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# NATO Defense Science and Technology

*by Donald C. Daniel and Leigh C. Caraher*

## Overview

**The accord establishing the North Atlantic Treaty Organization (NATO) in 1949 provided the framework for the greatest international mechanism ever in defense science and technology. From its earliest days, NATO involvement in science and technology has sought to build cooperation and promote security and stability. Today, the central element of the NATO defense science and technology program is the Research and Technology Organization (RTO), which provides the best basis for collaboration among the most technologically advanced countries in the world. Through this body, alliance nations plan and execute activities that cover the full spectrum of technologies vital to current and future security.**

**RTO and its two predecessors, the Advisory Group for Aerospace Research and Development and the Defense Research Group, have a history of fostering long-term relationships among senior executives, scientists, and engineers; sharing information and research; and enhancing military capabilities. There is no international activity that rivals RTO in scope, magnitude, or potential. RTO can continue to build on these successes by emphasizing longevity of its highly qualified members, prioritizing areas of opportunity, integrating the seven newest NATO invitees, and building a closer relationship with Russia. This paper examines the origins of NATO defense science and technology, provides an overview of the Research and Technology Organization, and analyzes the elements that make RTO successful. The paper concludes with recommendations for enhancing RTO effectiveness in the 21st century.**

## Origins of NATO Science and Technology

Involvement of the North Atlantic Treaty Organization (NATO) in defense science and technology dates to the earliest days of the alliance. It was founded on the principles of international cooperation and security. Although neither science and technology nor research and technology are explicitly mentioned in any of the 14 North Atlantic Treaty articles, they are clearly implicit in Articles 2 and 3, which address "promoting conditions of stability and well-being" and achieving "the objectives of this Treaty . . . by means of continuous and effective self-help and mutual aid, (to) maintain and develop . . . capacity to resist armed attack."[1] In drawing the connection between promoting stability and providing for mutual aid for defense, the NATO charter laid the foundation for future cooperation among the alliance nations in defense science and technology. This unique cooperation has been a key element in establishing and maintaining the connection between the military and technology.

The first scientific and technical organization of the alliance was the Advisory Group for Aerospace Research and Development (AGARD), founded by Theodore von Karman in 1953. Von Karman was a powerful, if quiet, voice in establishing the post-World War II model of a military that was closely coupled with the scientific and technical community. He contended that "scientific results cannot be used efficiently by soldiers who have no understanding of them, and scientists cannot produce results useful for warfare without an understanding of operations."[2]

The mission statement of the AGARD Charter actively sanctioned the free exchange of militarily relevant scientific information to strengthen the NATO common defense posture and increase the scientific potential of member nations, thereby providing the essence of international technical cooperation for NATO that continues today.[3] Although commonly accepted now, this charter at the time represented significant new thinking for an international activity. Oversight and management of AGARD evolved somewhat over the years but generally consisted of a Board of Delegates, which reported to the NATO Military Committee, and various technical panels, which had oversight in their own areas. The Board of Delegates provided guidance to the technical panels and approved their program of work.[4]

A second scientific and technical organization within NATO, the Defense Research Group (DRG), was formed in 1967, also based on input from von Karman. DRG was created simultaneously with the Conference of National Armaments Directors (CNAD). Unlike

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AGARD with its research focus, the primary purpose of DRG was to foster technical cooperation among alliance nations that could lead to the development of future defense equipment. Also, unlike AGARD, which reported to the Military Committee, DRG reported to the newly created CNAD. At the highest level, DRG was made up of individuals from the alliance nations who had responsibility for national defense research and development. DRG featured eight panels and two special groups of experts.[5]

During the 1990s, senior leaders from the member nations and NATO headquarters increasingly perceived that unnecessary duplication existed between DRG and AGARD. There was also some concern about the number of individuals involved, which had grown to more than 1,000 scientists, engineers, and administrators. The consensus among several nations was that both the total number of people and unnecessary duplication needed to be reduced. In an effort to solve these problems, NATO Secretary General Javier Solana formally disbanded DRG and AGARD in April 1997 as part of a major restructuring of defense research and technology. The Research and Technology Organization (RTO) was then created, and it absorbed the duties of its predecessors.

## The Research and Technology Organization

Formed in 1998 by the merger of AGARD and DRG, the Research and Technology Organization is the primary NATO organization for defense science and technology. RTO reports to both CNAD and the Military Committee; it has both a board and technical panels; and it blends the research and technical missions of its predecessors. RTO promotes and conducts cooperative research and information exchange, develops and maintains a long-term NATO research and technology strategy, and provides advice to all elements of NATO on research and technology issues. In pursuit of this mission, RTO operates at three levels: the Research and Technology Board, technical panels, and technical teams. A Research and Technology Agency provides staff support to RTO

The *Research and Technology Board (RTB)* constitutes the highest authority in RTO. It is the policy body tasked by the North Atlantic Council through the Conference of National Armaments Directors and the Military Committee to serve as the single integrating body within NATO for the direction and/or coordination of defense research and technology. RTB consists of up to three members per NATO nation. The members are chosen by the nations and may be from government, academia, or industry, although the majority of members are from government. Board members are typically senior science and technology executives at the deputy under secretary, deputy assistant secretary, or deputy administrator level. RTB elects a chairman for a 3-year term from nominations submitted by the nations.

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*Technical panels* are composed of senior-level technical experts appointed by member nations. Panels have considerable autonomy and are charged with initiating, planning, and managing technical activities, subject to RTB approval, within their areas of responsibility. Each technical panel consists of up to three national members from each NATO nation. These members are chosen by the nations, with the majority coming from government. In addition, members-at-large, who may be required for a specific technical expertise, may also be appointed based on a panel request or recommendation. The total membership of a panel is limited to 60, however. National panel members typically have been government senior executive personnel with extensive science and technology responsibility and authority. Panel members-at-large most often have been internationally recognized experts of high technical stature from government, academia, or industry.

*Technical teams* are formed by the technical panels to perform specific tasks, which include organizing and hosting symposia, specialist meetings, workshops, lecture series, technical courses, and other activities. Technical team activities have clearly defined products and are limited in scope as well as duration, with 3 years being the maximum time a team may be in existence unless specifically extended by the board. Panel or board members appoint technical team members. Any significant change in activities or team membership requires board approval. At any given time, dozens of technical teams exist. Each team typically has multiple representatives from the nations coming from a variety of backgrounds and experience levels.

The *Research and Technology Agency (RTA)* provides RTO staff support. The multinational RTA staff numbers approximately 50 people. It consists of formal NATO positions and a larger number of positions that member nations voluntarily provide in an ad hoc manner. The assigned personnel may be civilian or military and either technical or administrative. RTA is led by a director whom RTB selects subject to approval by CNAD and the Military Committee in consultation with the Secretary General. The director is a full-time NATO employee.

## Benefits to RTO Nations

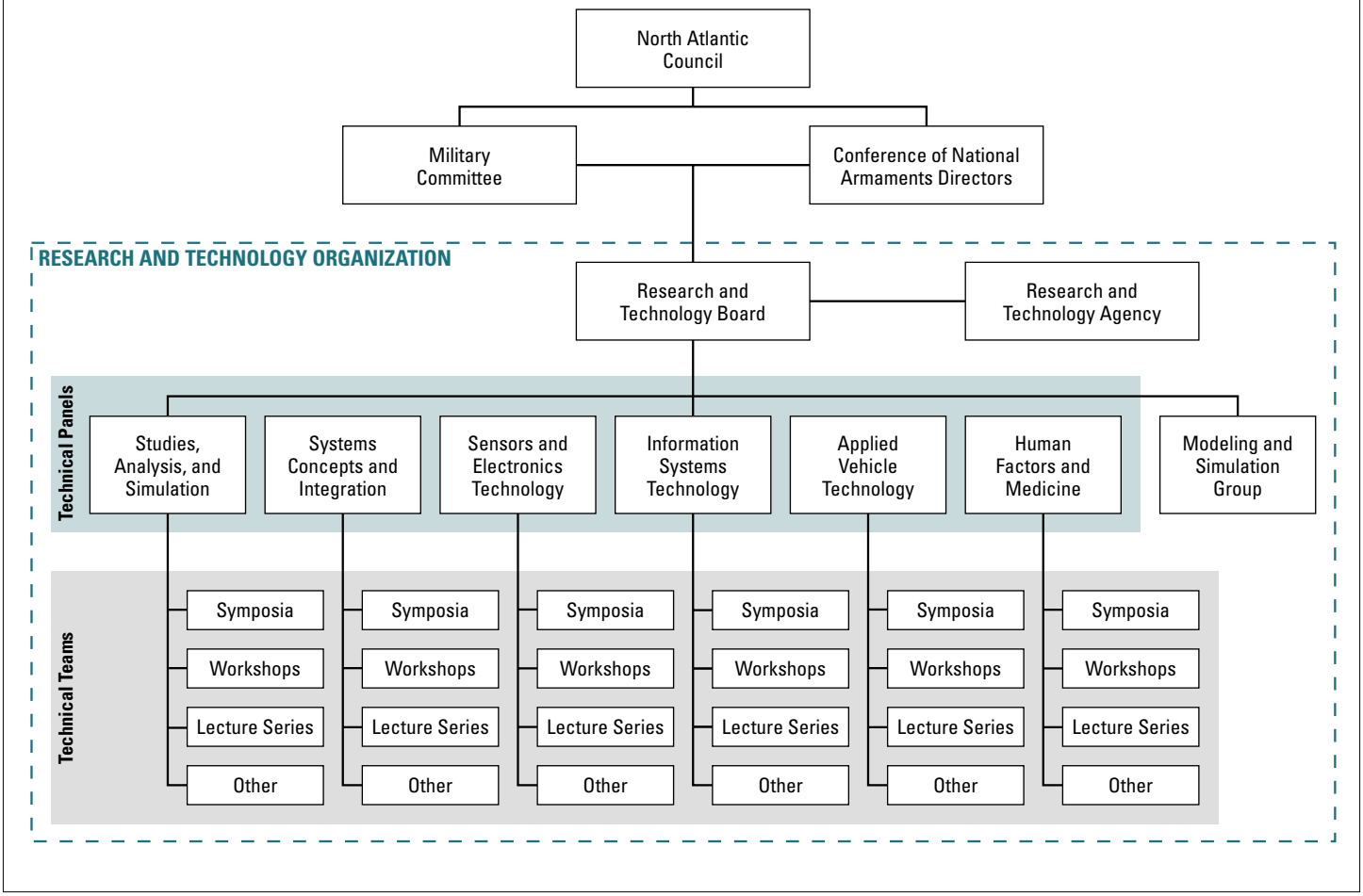
The RTO structure provides the framework for the greatest international scientific and technical cooperative mechanism for sharing of defense-related information of its kind. These research results lead, in turn, to significantly enhanced military capabilities of benefit to the entire alliance. As the NATO Standing Group communiqué to the AGARD Second General Assembly in 1952 declared:

> The research and development potential of the North Atlantic Treaty Nations is one of the greatest resources of the West. Any feasible pooling of these resources should achieve a greater rate of technical progress than would each nation working alone. *It is self-evident that any contribution to this rate of progress is a contribution of fundamental importance to NATO defence objectives.*[6]

### *Long-Term Relationships*

Progress in science and technology frequently is made with a long-term investment; often a decade or two passes before results appear outside the immediate technical community in the form of products or processes. Perseverance and steady advancement are key elements in the success of science and technology and lend

**NATO Defense Research and Technology Structure**




themselves to long-term international relationships that provide both new approaches to difficult problems and the scientific feedback necessary for progress.

RTO provides an exceptional opportunity for member nation senior executives, scientists, and engineers to establish long-term professional relationships. Regularly scheduled meetings in various nations over the years give participants the opportunity for repeated dialogue and exchange of ideas. Professional relationships and strong ties evolve based initially on common technical interests, but with continued contact, the relationships evolve further based on in-depth, personal knowledge of individuals and institutions. These solid relationships significantly enhance the prospects for resolving technical, or even political, issues.

### *Multiple Approaches to Technical Problems*

Difficult technical problems can most often be solved by having top-quality people take different approaches. Because schools of thought develop within institutions, the approach a senior specialist takes toward a technical problem can vary widely by geographic area, institution, or culture. For example, scientists and research engineers in some nations (especially those with limited funding) spend considerable amounts of time analyzing problems, whereas other scientists and research engineers with greater funding may move quickly to experimentation or even rudimentary concept development. Either approach may be the one that provides the timely breakthrough or ultimately provides a key element for the other's research program. With the participation of 19 nations and a combined membership possessing the highest technical capability in the world, RTO inherently provides superior access to various schools of thought and multiple technical approaches to many of the most difficult military problems.

### *Leveraged Resources*

Leveraging resources has always been at the heart of NATO. In 1945, von Karman concluded, "progress in technology was so swift that only a pool of nations could properly utilize scientific advances for mutual protection." This statement has as much validity today as it did over 50 years ago, and it continues to underscore NATO scientific and technical cooperation. By combining the financial and human resources as well as technical capacities of its members, NATO can make greater advances in defense science and technology

than any one nation working alone. As the NATO Standing Committee communiqué indicated to the Second AGARD General Assembly in 1952, "the research and development potential of the North Atlantic Treaty nations is one of the greatest resources of the West."[7]

### *Documented Results*

The foundation of any technology is the archival literature. Documenting the results of research conducted by thousands of its scientists and engineers is an essential element of the RTO mission. RTO (including its predecessors) is one of the largest scientific and technical publishers in the world, with well over 3,000 publications issued since 1952. These publications include focused volumes on defense-related technologies, extensive collections of symposia papers, and numerous workshop reports. Recent examples of the subjects of some of these publications include *Multisensor Image Exploitation*, *Active Control of Engine Dynamics*, *Future Modeling and Simulation Challenges and Integrated Mission System Concepts*, *and Technologies for Future Unmanned Combat Applications*. NATO members have access to all publications through RTA. Many are also available via the RTO Web site.

## Issues and Recommendations

Built on a foundation of international scientific and technical cooperation, the NATO Research and Technology Organization has achieved many successes in defense science and technology that have contributed significantly to NATO military capabilities. Since the November 2002 NATO Summit in Prague, even more opportunities exist to build on these past successes. Not only were seven new nations invited to join in accession talks for future membership in the alliance, but the North Atlantic Council also announced new NATO efforts at transformation—from streamlining its command structure to creating a NATO Response Force. RTO can and must play an integral role in working with the new strategic command for transformation and the NATO Response Force, the integration of the new members, and building relations with Russia.

### *Increased Defense Spending*

Proportionate leveraging of financial resources in defense science and technology is one of the most fundamental and important tasks for RTO. The gross domestic products of the United States and Europe are almost equal, at approximately $10 trillion. However, the United States outspends Europe almost 4 to 1 in defense research and technology. With a defense science and technology budget that approaches $10 billion per year, a multibillion-dollar laboratory infrastructure, and over 20,000 people employed in the laboratories, the U.S. investment is a formidable one. An already exceptional leveraging opportunity can clearly be enhanced by an increase in European defense budgets.

It is gratifying to see that, concerned by the growing capabilities gap between Europe and the United States, many European leaders have already taken steps to increase their defense budgets. France, Norway, Portugal, and the United Kingdom have submitted budgets with a boost in defense spending, ranging from 1.2 percent in the United Kingdom to 8.2 percent in France. The Czech Republic, Poland, and Hungary have also announced plans to increase their budgets. France's $13.3 billion proposed 2003 defense budget is especially significant since it includes an increase in research and development to $3.7 billion.[8]

### *Prioritization of Technical Areas*

RTO must achieve a balance of its activities across the spectrum of land, air, sea, space, and command, control, communications, computers, and information technologies. Because of its AGARD heritage, RTO activities perhaps continue to be too aeronautics-centric, and RTB must be more proactive in providing policy guidance to its panels to improve this situation. Perhaps the two major technical areas of opportunity are information technology and communications, which are also the two most dominant emerging areas demanding increased interoperability. These should be a top priority. Information technology is particularly appealing since it does not require large infrastructure investments. As Ann Miller, chair of the Information Systems Technology Panel, recently pointed out, "The playing field is more level between Europe and the U.S. industry when it comes to information technology."[9]

In setting research priorities, RTB must continue to listen carefully to its primary customers: the two strategic commands, the Military Committee, and the Conference of National Armaments Directors. These customers will become increasingly important as NATO transforms its forces and stands up the NATO Response Force. The new strategic command for transformation, announced at the Prague Summit, will be responsible for the continuing transformation of military capabilities and for the promotion of interoperability of alliance forces.[10] The formation of this command provides a unique opportunity to rapidly transition the right technologies with the highest impacts.

### *Interoperability*

One of the most critical issues that NATO has faced over the last 50 years has been improving military interoperability. RTO has excellent potential to increase interoperability from the research beginnings of a given technology. With appropriate RTB policy guidance, the technical panels can perhaps derive solutions to interoperability problems early in a technology's research and development cycle. Information technology and communications are two areas where interoperability is not only critical but also where technical opportunities may be highest. More opportunities for enhanced interoperability may also evolve as the defense industry becomes more multinational over time; RTO must stay in touch with this evolution through the NATO Industrial Advisory Group and foster cooperation within the framework of growing interoperability.

### *Integration of New Members*

At the NATO Summit in Prague, seven nations[11] were invited to begin accession talks to join NATO by May 2004. With their membership so close, RTO must formulate and implement plans to integrate these new members into a broad spectrum of technical activities. Their technical capabilities and desires must be considered equally, and proactive plans that are mutually beneficial to NATO and the new members must be put in place. The new members must understand from the beginning that their active participation in RTO is welcome and that their scientific and technical contributions are expected.

### *Outreach to Russia*

A major, proactive initiative by the RTO to Russia is perhaps overdue and could contribute significantly to security and stability in Europe and the world. Although RTO activities have been open to Russia for some time, the organization has yet to formulate and implement a proactive plan. With the eastward enlargement of NATO, increasing commonality in our national security interests, and the continuing excellent ability of Russian defense research and technology, now is the time.

### *Increased Longevity in Membership*

The key to establishing and maintaining the long-term relationships that are essential for the NATO defense science and technology program to flourish rests with the Research and Technology Board and technical panels. Because RTB formulates and directs NATO strategy for research and technology, RTB members must continue to come from the ranks of the most senior defense research and development organizations in the member nations. These board members must commit to the time and travel required to participate in semiannual board meetings, and they must be active participants.

Nations must also strive for the stability and longevity of their board members. For example, U.S. members have served on average only 2 years, with no current member having served continuously since the board's inception. Given the desirability of establishing long-term relationships within the scientific and technical community of the alliance nations, this matter requires increased attention.

### *Technical Panel Membership*

Membership on RTO technical panels also requires increased attention. Nations must appoint members who are prominent in their research and technology organizations and command appropriate resources to execute the programs put in place by their panels. Also, member nations must strive for continuity and appropriate longevity in panel membership. The average length of service for all U.S. members on technical panels, for example, is only 2 years. Nations individually and the alliance at large will benefit from longer terms.

## Conclusion

Allied cooperation in defense science and technology through the NATO Research and Technology Organization remains critical to the promotion of peace, stability, and security throughout the world. By encouraging international scientific and technical cooperation and by conducting research to maintain a technological lead in defense capabilities, NATO assures its active engagement and continued viability in the new strategic environment.

No international defense research and technology activity rivals RTO in scope, magnitude, or potential. As NATO enlarges and takes on new missions, the common language of scientists and engineers will offer a mechanism for exchange and growth in a world that will continue to be dominated by technology. It is imperative that the technical arm of NATO grasps this opportunity and remains a key ingredient in our collective security.

## *Notes*

[1] Article 2 of the NATO Charter states, "The Parties will contribute toward the further development of peaceful and friendly international relations by strengthening their free institutions, by bringing about a better understanding of the principles upon which these institutions are founded, and by promoting conditions of stability and well-being." Article 3 adds, "In order more effectively to achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack."

[2] Theodore von Karman with Lee Edson, *The Wind and Beyond: Theodore von Karman, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown and Company, 1967).

[3] Jan Van der Bliek, ed., *AGARD, The History 1952–1997* (Essex, UK: SPS Communications, 1999). The elements of the AGARD Charter were to:

- recommend effective ways for member nations to use research and development capabilities for the common benefit of the NATO community
- provide scientific and technical advice and assistance to the Military Committee in the field of aerospace research and development (with particular regard to its military application)
- continuously stimulate advances in the aerospace sciences relevant to strengthening the common defense posture
- improve the cooperation among member nations in aerospace research and development
- exchange scientific and technical information
- provide assistance to member nations for the purpose of increasing scientific and technical potential
- render scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field.

[4] The number and titles of the AGARD technical panels varied over the years, but, for the most part, seven were organized around the following areas: aerospace medicine, flight vehicle integration, fluid dynamics, mission systems, propulsion and energetics, sensors and propagation, and structures and materials. The technical panels were made up of experts in the various fields from most member nations. Total membership varied, but by the late 1990s was approximately 500 people. The technical panels had considerable autonomy subject to board approval in the formulation and execution of their programs.

[5] The DRG panels, made up of senior laboratory directors and administrators, were long-term scientific studies; physics and electronics; optics and infrared; operational research; human and biomedical sciences; electronic warfare; air defense; and information processing technology. The two special groups of experts were concealment, camouflage, and deception; and combat engineering technology. Total membership varied, but by the late 1990s was approximately 500 people.

[6] Van der Bliek. Emphasis added.

[7] Ibid.

[8] "France Increases Defense Spending Through 2008," *Defense Daily*, September 12, 2002.

[9] G. Ratman and A. Svitak, "How Europe Can Close the Gap," *Defense News,* August 5–11, 2002.

[10] Prague Summit Declaration, issued by the heads of state and government participating in the meeting of the North Atlantic Council, Prague, November 21, 2002.

[11] Bulgaria, Estonia, Latvia, Lithuania, Romania, Slovakia, and Slovenia.

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