance of government agency advocates and Export Development Canada (EDC, the Crown corporation that provides financing and risk management services to Canadian exporters), MDA won the contract to build a submersible system for the Soviets.[45]

MDA's original ADAS enhanced Canada's and the young firm's international visibility. Moreover, it prompted the Canadian Advisory Committee on Remote Sensing to invite MacDonald to participate in a Sensor Working Group. There, MacDonald learned about opportunities in signal processing and sonar systems, another up-and-coming field in global surveillance. He also got better acquainted with significant players in Canada's remote sensing community, including the working group's chairman, Philip Lapp. Although

43. MacDonald qtd in L.A. Varah, 3; Synaptic Systems, *ERTS*.

44. Interviews with Lennox, 9–10, Renwick and Seymour, 18–19, and Semrau, 3.

45. Interviews with Dettwiler, 15–16, Lennox, 9–10, and Maxwell, 14 and 32; MacDonald to Meyboom.

ADAS initially convinced MDA's leaders that they had entered dangerous waters by undertaking too many innovative projects on a modest budget, meetings with Lapp confirmed that the firm could "go global." MDA's work both provided international opportunities as well as secured MacDonald a place in the country's remote sensing elite, a position he planned to exploit fully.[46]

By 1974, the company had received three key government contracts totaling $251,000. From the technology thus developed, MDA derived additional hardware business worth $1.2 million, $800,000 of that in the export market. For a small firm, those figures seemed like an international bonanza, and such results convinced MDA managers that they had a fighting chance to win larger prizes internationally. After all, they reasoned, once MDA successfully completed a contract for Brazil, both Hughes and Bendix decided to leave the ground station market. MDA's board thus set a corporate objective to supply full ground stations to every future Landsat project. Still, the company needed a government champion to help them convince potential international customers that a small firm could deliver a sophisticated system. In addition, without venture capital, MDA also needed the government's financial support. The CCRS came to the rescue.[47]

In 1974—while Canadians celebrated *Global Television* network's first broadcast and the *Pioneer 11* probe passed Jupiter—the CCRS launched its "Unsolicited Proposal Program" (UPP). Initiated to provide bridge financing for projects suggested by under-funded private companies that also promised to hire university students, the UPP helped many Canadian firms to build significant business capabilities. MDA quickly emerged as worthy of development through the UPP. By year's end, Dave Sloan also shared with John MacDonald another idea he had pondered for some time. Employing the UPP, he aimed to build Canada's second receiving station, this time a full turnkey earth resources ground station housed within a portable trailer (PERGS). Sloan argued that MDA could build it for no more than $2 million. Comparing his $2 million plan to NASA's $25 million system, Sloan concluded that the portable ground station could secure the international reputation the team craved. MacDonald embraced Sloan's concept as plausible, even exciting.[48]

46. Interviews with Lapp, 1–5 and 11, and MacDonald (January 7, 1993), 33–39.

47. Seymour, *A Study*, 5; MDA, *1975 Annual Report,* 2; "They Know About Us in Moscow," 37.

48. Interviews with Collins, 5–8, Connor, 1–2, Lennox and Price, 19–20, and MacDonald (January 7, 1993), 66–72.

A few months later, MDA secured its first UPP contract through the CCRS. Valued at $1.3 million, it became the most significant milestone in the company's early history. Smaller than the $2 million the company had proposed, it nevertheless gave MDA its chance to build a turnkey system. Reflecting on his career, one MDA engineer summarized a shared perception about these vibrant 1970s' projects. "There was a special synergy, a special gathering of the right people in the right place," Ray Maxwell recalled. Moreover, "John, in particular, was like a messiah figure, saying to each and every one of us, '*This way to the promised land*.' And if he had walked over a cliff, everybody would have lock-step followed him right over it." For Maxwell and others, MDA represented the fulfillment of the engineer's dream—working at technology's edge, they could venture into uncharted spaces and unmapped possibilities. That sort of energy and commitment also served Canada's ambitions well.[49]

With the assistance of government officials at CCRC, CRC, EDC, and other interested agencies, MDA went global by negotiating its first complete ground station contract with the Republic of South Africa. The job revealed two important things: that other nations had begun to boycott business transactions with the Apartheid government; and that, with Canadian governmental representatives paving the way, MDA had decided that the firm should capitalize on the country's pariah status and follow the money no matter where it led. After all, they reasoned, this large contract could allow the firm to develop additional ground station features, which it could then sell to others. MDA won the job, and designed a generalized linescan receiving and processing system that could read data from both Landsat and the European Space Agency's new Meteosat weather satellite. As its first "plug-and-play" export system, the South African contract prompted company promoters to anticipate future applications. Those soon emerged. Within the next four years, five other nations—Japan, Sweden, Argentina, Indonesia, and Thailand—contracted with MDA

49. Interviews with Maxwell, 34, Bennett, 6–7, Butler, 3, Connor, 2–3 and 22, Dettwiler, 4–6, Friedmann, 2, Gelbart, 2–4, George, 34, Immega, 1–2, Lapp, 11, Lennox, 11, MacDonald (January 7, 1993), 42–44, Prentice, 39, Renwick and Seymour, 5–8, Sloan, 3–10, and Spencer, 5; Seymour, *A Study*, 3; "Practical Solutions to Difficult Problems," 32; "MacDonald, Dettwiler & Associates Ltd., Exceptional Talents," 5; "Canada's Second Ground Station Capable of Receiving and Processing Earth Resources Technology Satellite Images"; "Satellite Unit Contract Set"; "City Firm Wins Space Job"; and "BC Firm Wins $1.3 Million Job."

so that they too could enhance their competitive positions in the business and politics of remote sensing/surveillance.[50]

Although Sloan and others polled employees about whether they wanted to work with South Africa (or other customers), few voiced political or ethical qualms about doing so. Twenty years later, reflecting on that and other sales, some to Middle East antagonists, MacDonald argued: "I'm the exact opposite of a person who believes in Apartheid [but] I've always taken the attitude that business is business." Most of the firm's engineers and the government technocrats with whom they also did business apparently agreed. Moreover, MDA made profits on every subsequent ground station sale, profits employed in funding further development, not only to improve ground station product lines but also to diversify the company's base. MDA's success in reading Meteosat data also convinced the CCRS to fund another weather image processing system, a meteorological product called WIPS. MDA completed its first WIPS contract with Atmospheric Environment Service Canada, and then negotiated twelve export contracts, including systems for Sweden, Czechoslovakia, and Indonesia as part of détente, and one for the Israeli military.[51]

With ground station sales well underway by the mid-1970s, other significant government-funded ventures materialized, including a sonar signal processing contract that turned into the globe's first digital images from SAR. While SAR's implications only reached the public during the 1991 Gulf War, the American military had developed the technology during the 1950s as the best way to retrieve images from deep space. When the United States declassified its SAR documents, many thought the technology held significant commercial promise. MDA received its first opportunity to undertake SAR application research for *Seasat*, the first earth-orbiting satellite with an onboard, spaceborne SAR, designed to extract images from deep space for remote sensing of the earth's oceans. Although hired to work on other things, John Bennett, one of MacDonald's former PhD

50. Interviews with MacDonald (January 7, 1993), 48–49, Collins, 8, Maxwell, 32, Connor, 2–3, Morris, 7–8, Murray, 4, Pitts, 12–14, and Renwick and Seymour, 18–19, 21–23, and 29. For comparisons, see Krige, "Crossing the Interface from R&D to Operational Use," 27–50; Cracknell and Hayes, *Introduction to Remote Sensing*, 12–16, 49–52, 193–97; Mack, 15.

51. Interviews with MacDonald (January 18, 1993), 23, and (January 7, 1993), 48–49, Collins, 8, Maxwell, 9–10, 23 and 32, Connor, 2–3, Morris, 7–8, Murray, 4, Pitts, 12–14, and Renwick and Seymour, 18–19, 21–23 and 29; Seymour, *A Study,* 3; MDA, *1976 Annual Report*, 13.

students, had always wanted to work in the digital filtering field. Thus, when Morley called about another unsolicited proposal idea, MacDonald gave Bennett the SAR project. It took some time to nurse the proposal through the system, but by late 1976, the contract arrived. MDA engineers then set to work, acquiring a team of highly trained mathematicians and scientists to make the system work. The SAR processor represented an enormous risk, something that initially escaped MDA's notice. For the moment, it was enough that the Canadian government had provided another opportunity to undertake another cutting-edge engineering project.[52]

Meanwhile, on June 28, 1978, the United States launched *Seasat*, complete with instruments designed to return a plethora of information from the globe's ocean surfaces. The satellite operated for three months, then died under mysterious circumstances. Some speculated that the American government "turned off" *Seasat*, given the satellite's ability both to see through cloud cover no matter the time of the day and to detect submarines down to a level of about 1,000 feet. Perhaps military personnel feared the possible implications of *Seasat*'s commercial development. Others argued that a hardware failure in the power supply had triggered *Seasat*'s demise. Regardless, *Seasat* had gathered forty-two hours worth of data, enough to keep engineers busy for many years. Moreover, because MDA had sent an employee to the PERGS station in Shoe Cove at the same time that *Seasat* made one of its initial flights over Canada, MDA had managed to acquire four tapes worth of data, enough to create a *Seasat* image of Three Rivers, Quebec.[53]

Producing the first image took approximately 100 hours worth of computing time. Moreover, the SAR project involved intensive overtime, more than double the effort MDA had originally proposed. Within five months, the United States' Jet Propulsion Laboratory repeated MDA's accomplishment, but the scientific community

52. Interviews with Allan, 8, Bennett, 3–9 and 12–14, Collins, 5–6, Connor, 7–9, Dettwiler, 6–8 and 19, Friedmann, 2, George, 2–5, 7–10 and 30–31, Immega and Kaufmann, 19, Lapp, 3, MacDonald (January 7, 1993), 4 and 66–80, McDonald, 1–3 and 10–12, McConnell, 1–8, 11–12, 18 and 22, Morley, 14, Murray, 4–5, Renwick and Seymour, 11–13 and 29–30, and Widmer, 6–12; Gupta, *Remote Sensing Geology*, 1–16, 75–80; Kramer, *Observation of the Earth and Its Environment*, 32, 489; Verstraete, Menenti, and Peltoniemi, eds, *Observing Land from Space*, 35; Haykin, Lewis, and Raney, *Remote Sensing of Sea Ice and Icebergs*, 1–9, 515, 637; Curlander and McDonough, *Synthetic Aperture Radar*, 33; Mack, 57; Cumming and Bennett, "Digital Processing of Seasat Data," 710–18.

53. Interviews with Bennett, 3–9, and McConnell, 11–12; Westwick, *Into the Black*, 67–120.

acknowledged that MDA had delivered the world's first digitally processed synthetic aperture radar image from a spacecraft. This achievement attracted the attention of the German Space Agency, the European Space Agency, and the United States military. Indeed, as one engineer recalled, "all of a sudden, two guys from the National Security Administration came up, with government-issued black patent leather shoes and thick black-rimmed glasses" to see precisely what people at MDA knew, because *Seasat* SAR images showed air bases, military installations, aircraft carriers, surface destroyers, submarine wakes, and other classified information. Plainly, with this experience logged in, MDA looked forward to exporting their SAR potential just as they had exported their ground station expertise.[54]

By 1979, Dan Gelbart, a talented mechanical engineer, worked on a technical challenge that gave MDA another edge. Employing mechanics and optics to address the problem of image quality, he produced a black-and-white film image recorder (fittingly dubbed "FIRE"). Not only fast, the FIRE also produced accurate images. Within two years, Gelbart's machine set the global standard for ground station film image recorders. As he made progress on a color FIRE version, the electro-optical technology looked like a potentially promising product through which MDA could diversify.[55]

Despite the firm's solid reputation in ground station work, board members worried that MDA might soon saturate that market. They also feared what might happen if the Canadian government turned off the contracting tap. Thus, throughout the 1970s, MDA's board approved projects and proposal ideas that promised to produce repeat sales—particularly in flight operations, mobile terminals, business systems, radar, and then electro-optical products.[56]

Touting PERGS and other accomplishments, one reporter claimed: "With a growth rate averaging over 80 percent per year, MDA is currently achieving one of its objectives—to put the British Columbia electronics industry on the high-technology world map. Dr. MacDonald is the first to admit that MDA's marketing has, in the past,

54. Interviews with Bennett, 3–9, Dettwiler, 6–8, George, 7–10, MacDonald (January 7, 1993), 4, and McConnell, 11–12; MacDonald to Meyboom, 2; Mudgway, *Uplink-Downlink.*

55. Interviews with Dettwiler, 9-10, Gelbart, 1-11, MacDonald (January 18, 1993), 2-3, Murray, 4-5, Prentice, 24-27, and Spencer, 15-18; Kaihla, "Hissin' Cousins."

56. Interviews with Connor, 10–15, Gelbart, 16–20, Lennox and Price, 23–26, MacDonald (January 7, 1993), 83–93 and (January 14, 1993), 2–25, McConnell, 13, Morris, 12–14, Prentice, 6–10, Price, 8–12, Renwick and Seymour, 15, Sloan, 14–15 and 28–30, and Spencer, 8–18; Seymour, *A Study,* 2; Thompson, *Company Confidential Report.*

consisted of 'responding to the needs of people who come in through the front door,' but with the increased emphasis on market development, both nationally and internationally, MDA has already made a unique contribution to the growth of Canada's electronics industry on the Pacific coast, and much more will be heard of the firm in the years ahead."[57]

Bankers, government officials, MDA's clients, and the general public did hear a great deal more about the young firm, not all of it quite so bullish. Pursuing all the interesting work that came through the door not only resulted in technological firsts, but also put the firm at financial risk. By late 1981, the decision to expand without a major capital injection had created management rifts over the company's direction, the void into which one large-scale project (FOCUS) fell, and created the necessity to spin-off other product opportunities that profited others but ultimately not MDA. By 1982, MDA's staff had increased to 200, but the company also incurred a net loss of $1.85 million for fiscal year 1981. After many painful discussions, Dettwiler and others convinced MacDonald that the time had come to seek outside equity and that he had to step down from his presidential role. Unfortunately, mired in a recession with high-interest rates, Canada's 1981 economy made attracting investors almost impossible. Although undercapitalized expansion began the process of incubating a new Vancouver high-tech community during the crisis, and indirectly promoted MacDonald's vision of a regional engineering hub, MDA came within an eyelash of failure.[58]

Near-Death Experiences and a New Climate: from Scientific Data Processing to Project Management, Military Specifications, and Systems Integration, 1982–93

As FOCUS spiraled out of control, MDA's ability to make its payroll became uncertain. Remembering the sinking morale at MDA, one employee reported that rumors circulated and a general consensus formed that "An optimist is a guy who brings lunch." By March 1982,

57. "MacDonald, Dettwiler & Associates Ltd., Exceptional Talents," 5; Kapp, "Banging the Gong," 12ff; Faustmann, "Barclay Isherwood," 53.

58. Interviews with Connor, 10–15, Gelbart, 16–20, Lennox and Price, 23–26, MacDonald (January 7, 1993), 83–93 and (January 14, 1993), 2–25, McConnell, 13, Morris, 12–14, Prentice, 6–10, Price, 8–12, Renwick and Seymour, 15, Sloan, 14–15 and 28–30, and Spencer, 8–18; Seymour, *A Study,* 2; Thompson, "An Investigation Into the Extent and Cause of the Sagging Morale Within MDA."

with the Canadian recession deepening and agreements with potential investors falling through, finances intervened. After nearly a year searching for outside investment, John MacDonald started to run out of ideas and friendly investors. In desperation, he approached Ottawa about taking advantage of federal loans, but was turned down. It then appeared that MacDonald could secure financing through the venture capital arm of the Canada Development Corporation (CDC). But with interest rates climbing from 15 percent toward 20 percent, and investments in technology-related firms representing an enormous risk, the CDC canceled a last-minute deal. In such a tangle, MacDonald had few choices. Within weeks of receivership, however, chance events conspired to save MDA from ruin; and in a classic eleventh-hour bailout, several investors emerged, among them venture capitalists, private investors, and the government. As part of the package, outside investors insisted that MDA replace MacDonald with an experienced businessman. Within hours, MacDonald's ownership share plummeted from 60 percent to less than 15 percent, and he had to "promote" himself from president and chief executive officer to chairman of the board.[59]

Although each investor had different motivations for underwriting MDA's near-term continuation, together they provided the financial injection needed to save the firm. The scheme also brought MDA a necessary component for long-term survival: John W. Pitts, an experienced entrepreneur and executive with bottom-line administrative expertise, political clout, and the negotiating skills to refocus company operations. Under his leadership, from 1982 through 1995, Pitts transformed MDA from a loose collection of technological enthusiasts into a disciplined workforce primed to manage large and complex software development projects, the military specification environment, and the challenges of systems integration. No technical person working at MDA in the 1990s could fail to appreciate from whence the company had emerged as Canada's preeminent space contractor. Equally evident is the role MDA's space images have played (and continue to play) in its evolving relationship with the Canadian government and ability to "cash in" on American-centered commercial and military expansion.[60]

59. Interviews with Gelbart, 11, Connor, 13–15, Lennox and Price, 23–26, MacDonald (January 14, 1993), 2–25, Prentice, 6–10, and Price, 8–12.

60. Interviews with Allan, 5 and 8, Bennett, 10 and 20–21, De Farris, 1–2, Murray, 28, and Wallis, 11–12; Brown and Duguid; Bell, *The Coming of Post-Industrial Society* and *The Cultural Contradictions of Capitalism*.

With the shift from personal management to entrepreneurial/professional management, MDA's employees had to accept a sea change in organizational philosophy. The founders started MDA to be in business and to enjoy the work. Pitts and venture capitalists got in for the purpose of getting out, in circumstances meeting the goals that motivate such people—seeking a massive financial return in five years or thereabouts. Unlike many company founders before and after, Dettwiler and MacDonald secured a chance to carry on. Pitts recognized the basic philosophical divergence between himself and MDA's founders and technical staff, yet instead of removing them, he allowed MDA's innovators to find a place within the firm, and to promote the company's new direction. Pitts introduced cost controls, reduced MDA's inefficiencies, and set up three divisions as profit centers. He consolidated all ground station, meteorological, and space-borne synthetic aperture radar activities under the "Systems Division" to capitalize on the firm's systems products and turnkey projects, then established two other divisions—"Airborne Radar" and "Electro-Optical Products"—to exploit product opportunities the firm's new investors identified. By introducing these structures, Pitts hoped to generate consistent revenues from ground stations and the systems side of the business, so that MDA could generate cash reserves to ripen its products for larger-scale manufacturing.[61]

MDA entered a period in which sound business concepts reshaped the company from a technically obsessed firm, for which profit represented just a means to keep going, to an enterprise that could take an early-stage conceptual research contract and transform the results into a full turnkey system. In the process, MDA operations slowly, and sometimes grudgingly, yielded to the discipline inherent in the principle that profit is *the* goal of capitalist enterprise. Although the product vision ultimately failed, the government contracting formula continued to allow MDA's Systems Division both to acquire additional capabilities by developing key systems products and to capture a major share of the international remote sensing market by exporting interactive operating systems to new customers in Europe, the United States, the Middle East, and Asia.[62]

61. Interviews with Caddey, 5 and 20–22, Connor, 17, Dollard, 12–15, Gelbart, 16–20, Harrison, 17–20, Lapp, 14–17, Lennox and Price, 28, MacDonald (January 18, 1993), 33–55, McConnell, 23–25, Pitts, 1–6 and 15–17, and Stevenson, 21.

62. Pitts, *Draft President's Report to Shareholders, Year Ended March 31, 1985*; MDA, "1969–1989"; Interviews with Bennett, 10–11, Cwynar, 6–11, Dettwiler, 14–15, Dollard, 6 and 12–15, MacDonald (January 18, 1993), 23–27, Maxwell, 17, Pitts, 8–16, and Stevenson, 8 and 13.

During 1982, MDA also received its first opportunity to enter the large American military market by developing an automated weather distribution system (AWDS) for the United States Air Force (USAF). To that end, Pitts employed Western Management Consultants (WMC) as an instrument of change. Inventorying the firm's personality types, WMC argued that MDA needed to hire different sorts of people to change the company's culture. Those "different sorts" soon included former military personnel who understood the specification environment and the discipline of military organizations. As the largest contract MDA ever bid, the initial AWDS development work offered chances to employ engineering methodologies learned on FOCUS and meteorological systems, to manage a large software development project, and to learn how to work with the U.S. government. Thus, Pitts placed MDA's new hires at the center of the AWDS proposal-writing project. Moreover, because the contract promised the company future sales exceeding $150 million, Pitts wanted former military personnel to lead the process. If they could win the first contract, MDA's management team concluded, the development work promised to place the company in a unique position to build the AWDS production systems that the United States subsequently planned to install at every U.S. air force base around the world.[63]

Larger forces once again pushed MDA further into space and defense. The AWDS strategy involved courting American military contractors, then chasing the U.S. budgetary investment in Ronald Reagan's "Strategic Defense Initiative" (SDI; created in March 1983). Although widely criticized, SDI set the stage for a massive investment in ground- and space-based imaging systems, with the United States investing well over $100 billion in the project and other space-related research, testing, and follow-on work. Indeed, the Reagan administration's commercial space policy "assumed a symbiotic relationship between commercial and military interests. . . . A key tool for promoting private ventures in space was government itself through privatization (of Landsat) and NASA." The Defense Advanced

63. MDA, *President's Report to Shareholders On Behalf of the Board of Directors, Year Ended March 31, 1985, 1986 Annual Report*, 4–5, 1*987 Annual Report*, 2–4, *Automated Weather Distribution System, Advanced Airspace Management,* and *METDAS;* Interviews with Beattie, 4–5, Caddey, 3–13, Clark, 10, 15 and 27–28, Connor, 7–22, Cwynar, 6–11, Druce, 5, Friedmann, 5, George, 19–20 and 31, Harrison, 23-24, MacDonald (January 18, 1993), 22–27, McConnell, 21, McDonald, 18–22, Morris, 19, Pitts, 10–11, Prentice, 14–20, 29–30, and 35, Renwick and Seymour, 29–30, Stevenson, 21–26 and 35, and Wallis, 1 and 6–7.

Research Projects Agency, NASA, and other federal agencies devised commercialization plans, and thereby much of the Reagan-era investment in stimulating space entrepreneurship made its way into American universities, national laboratories, and military–industrial contractors. The initiatives also promised windfall opportunities to American allies, including Canadians working on space-based technologies, surveillance systems, and warfare expertise.[64]

The Canadian government played a central role in MDA's entrance into the American military market. Representing the next generation of international data handling stations, the AWDS opportunity resulted from a long-standing U.S.–Canada defense-sharing arrangement. On such contracts, each country agreed to pay 50 percent of the costs, with a Canadian firm acting as the prime contractor, and the United States supplying the subcontractor(s). In the past, the Canadian government had appointed prime contractors for all defense-sharing initiatives; however, during 1982, government representatives decided to run an open competition for these jobs. Just drafting the proposal presented MDA with an enormous challenge. Unaccustomed to reducing its engineering methods to writing, and unfamiliar with the rigors of writing proposals to military specifications, MDA's engineers had to look to the U.S.'s Harris Corporation for support. Harris helped MDA fashion a disciplined engineering environment, and by the time it submitted the proposal (May 1983), MDA added expertise in writing defense contract proposals to its operations.[65]

By summer 1987, with AWDS completed, the Systems Division had demonstrated that MDA could deliver large-scale software development systems. Despite delays, financial and management changes, and the novelty of meeting fixed standards, MDA not only delivered a superior system to Eglin Air Force Base in Florida, but the USAF also awarded MDA contracts to upgrade the system and train Air Force personnel on AWDS operation and maintenance. AWDS taught MDA's staff the importance of discipline and how to work to external standards. In addition, the project generated valuable

64. Butrica, *Single Stage to Orbit,* 8, 29. Although the privatization of Landsat commenced under President Jimmy Carter, Butrica argues that "Landsat privatization was doomed. The Land Remote Sensing Policy Act of 1992 ended the experiment in privatizing Landsat and transferred oversight from the Department of Commerce to NASA and the Department of Defense," 30–31. In addition, see John Lewis Gaddis, *The Cold War,* 195–235; Eisendrath, Goodman, and Marsh, *The Phantom Defense*; and Fitzgerald, *Way Out There in the Blue.*

65. MDA, *1986 Annual Report*, 4–5, and *1987 Annual Report*, 2–4.

experience in accounting, the software development review process, and documenting military specifications. More importantly, AWDS inspired confidence in MDA's Systems Division employees. Although many of the AWDS technical staff had come from FOCUS, complete with scars from that experience, the Systems Division could show something significant to other potential space, defense, aviation, and meteorological customers. With the development stage ended, praise from the U.S. Air Force and Harris Corporation encouraging them forward, and confidence in their new abilities, MDA personnel thus started work on the AWDS production contract proposal, poising themselves for further success and revenues in excess of $100 million.[66]

Between 1982 and 1987, MDA lost its innocence, and the Systems Division embarked on important projects involving complex management structures. As Daniel Friedmann argued in 1993, AWDS and other projects "went into space and defense, and we developed a number of business markets," including radar and sonar surveillance and control and logistics systems. By 1988 fiscal year's end, MDA's staff had expanded to 609, and gross revenues had climbed from $16 million to over $63 million. In 1988 alone, 397 MDA staff members occupied the Systems Division, and its gross revenues neared $44 million, both about two-thirds of company totals. Systems also generated a number of important repeat sales on the products it developed during the early 1980s. The West German Space Agency and the European Space Research Institute, two key European contacts, purchased MDA products. The Canadian International Development Corporation Agency bought a meteorological data analysis system for installation in Peru. Systems also served the CCRS and other significant international clients, including the United States, Australia, Thailand, India, and Saudi Arabia. These overseas installations solidified MDA's international reputation as a contractor capable of supplying and integrating large and complex turnkey systems.[67]

From the Division's initial work, MDA received three further system contracts from Italy, Spain, and Canada, as well as a contract to build the European Space Agency's Central User Service for the

66. MDA, *1986 Annual Report*, *1987 Annual Report, Automated Weather Distribution System*, *Advanced Airspace Management,* and *METDAS;* Interviews with Caddey, 3–19, Dollard, 14–15, Friedmann, 2–11, MacDonald (January 18, 1993), 18–22, and Pitts, 10–11.

67. MDA, *Frontiers in Digital Mapping*, *IRIS Tactical and Strategic Radar Reconnaissance*, and "1969–1989"; Interview with Friedmann, 1–6.

ERS-1 satellite. During 1988, MDA won an industrial research award for technological innovation in geocoded image correction. Combining that new expertise with SAR, the company installed systems in Ecuador and Canada's Arctic, and supplied a meteorological system to Canada's Atmospheric Environment Service as the foundation for all future Canadian national defense and meteorological applications, and another to the Republic of Korea, which further enhanced MDA's position in the Asian market. In the United States, MDA also teamed with Lockheed to provide a satellite data acquisition system for the Navy Tactical Environment Support Service.[68]

During 1988, with success in all areas of remote sensing, Systems Division managers decided to diversify, to build significant business areas in geographical information, space and defense, and aviation. Arguing that the Systems Division could take its skills into other areas, Daniel Friedmann and engineering managers had already drafted a new five-year plan, incorporating marketing strategies for expansion. From the company's early work on mobile data terminals and FOCUS, plus project management expertise on the AWDS contract, Systems pursued contracts that allowed it to explore new ventures in the aviation business—supplying flight operations, aeronautical information, and flight data processing systems. Its 1980s' strategy targeted defense/space opportunities to supply governments with systems engineering and integration expertise and embarked on a value-added approach for ground station upgrades.[69]

With the Systems Division five-year plan in place, MDA won its first two aviation contracts: a design contract from Transport Canada to upgrade Canada's civil air traffic system and an overseas contract with the Australian Civil Aviation Authority. Worth $13 million, the contract allowed MDA to deliver its first national aeronautical information processing system. In space and defense, MDA reaped three Canadian contracts for target detection, signal processing, electronic counter-countermeasures, and communications systems. In addition, Canada's Defense Research Establishment Pacific asked

68. "MacDonald Dettwiler to Receive $3.3 Million Under Defence Plan"; "MacDonald Dettwiler Focus on Digital Imaging Nets Growth of 30% Per Year"; "Canadian Defense Industry Profiles"; MDA, *Advanced Systems for Defense*; "Space Station Sparks Drive for New Heights"; "MacDonald Dettwiler Pursues Defense Market"; "Canadian Firm Leads the Way to Making 21st-Century Maps"; "Canadian Government and MacDonald Dettwiler Sign $10 Million Contract."

69. Faustmann, "John MacDonald Had A Firm," 60–66; MDA, *Automated Weather Distribution System, 1987 Annual Report*, 3–4, *Satellite Ground Stations, 1988 Annual Report*; Interviews with Dollard, 15–16, Friedmann, 2–24, MacDonald (January 18, 1993), 13–34, Pitts, 8–16, Wallis, 9–14, and Widmer, 10–13.

MDA to investigate sonar image modeling and a variety of mosaic techniques for creating ocean floor charts. In consequence, the company's backlog increased 26 percent to $40 million, with the new aviation systems and space/defense business areas promising significant expansion over the next five years.[70]

In the meantime, through contracts for the USAF and ESA, the Systems Division expanded its horizons by using its newly acquired skills in large-scale systems engineering and integration to target opportunities in aviation, space, and defense markets. During 1987, despite product division losses, MDA had a boom year. Following acceptance tests, the USAF awarded MDA contracts to enhance AWDS and to provide user training. This time, with Harris Corporation as prime contractor, and MDA as subcontractor, the firm undertook its largest pursuit: to capture the contract to install weather distribution systems for all the USAF's global military bases.[71]

Convinced that initial AWDS success favored the follow-on production contract (worth approximately $63 million), MDA's board decided to continue its product development activities. At the same time, it decided to raise equity capital through the sale of public securities, not only to accommodate the company's predicted expansion, but also to enable its "rescue" investors to liquidate their assets. MDA also leased a new research and production facility for its Airborne Radar and Systems Division staff. With a 50 percent purchase option, MDA's new facility promised to improve the company's efficiencies as well as entice potential investors. Unfortunately, during October 1988, just two months prior to the company's scheduled move to its new facility, MDA received the dreaded call—there would be no AWDS production contract. The MDA-Harris bid lost for a variety of reasons, the two most important among them a failure to master the specific market and to understand the competitive process. MDA had neglected to allocate sufficient funds for a market study, and it had also misread (or misunderstood) the USAF's procurement policy. Assuming, once again, that technological elegance could prevail over market realities, MDA failed to analyze whether, in fact, it had any competitive advantage. Although MDA had delivered two systems, when the USAF announced its request for proposals (RFPs), it leveled the playing field to accommodate the need for 100 such systems. Wedded to its original minicomputer architecture, MDA never tracked a significant

70. MDA, *Frontiers in Digital Mapping*, I*RIS Tactical and Strategic Radar Reconnaissance*, and "1969-1989"; Interview with Friedmann, 1–6.

71. MDA, *1988 Annual Report*.

technological (or rather market) shift, which meant the Harris-MDA team lost out to competitors who offered new, lower-cost microcomputer solutions. At the same time, the RFP stated that the overall project included a $40 million, 10-year maintenance subcontract on each operational site. Neither MDA nor Harris had this expertise. Because it had the current operations contract on USAF's bases, and offered a microcomputer solution, ConTel won both the production as well as maintenance contracts, in a combined project worth $103 million.[72]

This defeat devastated MDA, revealing that the great open market to the south would remain closed to the company until it could demonstrate a competitive advantage. Moreover, the effort expended on AWDS had suspended other Systems Division projects, thwarted further product development efforts, and put the company in a tenuous financial position, again. MDA's Systems and Airborne Radar divisions moved to new premises during January 1989, but their high-tech office felt empty without the AWDS job. As each month passed, costs associated with EOP and Airborne Radar escalated while the Systems Division's prospects waned. Although Aviation Systems booked a $13 million contract with the Australian Civil Aviation Authority to deliver a national aeronautical information processing system, for the first time it appeared that MDA had lost its edge in remote sensing. Worse, the Systems Division needed development funds for the Australian project as well as marketing resources to foster new opportunities. By 1989's end, instead of realizing returns, MDA's investors found themselves owning a company whose products and contract bids had faltered at the same time that Canadian technology firms generally had lost their luster in the investment community. In addition, Canadian competitiveness declined sharply from 1985, even though Canada's dollar fell against other currencies. Relative labor costs rose, the country's inflation edged up toward uncomfortably high rates, and other nations (the U.S. in particular) became more cost-competitive. Under dog-eat-dog conditions, even the Systems Division found itself losing important bids. In such a climate, Canadian investors sent their funds abroad rather than support a risky high-tech venture with two withering product divisions, and, by implication, no strategy.[73]

72. Interviews with Caddey, 3–19, Dollard, 14–15, Friedmann, 2–11, MacDonald (January 18, 1993), 18–22, and Pitts, 10–11.

73. "Magic Mountain," 22; Organisation for Economic Co-Operation and Development, *Economic Surveys Canada;* MDA, *Operations Report*; Interviews with Caddey, 3–19, Dollard, 14–15, Friedmann, 2–11, MacDonald (January 18, 1993), 18–22, Pitts, 10–11, and Wallis, 9–14.

By early 1989, with product divisions floundering, and sales declining in ground stations, MDA had no viable corporate strategy. Only the Systems Division had done a market assessment and set crucial goals. Within its five-year plan, operational since 1988, Systems had made several inroads into Aviation Systems and Space and Defense markets in an effort to reduce its business risks in remote sensing. With political, environmental, and economic pressures to cut defense spending under way, its managers had targeted areas outside the weapons business. Instead, they foresaw developing and integrating systems for information processing and reconnaissance. Based upon expertise on FOCUS, AWDS, and meteorological systems, they found potential markets with air traffic management requirements and started to devise airspace management and flight operations systems for civil aviation authorities and departments of defense. Thus, by 1990, the Systems Division had articulated, perhaps for the first time in the company's history, MDA's core business expertise. Neither a remote sensing nor a product company, MDA had evolved into a systems integrator, focused on software development and off-the-shelf hardware, to serve governments and agencies.[74]

In the meantime, from profits realized on ground station upgrades, Pitts concentrated on business acquisitions and shareholders' requests for liquidity. On October 31, 1991, MDA acquired 50.1 percent of an English firm, Earth Observation Sciences Limited. By expanding offices in strategic geographic locations during 1989, selling the EOP division during 1990, and acquiring Earth Observation Sciences in 1991, MDA enhanced its investors' original exit strategy. Its new worldwide systems engineering offices promised to provide critical connections to the European Economic Community, United States, and Asian markets, and to entice potential investors. As some board members departed and others arrived, Daniel Friedmann, an engineer deeply interested in business strategies, emerged as an obvious choice for the restructured board. As the Systems Division's marketing manager, Friedmann had understood MacDonald's vision. By marrying it with business and marketing strategies, he had exploited that vision into a profitable growth-oriented business. That reality also caught Pitts's attention. During August 1992, desiring liquidity and with Friedmann's abilities to run a profitable operation

74. In 1990, after a lengthy search for a buyer, Pitts negotiated EOP's sale to Cymbolic Sciences, Inc., a California company. MDA, *1987 Annual Report*, 5–6, and *1988 Annual Report*; Interviews with Cwynar, 1–9, Friedmann, 16–24, MacDonald (January 18, 1993), 41–56, Murray, 25–27, and Pitts, 8–16.

demonstrated, Pitts appointed the 36-year old as MDA's chief operating officer.[75]

By 1993, as they worked on the firm's next five-year plan, MDA's young management team (all under age 45) looked to a future focused on government contracts for space and defense. New ownership also resulted in a project to eradicate MDA's earlier history. Researching MDA's website and the company's current public relations documents presents an intriguing picture. Current company chronologies announce its 1969 founding by MacDonald and Dettwiler, but then skip through time and space to 1995, the year when Orbital Sciences Corporation (a satellite manufacturer and launcher heavily involved in missile "defense" systems) acquired MDA for $67 million in stock. Following 1995, highlights then offer a rosy picture of acquisition and revenue growth, the buy out of Radarsat-International from SPAR Aerospace, and an "initial" public offering in 2000 (ignoring the *first,* and decidedly disappointing IPO on the Vancouver Stock Exchange in 1993). MDA's post-Orbital account includes twenty-first century joint ventures, further acquisitions, more global expansion, and one of the firm's capstone achievements—at long last, after nearly forty years in business and with a global staff nearing 2,700—a coveted ranking among *Maclean's* 2007 list of "Canada's Top 100 Employers." In the same article, *Maclean's* offered no insight into or praise for the kinds of work the company has engaged in over the past four decades. Nor did it tackle any of the larger dilemmas that the firm's history has presented to the larger world.[76]

Closing Thoughts

Historians have long recognized the role of the military in capitalist expansion and technological innovation; however, contemporary

75. MDA, *1993 Annual Report; 1992 Annual Report; 1991 Annual Report; 1990 Annual Report;* "1969–1989"; Interviews with Friedmann, 5, Harrison, 19–20, Kaufmann, 12–13, McDonald, 10, McConnell, 14 and 22–24, Prentice, 22–23, and Wallis, 11–13.

76. Qtd, in "Canada's Top 100 Employers." In addition, see www.mdacorporation.com (accessed January 5, 2011); Kaihla, "Hissin' Cousins," 31; "Orbital Sciences Deal"; and Knapp, "Masters of the Universe," 119–22. Among the things touted as important, *Maclean's* included the fact that MDA has engineering "cool." Indeed, "Employees at MDA enjoy casual dress daily and can listen to radio or music while they are working," the magazine cooed. "There is also a company-subsidized social committee, called the 'MDA Social Club', which has operated since 1979." *Maclean's* "Social Club" reference is short-hand for Friday afternoon Happy Hours in MDA's cafeteria, where employees can quaff beer and hob-knob before going home (or back to work) for the weekend.

events confirm that we still need to know much more about the historical synergies between ideological and military ambitions, government contracting, business practices, educational institutions, and the expansion of larger surveillance systems, social norms, and cultural assumptions. Moreover, although we now have detailed perspectives on Route 128 and Silicon Valley, we still need to cast a wider net, into those once unlikely "hot spots" now girdling the globe, in places such as Seattle (Washington), Vancouver (British Columbia), Bangalore (India), and Beijing (China), where technological "family trees" have taken root in firms like MDA, thereafter spreading their influence both near and far. Whether sought or unsought, this reality becomes particularly critical when one considers the international consequences of military adventurism and the dangers inherent in the expansion of increasingly invasive global surveillance networks tied to the rhetoric of "defense," "security," and economic "freedom."

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