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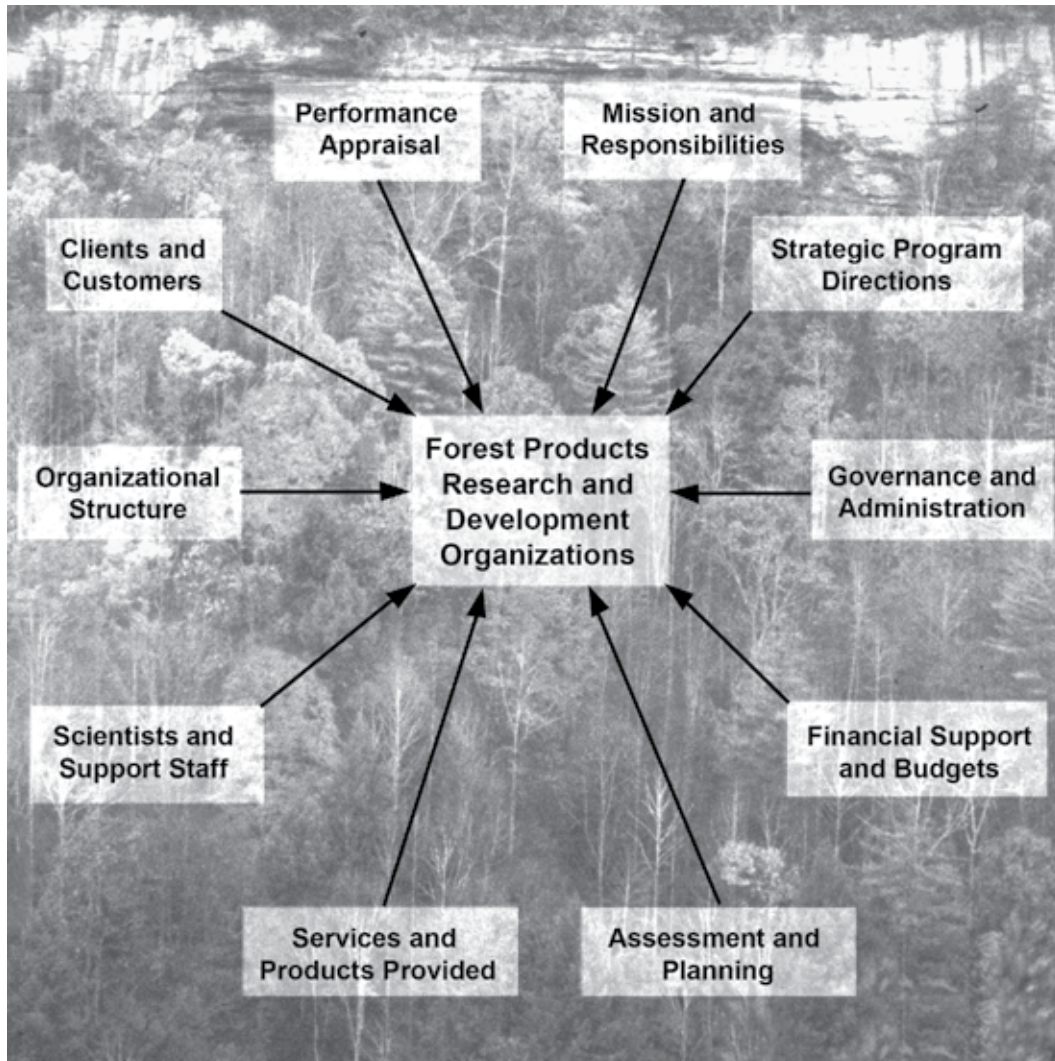
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Forest Products Research and Development Organizations in a Worldwide Setting: A Review of Structure, Governance, and Measures of Performance of Organizations Outside the United States

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Abstract

Located in 23 countries, 40 forest-products research and development organizations outside the United States were reviewed in 2004 and 2005. The intent was to obtain a better understanding of how such organizations are structured and administered and their performance judged. Investing over \$600 million annually, the 40 organizations employed 7,000 to 7,500 scientists and supporting staff. Especially noteworthy about the organizations are the many ways in which they identify themselves (such as institutes, laboratories, centers); their long history of sustained involvement in forest products research; and their movement from public to private ownership (whole or in part). The distinction between public and private sector responsibility for research is blurry with these organizations, as often they have public sponsorship, yet private operation and management. They offer a wide range of services to clients yet have complex ownership and partnering arrangements. Their organizational structures are seemingly scrambled with forest product research subunits located within larger parent organizations (with broad multisector research responsibilities) and specialized services to a single major group of clients. These organizations have an intense desire to meet the needs of clients, and feature the following: synthesis of existing information as an important service; fees charged for services provided; strategic

interest in clients located throughout the world; educational and degree-granting activities; multiple sources of income and revenue; diverse standards for measuring performance; adept response to broad economic-social changes; multiple location of physical facilities; and differing degrees of publicly available information describing mission and operation of organizations.

Keywords: forest products research, research organizations, organization structure, conduct and performance

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Executive Summary

In 2004 through 2005, we reviewed forest products and related research organizations beyond the boundaries of the United States with the intention of better understanding how such organizations are structured and administered and their performance judged. Ninety-three research organizations were initially identified for consideration by the review, 40 of which were chosen as case examples (located in 23 countries) and subsequently described in substantial detail. Provided with widely accepted principles of administration and organizational design, the lead administrators of the case-example organizations willingly provided advice about structural, managerial, and performance conditions necessary for a forest products research enterprise to effectively accomplish its mission.

The case-example organizations operated primarily as private independent research organizations (25 of 40), although 11 of these private organizations were legally authorized by, but operated independently of, government. The remainder was either government organizations or government organizations operating as independent entities. Organizational missions were dominated by interest in industry competitiveness, advancing scientific frontiers, contributing to national economic needs, supporting the technical and managerial needs of clients, and promoting resource utilization and sustainability. Organizational governance was exercised through independently empowered panels, direction from a larger parent organization, and authorities exercised by chief executives. Nearly all the case example organizations operated with one or more advisory committees. Structurally, organizational patterns included traditional hierarchies, horizontal patterns with few organizational layers, orientation around client demand for skills and information, units of strategic alliances such as partnerships and joint ventures, and forest products research entities located within a larger diversified (multisector) research organization.

Public and private clients were of interest to the case-example organizations, although many emphasized services to their owners or members. Research was the most common service provided to clients, although the organizations also provide consultation, information, training, testing, education, certification, and pilot scale production. As for research programs, 22 of the case-example organizations focused on forest products research and 11 on forest management research. Fewer than six organizations engaged in solid wood products research as well as pulp and paper research. Those engaged in forest products research tended to direct attention to pulp and paper, wood composites, furniture, engineered structures, and wood processing and preservation. As for forest management research, the focus was primarily on fiber production, forest protection, economic analysis, harvest systems, and fish and wildlife.

Financial information about research investments made by the case-example organizations was uneven in quality and often not publicly available (proprietary). However, the 2004 combined investment in forest products and related research made by 28 of the case-example organizations was in the range of 385 to 425 million U.S. dollars. Forty to 50% of these investments were made by private research organizations. The case-example organizations employed an estimated 7,000 to 7,500 scientists and supporting staff, although most employed less than 100 staff (three organizations report a staff of more than 400). The source of financial support was dominated by membership dues and similar assessments, fees and related charges for services provided, core funding provided by government agencies, in-kind services provided by government and private entities, and grants obtained from competitive processes. Very few organizations relied strictly on annual guaranteed funding by government.

Annual listings of research publications and written highlights of past research accomplishments were widely used as measures of performance. Other performance measures were the number of educational offerings, number and satisfaction of clients, statements of assets–liabilities and profits–losses, number of patents granted, process and product adoption rates, and a parent organization’s expressed approval of past performance. Some case-example organizations were especially sensitive to accomplishment of previously established targets (patents granted, seminars sponsored, joint ventures established), managerial and administrative health of an organization (staff turnover, new members), and contributions to broad social and economic conditions that are considered important to a country’s well-being (health and safety of employees, minorities and women employed, employee leadership training, support of nonprofit organizations).

The organization and administration of forest products and related research organizations in the United States can benefit from the experiences of similar organizations located beyond the nation’s boundaries. In this respect, especially noteworthy among foreign organizations engaged in forest products research are the many ways in which they identify themselves (such as institutes, laboratories, centers); long history of sustained involvement in forest products research; movement from public to private ownership (whole or in part); blurry distinction between public and private sector responsibility for research; public sponsorship, yet private operation and management; wide range of services available to clients; complex ownership and partnering arrangements; seemingly scrambled organizational structures; extensive use of subsidiaries and joint ventures; forest product research subunits located within larger parent organizations (with broad multisector research responsibilities); specialized services to a single major group of clients; intense

desire to meet the needs of clients; synthesis of existing information as an important service; fees charged for services provided; strategic interest in clients located throughout the world; engagement in educational and degree-granting activities; multiple sources of income and revenue; diverse standards for measuring performance; adept response to broad economic-social changes; multiple location of physical facilities; and differing degrees of publicly available information describing mission and operation of organizations.

Forest Products Research and Development Organizations in a Worldwide Setting: A Review of Structure, Governance, and Measures of Performance of Organizations Outside the United States

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Purpose and Method of Review

The United States annually consumes more than 555 million cubic meters of roundwood equivalent and requires the services of a forest products sector that contributes more than \$116 billion in gross value added to the nation's economy (1.3% of national total) (Howard 2003). These economic contributions are made possible by the employment of nearly 1.2 million persons. Investments in research and development support scientific innovation within the forestry and forest products sectors. An estimated \$400 million was so invested in 2002, although the total might well exceed \$500 million (National Research Council 2002). These financial resources sustained the research activities of nearly 2,200 scientist full-time equivalents (FTEs) located at universities, forest industry research centers, and various stations and laboratories of the USDA Forest Service. Investments in research and development are critical to gains in available timber supplies and to the more efficient use of wood as a raw material. Likewise, they are essential to long-term enhancement of environmental quality and to nationwide advances in economic and social welfare generally.

The ability of forestry and forest products research to contribute to the nation's well-being requires that research organizations be well organized, effectively managed, and held to high standards of performance. A number of conditions suggest that the research community may well experience important—possibly dramatic—changes in the way it carries out future research responsibilities. Consider, for example, possible redefinition of public responsibility for research and likely reductions in the role of the public sector in research generally; greater variety in the clients that seek the products of research and the subsequent broadening of research and development agendas; increased emphasis on

environmental values and a movement away from commodity-focused research to research programs that are systems-focused; increased potential for the commercial profitability of research results, leading to more private proprietary initiatives conducted “in-house;” decline in traditional organizational structures based on hierarchy and subsequent proliferation of organizations “without walls” (worldwide web of researchers); modification of funding sources and funding instruments, leading to less reliance on public funds and more reliance on user-pay systems; recognition of the importance of cooperative arrangements, resulting in the strengthening of public-private partnerships and of private sector joint ventures; and increasingly rapid technological advancements (especially outside the forest products sector) affecting the focus of research programs and the way they are implemented (Alston and others 1997, Arnold and others 1998, Billings and others 2004, Coccia 2004, Cohen and Kozak 2002, Duysters and others 1999, Goldman and others 1997, Ingham and Mothe 1998, Nair and others 1998, U.S. Government Accountability Office 2006).

Objectives and Scope

A review of forest products and related research organizations beyond the boundaries of the United States was carried out in 2004–2005. The objective of the review was to obtain a better understanding of how such organizations are structured, administered and judged, with an eye toward identifying conditions that might be of value to similar organizations that operate in the United States. Of special interest were those conditions that seemed especially innovative and forward-looking, and that, if adopted, might improve the way forest products and related research programs in the United States address the aforementioned challenges.

In order to focus the review, three major topical areas were of interest (Bain 1959, Consultative Group on International Agricultural Research 1997):

Structure: How are research establishments organized?

Focus on

- Authorities (laws, policies, rulings, directives)
- Governance (autonomous, governing body)
- Hierarchy (functional, territorial, service)
- Affiliations (partnerships, joint ventures, alliances)
- Clients (type, number, demands, support for organization)
- Budgets (size, focus, trends)
- Staff (size, expertise, tenure, education)

Conduct: How do research establishments function or operate?

Focus on

- Managing direction (values, mission, issues, planning)
- Exercising leadership (vision, commitment, tenure, building support)
- Managing budgets (promoting, formulation, documentation, execution)
- Structuring decision making (ad hoc, centralized, multiple advocacy)
- Human resources (recruitment, evaluation)
- Managing external environment (networks, coordination)

Performance: How well do research establishments meet standards or benchmarks?

Focus on

- Public acceptance (trust, integrity, fairness)
- Adaptability (developments in economy, technology, policies)
- Competence (professional)
- Decision making (consistency, participation, representation, networking)
- Economic efficiency (time, costs)
- Accountability (directives, clients, higher authority)
- Service and product quality (focused, useful, current, progressive)

The review and the observations drawn from it were sensitive to the reality that research programs in other countries are designed and administered to fit comfortably within each nation's unique economic, political, and natural resource setting. As such, the experiences of the foreign research establishments reviewed here should not be uniformly considered applicable to all conditions in the United States.

Methods and Procedures

Identification and Description of Organizations

Located in countries other than the United States, 93 research organizations were initially identified for consideration by the review. They were identified from a number of

sources, including web sites, annual reports, contact with research organization administrators and officers, and examination of various organizational directories and encyclopedias. Forty of the organizations were subsequently chosen as case examples (located in 23 different countries) (Appendix A and B). They were chosen because they provided representation from many countries worldwide, provided for a healthy mixture of public and private sponsorship, permitted review of a variety of different missions and research programs, and furnished opportunity for examination of diverse organizational structures and administrative procedures. Although the remaining 53 organizations appeared to have innovative organizational and administrative characteristics, information about them was very limited or the information that was available was in a language other than English (a listing of these organizations can be found in Ellefson and others 2005).

For each of the case-example organizations, a draft narrative of their structure and administration was prepared. The lead administrator of each organization was subsequently contacted and asked to screen the narrative for accuracy, completeness, and timeliness (administrators from 30 organizations were thoughtful enough to respond with corrections). In some cases, lead administrators were asked to review the narratives more than once (often 4 to 5 times). Changes were subsequently made in the draft narratives.

Identification and Review of Potential Structures

Other (possibly more suitable) ways of structuring and administering research organizations were identified and subsequently examined (Ellefson and others 2006). Doing so involved identification of (a) conceptually sound qualities of an effective organization (relying on literature focused on organizations generally and on forestry and forest products research organizations specifically, see Appendix C) and (b) attributes experienced research program administrators regard as important to the operation of an effective research organization. For the latter, the lead administrator (president, managing director, chief executive office, director general, or chief operating officer) of each case-example organization was contacted. Thirty administrators were thoughtful enough to respond with unusually forthright commentaries.

Synthesis and Reporting of Information

With the intent identifying especially promising patterns in the structure, conduct, and performance of forest products and related research organizations, the information gathered from the aforementioned sources was organized with the following information: date constituted, public or private entity, primary research focus, governance and organization, strategic program directions, client groups, services provided, budget and funding sources, scientists and supporting staff, measures of performance. After careful examination of actual and potential conditions of structure, conduct, and

performance, meaningful patterns were described in detail and subsequently reported. A significant portion of the information subject to the synthesis is presented in detail in Appendix A and B.

The review generated important information that should be useful to administrators of forest products and related research programs in the United States. However, its shortcomings need to be acknowledged. Some research establishments were excluded from consideration because information about them was not publicly available (for example, information about financing and employees was often proprietary) or was available in a language other than English. Information about each organization was not always common to a single year, although most information reflects conditions occurring during the period 2003 through 2005. In some cases, request for information from program administrators was ignored (or disregarded), whereas in other cases administrators were simply unable to interpret and subsequently respond to the requests. As such, information voids occur in certain cases (for example, performance indicators). Separating forest products research from other research programs also posed difficulties for the review. Forest products research is very often described as part of a forest research program generally or as part of a broader research program that encompasses various industrial sectors (construction, packaging, transportation) or many overarching technologies (biotechnology, modeling, simulation). These shortcomings aside, the review is offered as a reasonable description of many forest products and related research organizations that are located beyond the boundaries of the United States.

Organizations and Countries

The 40 case-example organizations are located in one of 23 different countries, with most frequent representation being Finland and Sweden (each with four organizations) followed closely by Australia, Canada, and Norway (each with three organizations) (Table 1, Appendix A). Although having engaged in frequent merger and realignment activities over the years, the reported dates of establishment for the case-example organizations are distributed as follows (dates for three organizations not available): 1900–1939, 7 organizations; 1940–1979, 17 organizations; and 1980–2004, 13 organizations. Many of the 40 organizations have long, involved histories. For example, although the Swedish Institute of Wood Technology (Trätekt) merged with the Swedish National Testing and Research Institute, Statens Provningssanstalt (SP), in 2004 to form SP-Trätekt, Trätekt's roots as an organization can be traced to the mid-1800s. Similarly, Forintek Canada (**F**orest, **I**ndustry, **T**echnology) can trace its origin to the Canadian Forest Products Laboratory, which was established in 1915. And though formally reconstituted in 1945, the origin of the Taiwan Forestry Research Institute can be traced to the late 1890s. Also engaged in research and development for many years are organizations such as

the Forestry and Forest Products Research Institute of Japan established in 1905, KCL of Finland in 1916, Finnish Forest Research Institute (Metla) in 1917, and the Norwegian Forest Research Institute in 1917.

The research and development programs of the case-example organizations vary considerably in their focus (Table 1). At the risk of suggesting exclusive operation in one program area, the following distribution by major program area indicates that some organizations focus primarily on forestry matters, others on forest products initiatives, while yet others blend these major program areas: Forest product, 21; forest products and modest forestry, 1; forest products and forestry, 10; forestry and modest forest products, 4; forestry, 4.

Within these broad categories, substantial specialization can occur. For example, within the forest products category are at least three organizations that emphasize specialties involving pulp and paper: Finland's KCL, the French Pulp and Paper Research and Technical Centre (Metla), and the Paper and Fiber Institute (PFI) of Norway. Also within the forest products category are specializations in engineered products; for example, the Timber Research and Development Association (TRADA) of the United Kingdom and panel products (for example, Poland's Research and Development Centre for Wood-Based Panels). In contrast, some of the case-example organizations are quite diversified in their research and development interests. Again in the forest products category, the Swedish Trätekt programmatically addresses researchable problems involving milling, housing, furniture, and board products, while Sweden's Pulp and Paper Research Institute-Institute for Packaging and Logistics (STFI-Packforsk) directs research attention to a wide variety of packaging issues as well as to a number of very focused subjects involving the manufacture of pulp and paper.

The 40 case-example organizations make substantial public and private investments in research and development. For 27 of the 40 organizations for which budget information is available, the combined 2004 investment in forest products and related research was in the range of \$385 to \$425 million, of which 40% to 50% can be traced to investments made by private sector research and development organizations (Table 1). If budget information were available for all 40 organizations, total annual investment would likely exceed \$600 million. The 40 case-example organizations employed an estimated 7,000 to 7,500 scientists and supporting staff in 2004. Because of absent reporting, fluctuating exchange rates, and differences in reporting staff capacity, these estimates should be viewed with caution.

Demographic and Resource Context

Demographic, economic, and resource conditions can be major factors explaining whether or not research and development organizations exist within a country, and, if such organizations do exist, the type and intensity of forest

Table 1. Forest products and related research organizations (case-examples), by country, budget, and program focus, 2004–2005

| Organization | Country | Date established | Budget-income (million US\$) | Program focus |
|---|-----------|------------------|------------------------------|--|
| Cooperative Research Center for Sustainable Production Forestry (CRC) | Australia | 1997 | 2.2 | Forestry |
| Cooperative Research Center for Wood Innovations (CRC) | Australia | 2001 | 8.1 | Forest products |
| Ensis | Australia | 1949 | NA | Forest products and forestry |
| Holzforchung Austria (HFA) | Austria | 1953 | 4.4 | Forest products |
| Forest Engineering Research Institute of Canada (FERIC) | Canada | 1975 | 10.2 | Forestry |
| Forintek Canada Corporation (Forintek) | Canada | 1979 | 24.4 | Forest products |
| Pulp and Paper Research Institute of Canada (Paprican) | Canada | 1930 | 34.0 | Forest products, modest forestry |
| Research Institute of Wood Industry (CRIWI) | China | 1957 | NA | Forest products |
| European Forest Institute (EFI) | Finland | 1993 | 3.0 | Forestry, modest forest products |
| Finnish Forest Research Institute (Metla) | Finland | 1917 | 58.9 | Forestry, modest forest products |
| KCL (Oy Keskuslaboratorium-Centrallaboratorium Ab) | Finland | 1916 | 28.6 | Forest products, emphasis pulp and paper |
| Technical Research Center of Finland (VTT) | Finland | 1942 | NA | Forest products, modest forestry |
| Association Forest Cellulose (AFOCEL) | France | 1962 | 7.8 | Forestry and forest products |
| French Pulp and Paper Research and Technical Center (Centre Technique du Papier, CTP) | France | NA | 13.6 | Forest products, emphasis pulp and paper |
| Federal Research Center for Forestry and Forest Products (BFH) | Germany | NA | NA | Forest products and forestry |
| Institute of Wood Technology (Institut für Holz- und Papiertechnik, IWT) | Germany | 1952 | 6.0 | Forest products |
| National Council for Forest Research and Development (COFORD) | Ireland | 1993 | 2.1 | Forest products and forestry |
| Forest Products and Forestry Socio-Economic Research and Development Center | Indonesia | 1983 | NA | Forest products |
| Forestry and Forest Products Research Institute of Japan (FFPRI) | Japan | 1905 | 90.0 | Forest products and forestry |
| Hokkaido Forest Products Research Institute (HFPRI) | Japan | 1950 | NA | Forest products |
| Forestry Research Institute (Silava) | Latvia | 1946 | NA | Forestry, modest forest products |
| Forest Research Institute Malaysia (FIRM) | Malaysia | 1985 | 7.5 | Forest products and forestry |

| Organization | Country | Date established | Budget-income (million US\$) | Program focus |
|--|-----------------|------------------|------------------------------|--|
| Stichting Hout Research (SHR Timber Research) | Netherlands | 1991 | 2.9 | Forest products |
| SCION Crown Research Institute | New Zealand | 1947 | 26.2 | Forestry and forest products |
| Wood Technologies Research Sector, Industrial Research Limited (IRL) | New Zealand | 1992 | NA | Forest products |
| Norwegian Forest Research Institute (Skogforsk) | Norway | 1917 | 11.4 | Forest products and forestry |
| Norwegian Institute of Wood Technology (NTI) | Norway | 1949 | 4.6 | Forest products |
| Paper and Fiber Research Institute (PFI) | Norway | 1923 | 4.1 | Forest products, emphasis pulp and paper |
| Forest Products Research and Development Institute (FPRDI) | Philippines | 1954 | NA | Forest products |
| Research and Development Centre for Wood-Based Panels | Poland | 1974 | NA | Forest products, emphasis on panels |
| Forest Research Institute (Institutum Forestale Zvolen, FRI) | Slovak Republic | 1948 | 1.8 | Forestry, modest forest products |
| Forestry and Forest Products Research Center (FFP) | South Africa | NA | NA | Forest products and forestry |
| Institute for Commercial Forestry Research (ICFR) | South Africa | 1984 | 2.0 | Forestry |
| Forestry Research Institute of Sweden (SKOGFORSK) | Sweden | 1992 | 14.0 | Forestry |
| Swedish Institute for Wood Technology (SP-TRATEK) | Sweden | 2004 | 8.3 | Forest products, emphasis milling, housing, furniture, board |
| Pulp and Paper Research Institute-Institute for Packaging and Logistics (STFI-Packforsk) | Sweden | 2003 | 31.3 | Forest products, emphasis packaging, pulp and paper |
| Swedish Wood Ultrastructure Research Center (WURC) | Sweden | 1996 | 2.3 | Forest products |
| Swiss Federal Laboratories for Material Science and Testing (EMPA) | Switzerland | 1938 | 2.0 | Forest products |
| Taiwan Forestry Research Institute | Taiwan | 1945 | NA | Forestry and forest products |
| Timber Research and Development Association (TRADA) | United Kingdom | 1962 | 1.1 | Forest products, emphasis engineered products |

NA = Information not available.

Note: In 2007, Canada's FERIC, Forintek, and Paprican merged to form FPInnovations; in 2005, Australia's CRC reorganized to become the Cooperative Research Center for Forestry; and in 2006, Norway's Skogforsk reorganized to become the Norwegian Forest and Landscape Institute.

products and related research that is undertaken. Exactly how these factors exert such influence is difficult to fix conclusively. Focusing on the 40 case-example organizations, it appears that those countries whose forest sector contributes more than 3% to their nation’s gross domestic product tend to have a greater number of major research and development organizations engaged in forest products and related research (for example, Canada, three organizations; Finland, four organizations; New Zealand, two organizations; Sweden, four organizations) (Table 2).

However, this is not always the case. For example, 4.7% of Malaysia’s gross domestic product is attributable to the nation’s forest sector, yet the country has only one (of the 40 reviewed) major forest products and related research organization. Conversely, Norway’s forest sector accounts for only 1.1% of the nation’s gross domestic product, yet it has three such organizations. The relationship between other parameters (land area, population, gross national product (GNP) per capita, forest cover, roundwood removal, forest sector employment) and the number of research and development agencies in a country is also inconclusive and risky to judge. In part, identifying hard contextual relationships such as these fail because some countries have chosen to have a number of smaller research organizations rather than one large organization, or they may have established a single research and development organization that views the world as the market for their services—not just clients located within their country’s boundaries.

Structural and Administrative Patterns

Organization and Governance

Public and Private Position

Forest products and related research organizations exist and operate because they have been granted authority to do so by a free market system or by authority awarded to them by a public governing body. Some are strictly private enterprises (for example, SHR Timber Research, Netherlands) that are beholden to markets within which clients must be sought for the services that a research enterprise is capable of providing. Others are solidly part of government (for example, Forestry and Forest Products Research Institute of Japan). They must rely on the impulses of government for direction and the generosity of government for financial support. Within these extremes lies most forest products and related research organizations, as do most of the 40 case-example organizations reviewed here (Table 3): private independent, 14; private independent, government authorized, 11; private-public independent, joint venture, 2; public government, independent, 2; and public government, 11.

Organizations identified here as private independent (12 of the case examples) are not all totally independent of government. For example, the Forestry Research Institute of

Sweden (Skogforsk) operates as a government-sanctioned foundation subject to various laws that govern private companies generally (legal responsibilities; prerequisites for membership, financing and accounting; governing board representation) (Table 3). Similarly, France’s Association Forest Cellulose (AFOCEL) is considered a private entity, yet its structure and operations are governed by the 1901 French Law on Associations (specifies structure, reporting, and governance). Research organizations that tend to be more toward truly private and independent are the German Institute of Wood Technology (IWT) (corporately owned by shareholding organizations comprised of 72 private companies and associations), and the United Kingdom’s TRADA (annually audited in accord with the Companies Act of 1985 which specifies legal, financial, and regulatory standards for private concerns).

Although the government-authorized, private independent organizations identified here (13 of the case examples) may be classified as private for purposes of analysis, through complex intertwined legal connections, their authority to exist and operate is in reality solidly within the purview of government. An example is ENSIS of Australia, which is a joint venture involving Australia’s government-authorized CSIRO (Commonwealth Scientific and Industrial Research Organization) and New Zealand’s SCION (formally Forest Research, Ltd.), which was government-authorized by the Crown Research Institute Act of 1992 (Table 3). The Swedish SP-Träteck, which is reportedly a government authorized, independent entity (a “limited company”), is a government organization because all the organization’s corporate shares are owned by the Swedish government. A more exacting example of a private independent, but government authorized, research organization is Ireland’s National Council for Forest Research and Development (COFORD), which is authorized by Ireland’s National Development Plan (2000–2006) and is organizationally situated within the federal government’s Department of Agriculture and Food.

Some research entities may be viewed as independent private–public concerns that are organizationally set up as a joint venture or similar arrangement (two of the case examples) (Table 3). Their existence proceeds from authority granted by those that are party to the joint venture. An example is the Swedish Wood Ultrastructure Research Centre (WURC) which is jointly sponsored by the National Board for Industrial and Technical Development, Swedish University of Agricultural Sciences, Chalmers University of Technology, Royal Institute of Technology, Swedish Pulp and Paper Research Institute-Institute for Packaging and Logistics (STFI-Packforsk), six companies from the Swedish pulp and paper industry, and one company from the Swedish chemical industry. Another example of a public–private entity is South Africa’s Forestry and Forest Products Research Centre (FFPRC), a joint venture between the University of Kwa Zulu-Natal and the Division of Water, Environment,

Table 2—Demographic economic, forest resource and forest industry conditions by selected countries, 2003–2004.

| Country | Demographic and economic conditions | | | Forest and forest industry conditions | | | |
|---------------------|-------------------------------------|-----------------------------------|---|---------------------------------------|--|--|--|
| | Land area ^a (000 ha) | Population ^b (000s) | GNP ^c per capita (U.S.\$) | Forest cover ^d (000 ha) | Annual roundwood removals ^e (000 cm) | Gross value added by forest sector (million U.S.\$) | Forest sector employment (000s) ^g |
| Australia | 768,230 | 18,701 | 19,689 | 154,539 | 29,826 | 14,930 [0.9] ^f | 73 |
| Austria | 8,273 | 8,177 | 29,309 | 3,886 | 17,055 | 3,744 [2.2] | 60 |
| Canada | 922,097 | 30,857 | 19,267 | 244,571 | 194,727 | 19,843 [3.2] | 373 |
| China | 932,743 | 1,274,106 | 668 | 163,480 | 286,107 | 14,930 [1.3] | 3,118 |
| Finland | 30,459 | 5,165 | 26,020 | 21,935 | 53,779 | 7,914 [7.5] | 91 |
| France | 55,010 | 58,886 | 27,437 | 15,341 | 36,850 | 8,249 [0.7] | 165 |
| Germany | 34,927 | 82,178 | 30,133 | 10,740 | 51,182 | 15,252 [0.9] | 372 |
| Ireland | 6,889 | 3,705 | 17,739 | 659 | 2,683 | 581 [0.7] | 13 |
| Indonesia | 181,157 | 209,255 | 1,096 | 104,986 | 112,004 | 3,977 [2.5] | 562 |
| Japan | 37,652 | 126,505 | 43,574 | 24,081 | 15,290 | 43,477 [0.9] | 514 |
| Latvia | 6,205 | 2,389 | 2,815 | 2,923 | 12,916 | 306 [4.9] | 50 |
| Malaysia | 32,855 | 21,830 | 4,469 | 19,292 | 21,337 | 3,694 [4.7] | 189 |
| Netherlands | 3,392 | 15,735 | 27,402 | 375 | 1,044 | 2,383 [0.7] | 35 |
| New Zealand | 26,799 | 3,828 | 15,233 | 7,946 | 21,399 | 1,837 [3.9] | 34 |
| Norway | 30,683 | 4,442 | 35,947 | 8,868 | 8,302 | 1,632 [1.1] | 29 |
| Philippines | 29,817 | 74,454 | 1,170 | 5,789 | 15,988 | 590 [0.9] | 63 |
| Poland | 30,442 | 38,740 | 3,472 | 9,047 | 28,835 | 1,840 [1.3] | 163 |
| Slovak Republic | 4,808 | 5,382 | 3,645 | 2,177 | 6,355 | 453 [2.7] | 46 |
| South Africa | 121,758 | 39,900 | 3,377 | 8,917 | 30,616 | 1,856 [1.6] | 172 |
| Sweden | 41,162 | 8,892 | 25,685 | 27,134 | 67,300 | 6,912 [3.4] | 103 |
| Switzerland | 3,955 | 7,344 | 46,448 | 1,199 | 4,800 | 3,329 [1.5] | 69 |
| Taiwan ^h | 56,253 | 22,894 | 25,300 | 3,592 | — | — | — |
| United Kingdom | 24,160 | 58,974 | 19,946 | 2,794 | 7,835 | 9,696 [0.8] | 192 |
| United States | 915,895 | 276,218 | 28,310 | 225,993 | 448,059 | 116,014 [1.3] | 1,154 |

^a Land area (1998).^b Population (1999).^c Gross National Product (GNP) per person (1997).^d 2000 forest cover from Food and Agricultural Organization, United Nations (2001).^e Roundwood removal (production) (2003) information from Food and Agricultural Organization, United Nations (2005).^f Numbers in []s are percentage contribution of forestry and forest industry sectors to gross domestic product in 2000.^g Forestry sector employment (forestry and logging, manufacture of wood products, and paper and paper products) (2000) from Food and Agricultural Organization, United Nations (2004).^h Where otherwise not available, information for Taiwan is incorporated in information for China.

and Forestry Technology of the Council of Scientific and Industrial Research (CSIR) (see Appendix A and B).

Research organizations may also be solely within the purview of government, yet may operate as a self-governing autonomous government entity (two of the case examples) (Table 3). An example is the Swedish Skogforsk, which is organizationally located within the Ministry of Agriculture

of the Norwegian federal government. Similarly, the Latvia State Forestry Research Institute (Silava) is an independent nonprofit organization responsible in a very limited fashion to the federal government's Ministry of Education and Science. Both of these organizations have considerable flexibility to determine research directions. The latter does not receive annually guaranteed funding for its programs (see Appendix A and B).

Table 3—Forest products and related research organizations (case examples), 2004–2005

| Organization, Country | Public–private sector | Mission | Governance and organization |
|--|--|---|---|
| Cooperative Research Center for Sustainable Production Forestry (CRC), Australia | Private independent, government authorized | Enhance viability of industry through research | Governing board, center director, advisory bodies, three organizational units for research, and one for education |
| Cooperative Research Center for Wood Innovations (CRC), Australia | Private independent, government authorized | Develop applied technologies to benefit industry | Governing board, center director, three management specialists, director of research, independent intellectual |
| Ensis, Australia | Private independent, government authorized | Address complex problems to help sector remain globally competitive | Parent organizations (CSRIO, SCION), chief executive, seven research units, subsidiaries and joint ventures |
| Holzforchung Austria (HFA), Austria | Private independent | Strengthen innovation through research, testing, and technology transfer | Institute head, managing director, 11 research units |
| Forest Engineering Research Institute of Canada (FERIC), Canada | Private independent | Provide knowledge required to conduct competitive industry operations | Governing board, chief executive, advisory committees, eastern and western divisions, three research directors, 16 research units |
| Forintek Canada Corporation (Forintek), Canada | Private independent | Advance industry by development of creative concepts, processes, and products | Governing board, chief executive, advisory committees, seven research units |
| Pulp and Paper Research Institute of Canada (Paprican), Canada | Private independent | Promote competitiveness of pulp and paper industry | Governing board, chief executive, advisory committees, eight research units |
| Research Institute of Wood Industry (CRIWI), China | Public government | Develop wood technologies to meet national and peoples needs | Parent organization, director, advisory committees, eight research divisions. |
| European Forest Institute (EFI), Finland | Private independent, government authorized | Promote research to advance conservation and sustainability | Governing board, institute director, advisory committee, four research units |
| Finnish Forest Research Institute (Metla), Finland | Public government | Promote economically, ecologically, and socially acceptable use and management of forests | Parent organization (federal ministries), governing board, director general, advisory committees. |
| KCL (Oy Keskuslaboratorium-Centrallaboratorium Ab), Finland | Private independent | Support owner companies through research provided innovations, knowledge and technology | Governing board, president, advisory committee, consulting unit, services unit, administration unit |
| Technical Research Center of Finland (VTT), Finland | Private independent, government authorized | Create and apply technology to enhance globally competitive industry | Governing board, director general, six research institutes, eight access portals |

Forest Products Research and Development Organizations in a Worldwide Setting

| Organization, Country | Public-private sector | Mission | Governance and organization |
|--|--|--|--|
| Association Forest Cellulose (AFOCEL), France | Private independent | Increase competitiveness of wood and paper sectors | Governing board, director general, four research units |
| French Pulp and Paper Research and Technical Center (CTP), France | Private independent | Produce information to improve members' competitive position | Governing board, executive officer, six research units (four direct, two subsidiaries) |
| Federal Research Center for Forestry and Forest Products (BFH), Germany | Public government | Provide scientific basis for decisions involving forests | Ministry, director, advisory committees |
| Institute of Wood Technology (IWT), Germany | Private independent | Provide application-related research on wood use and processing | Parent organization (private company) governing board, managing director, eight research units, one subsidiary |
| Forest Products and Forestry Socio-Economic Research and Development Center, Indonesia | Public government | Coordinate and conduct research and development | Parent organization (federal ministry), director, operation division, research division, 12 research units |
| National Council for Forest Research and Development (COFORD), Ireland | Public government | Promote the competitiveness of forest products industry | Parent organization (federal ministry), governing board, director, administrative units, research program unit (three programs) |
| Forestry and Forest Products Research Institute of Japan (FFPRI), Japan | Public government | Promote sustainable forestry and forest resource utilization | Parent organization (federal ministry), president, administrative support units, 23 research departments |
| Hokkaido Forest Products Research Institute, Japan | Public government | Promote utilization of forests, provide information to industry | Director, six research units |
| Forestry Research Institute (Silava), Latvia | Public government, independent | Provide scientific advice on the management and utilization of forest ecosystems | Parent organization (federal ministry), governing board, institute director, nine research units |
| Forest Research Institute Malaysia (FRIM), Malaysia | Private independent, government authorized | Promote sustainable management through knowledge provided by research | Parent organization (federal ministry), governing board, director general, advisory committees, operations unit, research unit (four research divisions) |
| SHR Timber Research, Netherlands | Private independent | Carry out research and testing requested by clients | Governing board, director, four research units |
| Scion, New Zealand | Private independent, government authorized | Advance utilization of renewable materials and products from plants | Governing board, chief executive, 11 immediate research units (direct, subsidiary, joint ventures), seven indirect business arrangement units |

| Organization, Country | Public–private sector | Mission | Governance and organization |
|--|--|---|--|
| Wood Technologies Research Sector, Industrial Research Limited (IRL), New Zealand | Private independent, government authorized | Promote world-class science required for innovative businesses | Parent organization, research unit |
| Norwegian Forest Research Institute (Skogforsk), Norway | Public government, semi-independent | Strengthen scientific basis for management of forests | Governing board, director, five research units |
| Norwegian Institute of Wood Technology (NTI), Norway | Private independent | Promote company profitability through research diffusion of knowledge | Managing director, five sections |
| Paper and Fiber Research Institute (PFI), Norway | Private independent | Promote competitiveness of member companies through pulp and paper research | Governing board, director, three departments (two research, one administration) |
| Forest Products Research and Development Institute (FPRDI), Philippines | Public government | Generate and transfer technologies improving industry's competitive position | Parent organization (federal department), director, four divisions (one administration, three research) |
| Research and Development Center for Wood-Based Panels, Poland | Public government | Provide research and development for wood industry | Parent organization (federal ministry), director, four research units |
| Forest Research Institute (FRIS), Slovak Republic | Public government | Provide scientific knowledge about forest ecosystems and their management | Parent organization (federal ministry), director, advisory boards, research section (six units), services section (five units) |
| Forestry and Forest Products Research Center (FFP), South Africa | Private–public, independent | Maximize value of plantation timber for pulp and paper industry | Director, six research units, two cooperatives |
| Institute for Commercial Forestry Research (ICFR), South Africa | Private independent | Contribute to industry competitiveness through technical innovation | Governing board, director, advisory committees, four research units |
| Forestry Research Institute of Sweden (Skogforsk), Sweden | Private independent, government authorized | Contribute to international competitiveness of industry and sustainability of forests | Governing board, managing director, advisory committees, two research program units (three units each) |
| Swedish Institute for Wood Technology (SP-Trätek), Sweden | Public government, Independent | Strengthen competitiveness of wood and improve industry profitability | Parent organization (federal institute), one research unit (four research areas), advisory committees |
| Pulp and Paper Research Institute-Institute for Packaging and Logistics (STFI-Packforsk), Sweden | Private independent | Provide clients with knowledge required to secure competitive advantage | Governing board, president, director, advisory committee |
| Swedish Wood Ultrastructure Research Center (WURC), Sweden | Private–public, independent | Promote wood use by improving understanding of wood ultrastructure | Governing board, director, advisory committees, six research units |

| Organization, Country | Public-private sector | Mission | Governance and organization |
|---|--|--|---|
| Swiss Federal Laboratories for Material Science and Testing (EMPA), Switzerland | Private independent, government authorized | Promote sustainability by providing knowledge about materials and system engineering | Parent organizations (federal department, federal council), director general, advisory committees, two research units |
| Taiwan Forestry Research Institute, Taiwan | Public government | Conduct research on forests, forestry and forest uses | Parent organization (federal council), director, 10 research units |
| Timber Research and Development Association (TRADA), United Kingdom | Private independent | Provide quality information to maximize benefits from timber | Parent organization (private company), governing board, executive director, four research units |

Research organizations that are solidly part of government and are subject to all the planning, budgetary, and operational nuances of government (11 of the case examples) (Table 3). Some of the more striking examples in this respect are China’s Research Institute of Wood Industry (CRIWI) (branch of the Chinese Academy of Forestry), Poland’s Research and Development Centre for Wood-based Panels (within the federal Ministry of the Economy), and Germany’s Federal Research Centre for Forestry and Forest Products (BFH) (within the federal Ministry of Consumer Protection, Food, and Agriculture) (see Appendix A and B).

Mission and Strategies

The long-term interests of research organizations are brought to light by statements of mission. It is through the latter that the ultimate purpose of an organization is communicated: Why do we exist? What makes us unique? What do we want to do? An organization’s vision for the future and strategies for achieving that vision also flow from the mission statement: What do we hope to achieve? Who needs to be involved? What issues need to be confronted? (Arnold and others 1998). To some, mission statements are a reflection of what society expects from an organization in exchange for its continuing survival. For forest products research organizations, mission statements range from those that are brief and succinct, such as the Finnish Metla “build the future of the forestry sector through research,” and Norway’s PFI “be a world brand in pulp and paper research,” to those that are comprehensive as is the case with the STFI-Packforsk’s mission statement, “contribute to the productivity and profitability of clients in the entire value chain by carrying out research at the highest international level, implementing research results in commissions and in consultancy and training services, and providing services utilizing state-of-the-art laboratory and pilot plant equipment.”

As might be expected, the mission statements of the case examples reviewed here depict the very different ways that each organization sees its niche in the world of research (Table 3) (see Appendix A and B). Some mission statements are clearly focused on specific client groups (for example, government agencies, member companies, industrial sectors), while others construe their purpose to be contributing to the knowledge base generally and the economic and social conditions of a community or a nation as a whole. Some mission statements are presented as legislatively defined mandates whereas others are corporate directives arrived at after considerable thought and discussion. Recognizing this diversity, common categories (threads) of purpose found in the mission statements of the case-example research organizations reviewed here are as follows.

- *Advance science and new technologies*
“Develop applied technologies,” “strengthen innovation through research,” “develop creative concepts, processes, and products,” “provide scientific knowledge about forest ecosystems,” “strengthen scientific basis for forest man-

agement,” “promote world-class science,” and “provide scientific advice.”

- *Contribute to national needs and concerns*
“Promote economically and ecologically acceptable management of forests,” “coordinate research and development,” “research to advance conservation and sustainability,” “develop technologies to meet national and people’s needs,” “serve society by contributing towards improving the quality of life and the environment.”
- *Support technical needs of clients*
“Provide research and development for the wood industry,” “provide information to industry,” “provide application-related research to clients,” “support owner companies,” and “carry-out research requested by clients.”
- *Support economic and managerial needs of clients*
“Provide information to maximize benefits from timber,” “maximize value of plantation timber,” “promote company profitability through research,” and “enhance economic viability of industry.”
- *Promote resource utilization and sustainability*
“Promote sustainability and utilization through knowledge,” “advance utilization of renewable materials,” “promote sustainable management through research,” and “promote unitization of forests.”

Research organizations frequently set forth core values or philosophies that guide their behavior and create boundaries for their actions. These values speak to clients and to the broader public about what the organization believes is important and who it believes deserves respect and concern. As examples, the Finnish Metla promotes “respect for people and their expertise,” “independence and openness,” “scientific credibility, and “responsibility for the future and for nature,” while Finland’s KCL considers the following values to be especially important: “innovativeness,” “focus on customer with full confidentiality,” “responsibility for the environment,” “mutual respect,” “achieving targets,” and “exceeding customer expectations.”

In some cases, a single core value is clearly identified as important to the research entity. For example, the Swiss Federal Laboratories for Material Science and Testing (EMPA) clearly demonstrates commitment to sustainability by stating, “EMPA is committed to the principle of sustainability in processes, products, methods and applications ... [and] ... understands sustainability to mean development that meets the needs of today’s society without compromising the ability of future generations to meet their own needs.”

A research organization’s statement of mission and values may not be sufficiently complete as a basis for conducting the business of the organization. Clarification of mission and values in the form of strategies, goals, and objectives may be needed. Some forest product research organizations are quite complete in this respect. Consider the following:

Forintek Canada Corporation

Vision: Be a world-class research organization committed to our members and the ongoing prosperity of the Canadian wood products sector.

Mission: Be the leading force in the technological advancement of the wood products industry, through the creation and application of innovative concepts, processes, products and education.

Goals: Lead in the development and balanced application of knowledge and technology to support our members' sustainable development goals (economic, environmental, and social), and deliver research products and services to the satisfaction of members and clients.

Enabling Goals: Implement continuous improvements in internal practices that are critical to Forintek's success; make Forintek one of the best places to work; and increase member commitment to, and investment in, Forintek.

Employee Core Values: Employee commitment to the success of a strong research organization; understand and actively support the organization's goals; uphold the highest standards of ethics and professionalism; treat people with respect and fairness; demonstrate open and honest communication; work in a manner that fosters teamwork, innovation and creativity; have a "can-do" attitude; strive for continuous improvement in everything we do; work in a safe manner and take personal responsibility for the safety of others; be proactive in minimizing our impact on the environment.

Forestry Research Institute of Malaysia (FRIM)

Vision: Promote the sustainable management and optimal use of forest resources by generating knowledge and technology through research, development, and application.

Objectives: Generate knowledge and appropriate technology, provide research-based services to meet needs of clients, commercialize results of research and development, acquire and disseminate information, and create environmental and conservation awareness of forestry's roles.

Quality Policy: Committed to excellence in scientific research and development and to derive innovations for the benefit of clients.

Quality Slogan: Quality is the pillar of excellence, innovation is the key to preeminence.

Client Charter: Make available reliable, economically, and timely solutions to problems, create a core of dedicated scientists of high caliber and ability, speedily disseminate reliable scientific and technical information, promote environmental awareness by providing professional advice to the public, and provide a conducive working environment that encourages creativity among scientists and a close rapport with clients.

Pulp and Paper Research Institute of Canada (Paprican)

Vision: Be the leading pulp and paper research and technology institute in the world, delivering exceptional value for the benefit of member companies.

Goals-Strategies: Provide superior returns for investments made by member companies; integrate research and technology goals with the strategies of member companies as a true business partner in their endeavors; relentlessly pursue customer satisfaction; sustain excellence in science, technology, and education; maintain the link between fundamental science and business value; and empower Paprican people.

Guiding Principles: Customers – highest priority on customer needs; deliver value by ensuring products and services that address both short-term and strategic needs; through value delivery, inspire new customers to become full members. Institute – uphold with pride a reputation for excellence and integrity in all endeavors of science and technology; leading-edge resources drive value delivery; and derive great strength from the vigorous sense of community shared by all who work for the organization. People – highly creative and energetic people working in an environment where both teamwork and individual contributions are valued and recognized; and embrace the opportunities provided by constantly evolving environment. Resources – Dedicated to effective use of resources provided by member companies; provide all customers with highly cost-effective services in various lines of business; and run Institute as a progressive business. Accountability – Expect superior performance from everyone; individuals and employees collectively accountable for actions and results; and leaders set clear goals and expectations, are supportive, and promote open communication.

European Forest Institute (EFI)

Mission: Conduct, promote and cooperate in the research of forests, forestry and forest products in European countries; make results of research known to all interested parties, notably in the areas of policy formulation and implementation; and promote the conservation and management of forests for producing goods and services in a sustainable way.

Means: Conduct research and develop research methods; provide relevant information for policymaking and decision-making; compile and maintain data; organize and participate in scientific meetings, including forest research training; and publish and disseminate the results of research.

Governance and Advice

Authority to govern an organization emanates from many sources, most of which are embodied in notions of power and the charisma of leadership (Table 3) (see Appendix A and B). The source of authority to govern an organization may arise from interpersonal (rewards, coercion, knowledge, leadership style) and structural bases (legal assignment of responsibility, control over decision-making processes, and access to vital resources, such as money,

technology, clients), as well as control over important information (finances and budgets, conditions of employment). The essence of these factors plays out in how authority is exercised, how decisions regarding the direction and operation of organization are made and implemented. In some cases, decisions are programmed, addressing problems that are (for example, periodic reorder of inventories) and are handled by a well-defined repetitive, routine procedures (for example, merit systems for promoting employees). In other cases, the problems are novel, complex, and unstructured (for example, purchase of expensive experimental equipment, movement into a very high risk field of research, major reorganization of a research establishment), and procedures for handling them have not been well developed. Whatever an organization's decision environment may be, it is the exercise of the governance function that determines to a large extent whether it will be successful over the long haul. As for the governance and administrative structure of the case-example organizations assessed here, three major patterns occur as follows.

Independently Empowered Panel

An independent governing panel (board, council, committee) is a common organizational expression of authority for governing the case-example organizations examined here. The panels serve in a governance, not an advisory capacity, and thus engage in the establishment of overall policy and direction for an organization. Responsibility for daily management of the research entity is delegated by the board to the organization's chief executive and various deputies or assistants. Panels vary in size from three to four persons to as many as 20 to 30 persons (Forintek Canada Corporation has a 26-member board of directors).

The structure, responsibilities, and appointment processes for governing panels vary widely (Table 3) (see Appendix A and B). Some such as Australia's Cooperative Research Centre for Sustainable Production Forestry (CRC) are made up of representatives of member organizations. Other organizations have more complex representative requirements for their boards, such as Norway's PFI, which is governed by a six-person board of directors, three of which represent STFI-Packforsk, one represents the PFI foundation, one represents the four largest industry owners, and one represents PFI employees. Governing panels may be appointed or elected; for example, the United Kingdom's TRADA is governed by an 11-person elected board of directors. Other panels may be comprised of some other combination; for example, the board of the Forest Engineering Research Institute of Canada (FERIC) is composed of eight appointed and 12 elected persons. In some cases, a governing board may include the organization's chief executive officer whereas in others, the board and the lead staff person are separate. An example of the latter is STFI-Packforsk, which is governed by a 15-person board of directors (chair, 10 members and four deputy members), and administered

by two officers and eight directors (president, executive vice president, and six directors, one from each of STFI-Packforsk's divisions).

Hierarchy Position Within an Inclusive Organization

The positioning of research organizations within a larger organization with broader responsibilities is also a common approach to the governing of the case-example organizations examined here (Table 3) (see Appendix A and B). In such cases, a single director or chief administrator often establishes direction and orders authority vertically. Examples are Finland's Metla, which is responsible to the Ministry of Agriculture and Forestry and the Ministry of the Environment; Germany's BFH, which organizationally resides within the portfolio of the Ministry of Consumer Protection, Food, and Agriculture; and the FFPRI, which is located within the federal Ministry of Agriculture, Forestry and Fisheries.

Positioning within an organization that has broader responsibilities (such as economic development, natural resources management, comprehensive research obligations) does not imply allegiance to a vertical chain of command. Although many of the case-example organizations reviewed here are parts of a hierarchal structure, they are often afforded considerable flexibility to determine their own research obligations and directions (Table 3) (see Appendix A and B). An example is Metla. Although ultimately responsible to the Finnish Ministry of Environment and the Ministry of Agricultural and Forestry, an eight-person management board basically controls and directs all the activities of the Institute, including the overall mission and goals; an annual plan of research and associated budgets; appointment of personnel, including the research director, administrative director, center directors, and professorships (including discipline areas); use and management strategies for research natural areas; and the establishment of advisory boards, including their tasks and membership. The Latvian Silava also operates quite independently, being responsible in only a limited way to the Ministry of Education and Science. The Skogforsk operates with special independent credentials, although administratively located in the Ministry of Agriculture, and although situated within the federal Department of Agriculture and Food, Ireland's COFORD is self-governing in that it is largely responsible for developing and prioritizing its own research policies and funding sources. In a similar but more distant fashion, the Swiss EMPA is responsible to the ETH Council, which has semi-autonomous status from the Swiss Federal Department of Home Affairs.

Executive Officers

Regardless of whether a research organization is independent or part of a broader organization, all the case-example organizations reviewed here are guided by a chief executive officer, variously known as a director, president, director general, managing director, operating officer, or chief executive officer (Table 3) (see Appendix A and B).

Responsibilities assigned to chief executives are often very substantial, as is the case with the Director General of the Metla, "... to lead, control and develop the operations and activities of the Institute and be responsible for attainment of objectives and goals set for the Institute." Exactly how the governing activities of an organization's executive officer are carried out is dependent on the officer's leadership style and the structure and complexity of the organization being governed. In part, such is reflected by the type and size of supporting staffs required by executives. For example, the chief executive of Finland's KCL is supported by vice presidents for research (KCL Science and Consulting) and research services (KCL Services), whereas the director of the Malaysian FRIM is supported by deputy directors for operations and for research and development. Some organizations engage a sizable executive management team to support their chief operating officer's governing responsibilities. An example is Japan's FFPRI, which is supported by a director of research planning and coordination, director of general affairs (accounting, human resources), and eight principle research coordinators. Similarly, the chief executive of New Zealand's SCION is assisted in governing responsibilities by a chief financial officer and six group managers.

Advisory Committees

The case-example organizations examined here make extensive use of formally established advisory bodies (committee, council, commission) (Table 3) (see Appendix A and B). Although generally not assigned responsibility for overall governance of an organization, advisory bodies can have a significant impact on the direction and manner in which research is carried out. Although sharp lines of responsibility between committee types seldom exists, prominent responsibilities of advisory bodies affiliated with the research organizations examined here are as follows.

- *Scientific advice*—Guidance on scientific knowledge and procedures. Examples are the scientific council of the French Metla, advisory panel of Australia's CRC, scientific board of the Slovak Republic's Forest Research Institute, and the committee of scientific advisors of the STFI-Packforsk.
- *Research program advice*—Guidance on general long-term research directions. Examples are the consultative commission of the EMPA (Switzerland), COFORD (Ireland), the national research program committee of the Forintek Canada Corporation, and the strategic advisory committee of Canada's FERIC.
- *Research project advice*—Guidance on design and conduct of specific projects within programs. Examples are the advisory board of the SP-Trätekt and the technical advisory committees of Forintek Canada Corporation.
- *Performance advice*—Guidance on assessing results and effectiveness of research programs and projects.

Examples are the research commission of EMPA and the value-added research advisory committee of Forintek Canada Corporation.

- *Managerial operational advice*—Guidance on the administration and operation of an organization. Examples are the management committee of South Africa's Institute for Commercial Forestry Research (ICFR), the managing group of Sweden's WURC, the research management committee of the CRC, and the operational board of the Slovak Republic's Forest Research Institute.

The number of persons and eligibility for service on advisory bodies is far from uniform (Table 3) (Appendix A and B). Membership on advisory committees generally falls in the range of 10 to 15 persons, although some of the case-example organizations have seen fit to establish advisory bodies that are very large. For example, the Lumber Manufacturing Advisory Committee of Forintek Canada Corporation has 160 members, and the Composite Products Manufacturing Committee has 67 members. Ninety-three persons are members of the Advisory Committee on Forest Engineering of FERIC. In some cases, advisory committee membership is limited to representatives of member companies or owners of the organization, whereas in other cases, members represent a broad cross section of industrial sectors or the academic community. Geographic representation can be especially broad (for example, the Scientific Advisory Board of Finland's European Forest Institute; International Advisory Group of the WURC). Advisory bodies do not always neatly follow the functional areas described above. In some cases, they may have a product orientation (Advisory Committee on Lumber Manufacturing of Forintek Canada Corporation) or may be issue-oriented (for example, Advisory Committee on Wildland Fire Operations research of Canada's FERIC).

Structure and Linkages

The organizational structure of the research entities reviewed here ranges from organizations that are carefully arranged (vertically or horizontally) to entities that appear to be organizationally very cluttered (Table 3) (see Appendix A and B). At first appearance, the latter would seem to defy an administrator's efforts to exercise control and direction – it would seem to make hierarchical directives, such as planning, budgeting, very difficult. Yet "messy organizational maps" may simply describe a research organization that has administratively responded to new and important problems in need of research. Regardless of the outward organizational appearance, all the case-example organizations reviewed here have certain basic internal designs. They have structures that address administrative support functions (for example, accounting, legal advice, human resource management, communications, public affairs, computer systems), planning and reporting functions (for example, program development, monitoring, and evaluation), research and development functions (for example, divisions, sections, programs,

branches, subsidiaries), technology transfer functions (for example, publications, workshops), testing and inspection functions (for example, materials testing, certification), and educational functions (for example, graduate education, continuing education). Notwithstanding these basic characteristics, the case-example organizations have certain general patterns of administrative structure that are worth noting.

- *Vertically structured organizations*—Some organizations have assumed a very formal vertical structure that involves many layers of organization and a chain of command that flows from a chief executive to various subordinate units that are assigned tasks considered necessary to accomplish an organization’s mission. Accountability rests with “higher authority” within the organization. Nearly all the case examples reviewed here have some hierarchical component – some more than others (Table 3) (see Appendix A and B). Examples of what would appear to be organizations with a strong vertical structure are China’s CRIWI, Germany’s BFH, Japan’s FFPRI, and the Philippines’ Forest Products Research and Development Institute (FPRDI). In some cases, many layers of administrative structure suggest a strong hierarchy. An example is the Malaysian FRIM, which has deputy directors for operations (three divisions) and research and development (four divisions). Such also reflects the reality that the Forest Research Institute of Malaysia is quite large (budget, personnel, programs) and requires extensive division of responsibilities.
 - *Horizontally structured organizations*—Certain organizations seem to have assumed a horizontal organizational structure, wherein there are relatively few layers of organization, and top management conducts business in a collegial fashion – acting as coordinators and integrators (“linking pins”) of an organization’s myriad activities (Table 3) (see Appendix A and B). Examples of such organizations are New Zealand’s SCION, Technical Research Centre of Finland (Valtion teknillinen tutkimuskeskus, VTT), STFI-Packforsk, and South Africa’s Forestry and Forest Products Research Centre (FFP). Also tending toward a horizontal structure is the research program of Paprican.
 - *Information and skills structured organizations*—Some organizations seem to place great importance on fields of knowledge and the use of teams of specialists that can apply such knowledge to various problems in need of research (Table 3) (see Appendix A and B). Emphasis is on respect for expertise rather than on formal rank and hierarchy. Forest products research organizations structured in this fashion make much acclaim of portals or gateways to the variety of technical expertise available within their organization. An example is New Zealand’s Industrial Research Limited (IRL), which promotes easy access to areas of technology that cut across various industrial sectors (Fig. 1). A similar information and skills organizational arrangement is employed by Finland’s VTT. The latter has established eight knowledge portals through which clients can gain easy access to the organization’s diverse expertise and technologies: Environment, Materials, Pulp and Paper, Information Technologies, Nuclear, Renewables, Transport, and Life Science.
 - *Unit within large diversified organizations*—Organizations performing forest products and related research may also be a small entity (division, center, department) within a much larger research and development organization that has a research interest much broader than forest products (Table 3) (see Appendix A and B). Being part of such a “conglomerate-type” organization enables the forest products unit to draw on the wide variety of talents, experiences, and equipment that exist within the larger parent organization. In essence, the forest products unit may appear to be “small,” yet in reality it is quite large. Examples of forest products research entities that are part of a much larger research establishment are the Pulp and Paper Research Unit of Finland’s VTT, the Wood Technology Research Sector of New Zealand’s IRL, the SP-Trätek, and EMPA, which is part of the Swiss Federal Institutes of Technology (ETH Domain).
 - *Strategic alliances and partnerships*—Organizations engaged in research and development involving forest products often engage in alliances or unions with other organizations (Table 3) (see Appendix A and B). Often operating independently from the parent organization, these partnership arrangements are initiated for various reasons, including avoiding taxes on revenue, externalizing business risk, bringing together unique research talents, accessing new clients, and addressing short-term business opportunities. Some well-known research organizations are themselves business alliances. An example is Australia’s Ensis, which is an incorporated joint venture involving Australia’s CSIRO and New Zealand’s SCION (formally Forest Research Limited). The SCION part of Ensis has 17 joint ventures, subsidiaries or similar independent business arrangements, one of which, PAPRO, (pulp, paper and packaging) is an arrangement involving Australia’s Ensis and New Zealand’s SCION. Another organization that is, in essence, a joint venture is South Africa’s Forestry and FFP, which is a joint venture between a university (University of KwaZulu-Natal) and a large internationally known research organization, CSIR.
- Forest products research entities may also actively pursue partnerships as part of their operations. Examples of organizations doing so are France’s Metla (TECH PAP [paper making sensors] and in TechFibers [pulp and paper research]), and the United Kingdom’s TRADA (TTL Chiltern Group of Companies) (Table 3) (see Appendix A and B). TRADA engages in extensive partnering, including 12 partners focused on calibration, testing, and evaluation

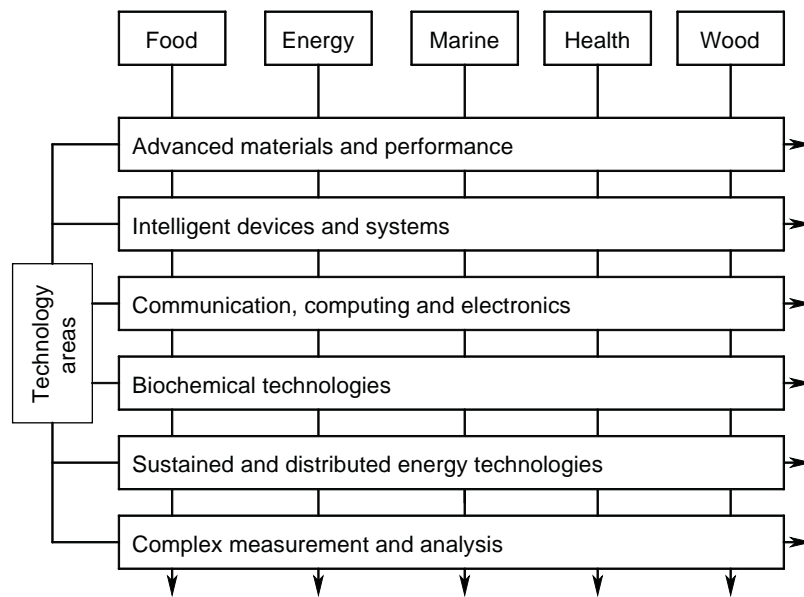


Figure 1—Research and development organization structured according to information and skills capacity.

of plywood glue bond. In some cases, the business partnership is not given a formal name, but simply involves an agreement to engage formally in collaborate activities (including reporting in each organizations’ annual report). An example of the latter involves PFI and STFI-Packforsk.

Business partnership arrangements can also take the form of cooperatives. Such have been initiated by Australia’s Ensis (operates nine cooperatives) and South Africa’s Forestry and Forest Products Research Centre, which sponsors two cooperatives, the Eucalypt Research Cooperative and the Fiber Research Processing Cooperative (Table 3) (see Appendix A and B). The latter involves Mondi Corporation (paper and packaging), Sappi Corporation (pulp and paper), Nampak (packaging), and CSIRO.

Forest products research organizations are typically very proactive with the commercialization of their research products. To promote this interest, some establish subsidiaries whose sole purpose is to promote the use of a new technology (Table 3) (see Appendix A and B). An example of a research organization that does so is Australia’s CRC. The latter directs its research findings and commercial operations through its management company, Institute for Knowledge Management (IWM). The IWM is assigned all background intellectual property and owns all new intellectual property on behalf of partners to the CRC.

- *Educational and university affiliations*—Some forest products research organizations have established formal connections with universities and similar educational institutions (Table 3) (see Appendix A and B). The arrangements often lead to a number of mutually beneficial results, including boosting the supply of technically competent professionals and exposing students to

administrators and researchers that have wide-ranging experiences in their respective fields. Especially noteworthy in this respect is Paprican, which has formal arrangements with McGill University, the University of British Columbia, and Ecole Polytechnique de Montréal. In partnership, Paprican, University of British Columbia, and the British Columbia Institute of Technology sponsor an advanced papermaking initiative. Other research organizations that have formally linked with universities are South Africa’s FFP, Germany’s BFH, and Australia’s CRC.

- *Geographically dispersed operations*—Very few of the organizations reviewed here have but a single central location for their operations (Table 3) (see Appendix A and B). For example, Forintek Canada Corporation has eastern and western regional offices, and the Finnish Metla has nine research centers and stations. Some organizations have an international orientation for their operations, including the EFI (seven regional project centers located throughout Europe) and Australia’s Ensis (offices in Australia and New Zealand). The VTT has offices in the United States (Palo Alto, CA). A number of research organizations are physically located on a university campus, a condition that provides for certain synergisms between the academic community and the research organization.

Administrator Perspectives

The executives and management staff of forest products and related research organizations are often in a position to provide especially noteworthy insight about the organization and governance of research organizations generally. With such in mind, the directors (or their deputies) of the

case-example organizations reviewed here were contacted and asked to provide the following information about the research organizations for which they were responsible: “Forest products research organizations can be chartered and organized in many different ways. For example, consideration might be given to ownership (public, private, or some combination), governance (board of directors, chief executive office, advisory committees), partnerships (affiliates, subsidiaries, joint ventures), and decision-making processes (centralized, decentralized). In your judgment, what *three features* of (... organization’s name ...) structure enables it to effectively carry out its mission?” With only slight paraphrasing of respondent replies, the administrators identified the following.

Public–Private Positioning

- Regarding ownership, we are privately owned and managed by a board composed of member companies. This private orientation keeps [planning and management] matters simpler and less consuming of our organization’s energies.
- Our private research association, composed of [over 100] member companies, gives close contact to industry and facilitates industry participation in all our research and development projects.
- We are in public-to-private transition. Our state-owned organization is in the process of becoming a commercial company with the participation [ownership] of the state treasury, manufacturers of wood products, and our research organization’s staff. We seek to increase our organization’s independence from government.
- Private ownership still offers us the highest degree of independence and liberty in identifying the research areas we intend to focus on. With force (authority) we can plan, structure, coordinate and substantiate our own research activities.
- Organizational strength lies in combined ownership (public [state and federal] plus private industry plus universities) and subsequent financing by all these sources.

Organizational Governance

- As a privately owned organization, of greatest importance for management of the institute is committed owners who set clear objectives for and expectations of the organization. This clarity in direction enables staff to understand why the institute exists and their role in its future.
- Our organization is a privately owned research company, which has a board of directors and several kinds of partnerships. Major decisions within the organization are made by a board of directors, president, management team and a research committee. We find such an arrangement to be very effective.

- We are part of a larger parent organization. We can avail ourselves of the competence of our [larger parent owner] in the whole range of topics and technologies within the field of pulp and paper.
- Small [research] companies like us have a short way to go from ideas to decisions. As such, we are not burdened with highly bureaucratic processes. Our governing board is an active board and is a competent part of our decision-making processes.
- Our institute is effectively run by two directors: (1) director of the institute and in charge for scientific, personnel and development questions, and (2) director of financial management and personnel issues. [Even though ultimate responsibility rests with the directors], decision making is quite decentralized.
- As a private organization, our organization’s overall governance is by a board of directors, with the structure for managing research involving advisory committees and external reviews of our programs. This governance has proven quite effective.
- We have a very sophisticated governance system. A subset of our member company CEOs comprise the board of directors on a three-year rotation cycle. Generally, the largest member companies are always on the board and the smaller ones participate in the rotation. This gives direct oversight of the organization’s research agenda by senior industry leaders.
- Our organization is a consortium research organization sponsored by member companies that are producers of pulp and paper products only. Some private research organizations allow non-producers as members, especially the suppliers to the industry. We see a conflict here because we do not want potential commercialization partnerships to be hindered by membership [in our organization] of a supplier who may not be the best commercialization partner, but might want the right of first refusal because of membership [in our organization].

Program Planning and Implementation

- Focus is on our members and the project centers, which [conduct] the forest research activities. Being a member driven organization, decision-making is very democratic and stems directly from the members’ needs and expectations.
- Important is the way our industry and government members participate in our advisory process in setting strategic direction for our organization making sure the organization is accountable. All members are invited to participate in meetings of our technical committees, and many do.
- Engaged representatives from our owner–members ensure that the organization is dealing with the right (demand driven) topics in need of research.

- We definitely focus on member priorities. However, in tough economic times, as we have seen for the past decade, we tend to be driven to shorter term research objectives and have to struggle to include strategic longer term priorities. An example is our work to ensure that we have a finger on the pulse of nanotechnology, which has the potential to add entire new long-term features to paper products.
- The organization's board annually establishes general research directions, an annual overall budget, and an annual operating plan. These three elements are pulled together by a regularly updated long-range strategic business plan.
- Individual member companies of our organization may act as project liaisons for specific projects, doing so in order to provide guidance to ongoing research and to implement research results in their businesses as soon as results are available.
- We operate on the basis of a program established periodically by an advisory committee composed of representatives of our shareholders. The committee identifies current research needs of industry and assists in the implementation of research results.
- Important to our organization is our overall research program committee, which reports to our board of directors. Although the staff of our organization is represented on the committee (chief executive officer and its vice president of research), the research planning committee is very much dominated by industry membership.
- Reporting to the board, and chaired by one of the board members is our research program committee, which sets the technical directions for the research program and does this through its members, most of whom are senior industry technology leaders. It sets overall industry strategic directions and the members are asked to focus this way rather than to represent their own company viewpoints on priorities.
- Our research program committee (reporting to board of directors) manages through a set of subcommittees (seven) that deal with individual research programs. They address specific details of the research program, identify gaps in the program and recommend the priorities to the full committee. A key point is that all the research priorities are industry-driven. This is a strength and occasionally a drawback.
- Reporting to the organization's governing board is our future awareness committee (FAC), which looks at issues important to the industry 25 years out (such as fibre supply, capital effectiveness, market dynamics and sustainability). The FAC uses the Shell Development Company Scenario Planning Tools to lay out extreme but plausible pathways that are relevant to the particular topic being

studied. It then looks at research questions that should be addressed for each scenario, plus some that should only be followed if there is evidence that a scenario is actually occurring. From this set, we choose the most robust research areas for investigation irrespective of which scenario might occur, as well as summarize important business (but nontechnical) factors that might be relevant to our members. The FAC reports back to the board and to the research planning committee with a strategic long-term view to the research and business issues that need to be assessed.

Partnering and Collaboration

- We are a private organization that operates in a partnership structure based on shared risks, shared costs, and shared benefits. This structure allows the [... federal government, state-provincial governments ...], and companies producing solid wood products to [focus] toward a core research program that is the heart of our organization's research effort.
- We have evolved with our university partnerships from one [university], which gave us a connection to academic research and the education of graduate students, to the current system wherein we use partnerships with many different universities to complement our research program and to provide a fundamental science base (as an organization, we no longer do as much basic science as we did historically).
- We have very close cooperation and networks with relevant industry associations and instruments (promotion body, schools, universities, research and development institutes). All work together with different roles, but with a common main goal of conducting and implementing quality research products.
- Our organization is one that involves flexible partnerships. We have become structured over the years to allow for individual sponsorships with allied industry companies on individual research projects. They participate through grants-in-aid of research. These [grants] allow selected supplier companies to participate, not in a controlling fashion, in the research program, and potentially to become the commercialization partners for the [research] results that are produced. Since we are a research consortium organization, not a manufacturing organization, these partnerships give us a way to take technology right through to final commercial products.
- Partnering is extremely important, simply because it is impossible to have a full range of specialized research expertise within our own organization.
- Our organization has a very well developed member company partnership system, in which individual member company employees participate as observers and short-term guides for the actual research program at the

detail level. This gives direct member company input into each research project and lays the groundwork for efficient technology transfer as research results become available.

- We are located [on a university campus], which means that education and research go hand in hand. Thus we have the possibility to attract students to work on our projects and to perhaps offer employment to the best students.
- Our partnership and close cooperation with the four major industrials concerns in our country is important. They have guaranteed us certain work for the next four years.

Administration and Management

Clients and Services Provided

Clients and Patrons

The importance of a research organization's relationship with client groups (customers, patrons, sponsors) cannot be underestimated, irrespective of whether an organization is chartered as public or private. For the case-example organizations reviewed here, the importance of clients is exemplified by their publicly made statements which follow.

- Our primary focus is on industry and client needs, including government agencies. In today's markets, relevance is crucial. Market trends and our client needs drive not only the way in which we deliver service and solutions, but also our science planning and investment.
- Committed to a long-lasting relationship with clients by offering top-quality services ... first link in chain of collaboration: listen to clients. Meet expectations of clients with efficiency and respect for contractual commitments.
- Client relations are built around each client's needs ... tailor-made information is a powerful tool and one of the cornerstones of [our] business success ... close contacts with clients' production plants are a key element of [our] work.
- Primary role is to ensure the application of [our] resources in ways that support its membership's needs ... our goal is to support our members' businesses.
- Committed to achieving excellence in scientific research and development ... and to derive innovations for the benefit of our clients. We shall ensure that those working with clients are committed and adhere to [high] quality standards.

As the above statements suggest, many research organizations take clients very seriously. In reality, both organizations and their clients must recognize that they have common interests that must be nurtured if either is to remain relevant to the advancement of broader public and private interests. The former must maintain their physical infrastructure, nurture talented staffs, purchase new and innova-

tive equipment, and steer investment in research directions that may not prove worthwhile for many years to come. At the same time, client groups seeking information critical to continuation of their operations may become quite dependent on (or affected by) the services that a research organization is capable of providing. Clients may find themselves holding an important stake in the type and intensity of the research being carried out by a research enterprise. This interdependence of clients and research organizations can lead to important reciprocity relationships. Whereas a research entity may seek stable support from clients (expressed by market transactions or by the actions of government), clients seek from research organizations various services that are required in order for them to effectively compete in private markets (or to serve the information demands made of them by government organizations). An example of this reciprocity relationship is suggested by Paprican, which states "... our driving belief is that if Paprican delivers real value to its members, the funding to support the organization will be a natural outcome of this business success."

The 40 case-example research organizations reviewed here provide services to a variety of different organizations (Table 4) (see Appendix A). Some have a major focus on government as a client (for example, the Slovak Republic's Forest Research Institute), while others seek to serve a wide range of clients that exist within both the public and the private sector (for example, the VTT). Some of the case-example organizations have as their primary clients the organizations that are members (or owners) of the organization (for example, the French AFOCEL and the Norwegian Institute of Wood Technology (NTI)). Most of the case-example organizations reviewed here provide services to both public and private clients as indicated by the following: Public (government) clients only, 0; public and private clients, government emphasis, 2; public and private clients, 21; public and private clients, owner–member emphasis, 14; and private clients, owner–member emphasis, 3.

There is considerable variation in the exactness with which the case-example organizations specify the client groups they seek to serve. For example, the Slovak Republic's Forest Research Institute "conducts research at the request of the Ministry of Agriculture" (for example, research on soil properties, tree species biodiversity, forest protection), while customers of the SP-Träteck include "sawmills, joinery companies, manufacturers of timber house and other buildings, furniture manufacturers, producers of boards and other wood-processing products, producers of input materials and equipment for the industry, as well as institutional customers." The PFI reports that its "research is directly related to the needs of large industrial concerns, although small and medium-sized businesses may also use our laboratory facilities for quality testing and product development." The Netherlands's Stichting Hout Research (SHR) Timber Research indicates its target client groups to be the joinery industry (windows and doors), board material industry, pallet

Table 4. Case-example forest products and related research organizations, 2004–2005

| Organization | Clients | Services provided | Research program directions | Budget and financing | Scientists and staff |
|---|---|---|--|---|--|
| Australia | | | | | |
| Cooperative Research Centre for Sustainable Production Forestry (CRC) | Public and private, owner–member emphasis | Information, research, consultation, training | Genetics, tree improvement, site productivity, resource protection | \$3 million (AUD), 89% from government, \$6.9 million (AUD) in-kind contributions | 52 total staff: 46 research, 6 administration |
| Cooperative Research Centre for Wood Innovations (CRC) | Public and private, owner–member emphasis | Information, research, consultation, training | Microwave processing, value-added technology, wood surfaces, raw wood enhancement | \$2.3 million (AUD) | 28 total staff: 12 lead research staff |
| Australasia | | | | | |
| Ensis | Public and private | Information, research, consultation, training | Genetics, forest sustainability, fiber quality, biosecurity, wood processing, pulp, paper, packaging | NA | 350 total staff |
| Austria | | | | | |
| Holzforschung Austria (HFA) | Public and private | Information, research, consultation, training | Round wood, housing, adhesives, construction, furniture, surfaces, preservation, pulp and paper, bioenergy | 3.69 million (EUR), 80% commissioned | 58 total staff |
| Canada | | | | | |
| Forest Engineering Research Institute of Canada (FERIC) | Public and private, owner–member emphasis | Information, research, consultation, training | Harvesting, transportation, silviculture, bioenergy, wildland fire, decision support | \$11.8 million (CAD), 47% member fees, 35% contracts, 18% government | 140 total staff: 100 researchers and engineers |
| Forintek Canada Corporation (Forintek) | Public and private, owner–member emphasis | Information, research, consultation, training | Resource assessment, lumber, composites, building systems, codes and standards, marketing, economics | \$28.3 million (CAD); 66% member fees, 32% service fees, 2% other | 210 total staff |
| Pulp and Paper Research Institute of Canada (Paprican) | Public and private, owner–member emphasis | Information, research, testing, consultation, education | Fiber supply, pulping, papermaking, product performance, development engineering | \$39.4 million (CAD), 67% member fees, 20% government, 13% other | 340 total staff |

| Organization | Clients | Services provided | Research program directions | Budget and financing | Scientists and staff |
|--|---|---|---|---|---|
| China | | | | | |
| Research Institute of Wood Industry (CRIWI) | Public and private | Research, education | Wood properties, processing technology, panels, utilization, marketing | NA | 161 total staff: 140 research and technical, 21 administration |
| Finland | | | | | |
| European Forest Institute (EFI) | Public and private, owner–member emphasis | Information, research, consultation, training | Forest ecology, forest products, policy analysis, information systems | 2.5 million (EUR), 79% government, 21% member fees and special projects | 53 total staff |
| Finnish Forest Research Institute (METLA) | Public and private, government emphasis | Information, research, consultation, testing, training | Markets, economics, planning, inventory systems, silviculture | 49 million (EUR), 73% government, 27% commissioned | 875 total staff: 321 research |
| KCL (Oy Keskuslaboratorium-Centrallaboratorium Ab) | Public and private, owner–member emphasis | Information, research, consultation, testing, training | Fiber evaluation, papermaking, printing surfaces, printing technology, packaging | 23.8 million (EUR) | 300 total staff: 130 research, 141 service, 29 administration |
| Technical Center of Finland (VTT) | Public and private | Information, research, consultation, testing, training | Pulp, paper, structural design, manufacturing, biotechnology, environmental technologies | 218.5 million (EUR) total for center; funding 31% government base, 69% other | 200 scientists pulp and paper portal, information on staff in other portals not available |
| France | | | | | |
| Association Forest Cellulose (AFOCEL) | Private, owner–member emphasis | Information, research, consultation | Wood supply, wood processing, forest management, regional issues | 6.5 million (EUR), estimate 50 public, 50% private | 96 total staff: 44 research, 52 administration |
| French Pulp and Paper Research and Technical Center (CTP) | Public and private | Information, research, consultation, testing, training | Fiber resources, pulping, coating, calendaring, emission control, monitoring systems | 11.3 million total (EUR), 7.8 million research; 42% government, 58% contracts | 155 total staff: 49 scientists, 62 technicians, 44 administration |
| Germany | | | | | |
| Federal Research Center for Forestry and Forest Products (BFH) | Public and private, government emphasis | Information, research, consultation, certification, raining | Forest management, genetics and tree breeding, economics and policy analysis, wood chemistry and physics, forest ecology, resource assessment | NA | 120 total staff (estimated): 108 research, 12 administration |
| Institute of Wood Technology (IWT) | Public and private, owner–member emphasis | Information, research, consultation, testing, certification | Wood anatomy, panels, adhesives, processing technology, surface coatings, chemical analysis, furniture, construction technology | 5 million (EUR), 60% government, 40% industry | 80 total staff (estimated) |

| Organization | Clients | Services provided | Research program directions | Budget and financing | Scientists and staff |
|---|---|--|--|--|---|
| Indonesia | | | | | |
| Forest Products and Forestry Socio-Economic Research and Development Center | Public and private | Information, research, testing, consultation, training | Wood anatomy, biodeterioration, wood properties, wood preservation, sawmilling, panels, drying, harvesting, economics | NA | 160 total staff: 143 research, 17 administration |
| Ireland | | | | | |
| National Council for Forest Research and Development (COFORD) | Public and private | Information, research, consultation, training | Nurseries, silviculture, harvesting, transportation wood products, economics, carbon sequestration | 1.7 million (EUR), 68% research | 714 total staff (70 FTEs) |
| Japan | | | | | |
| Forestry and Forest Products Research Institute of Japan (FFPRI) | Public and private | Information, research, consultation | Biodiversity, remote sensing, harvesting systems, recycling, policy analysis | 10.4 billion (JPY), 86% public | 661 total staff: 453 scientists, 208 administration and support staff |
| Hokkaido Forest Products Research Institute (HFPRI) | Public and private | Information, research | Timber engineering, wood utilization, wood processing, mushroom culture | 91 total staff | NA |
| Latvia | | | | | |
| Forestry Research Institute (SILAVA) | Public and private | Research | Silviculture, genetics, regeneration, forest protection, harvest machinery, game management, chemicals, economics | NA | 100 total staff (estimated): 80 research, 20 administration |
| Malaysia | | | | | |
| Forest Research Institute Malaysia (FRIM) | Public and private, owner-member emphasis | Research, consultation, education | Industrial development, information infrastructures, eco-tourism, commercialization of wood products | 28.2 million (MYR), 56% government. Intend to be financially self-sufficient | 160 total research staff |
| Netherlands | | | | | |
| SHR Timber Research | Public and private | Research, testing, consultation | Adhesives, windows and doors, wood preservation, wood anatomy, furniture, coatings | 2.4 million (EUR), 100% from clients served | 35 total staff |
| New Zealand | | | | | |
| SCION | Public and private | Information, research, consultation, training | Genetics, fiber quality, biosecurity, pulp and paper, packaging, composites, biotechnology, life cycle assessment, renewable consumer products | 35.2 million (NZD); government (46%), commercial (44%), and other (10%). | 380 total staff (estimated) |

| Organization | Clients | Services provided | Research program directions | Budget and financing | Scientists and staff |
|--|---|---|--|--|--|
| Wood Technologies Research Sector, Industrial Research Limited (IRL) | Public and private | Information, research, consultation, pilot scale production, training | Materials and materials performance, sensing and detecting, biochemical technologies, energy technologies, measurement and analysis | Not available; IRL total funding \$62 million (NZD), 46% private, 54% public | 15 total staff wood technology research unit (estimated) |
| Norway | | | | | |
| Norwegian Forest Research Institute (Skogforsk) | Public and private | Information, research, consultation | Forest ecology, forest management, economics, wood utilization | 76 million (NOK), various sources | 107 total staff: 75 research, 32 administration |
| Norwegian Institute of Wood Technology (NTI) | Private, owner–member emphasis | Information, research, consultation, certification, training | Wood utilization and durability, production technology | 31 million (NOK), member fees (11%), service fees (89%) | 36 total staff: 27 research, nine administration |
| Paper and Fiber Research Institute (PFI) | Public and private, owner–member emphasis | Information, research, consultation, training | Fiber, pulp, paper, novel materials | 27.1 million (NOK), 72% from private industry | 25 total staff: 12 research, nine engineers, four administration |
| Philippines | | | | | |
| Forest Products Research and Development Institute (FPRDI) | Public and private | Information, research, consultation, testing, training | Furniture and handicrafts, construction materials, material science, paper, biomass energy | NA | 238 total staff: 161 research, 77 administration |
| Poland | | | | | |
| Research and Development Center for Wood-Based Panels | Public and private | Information, research, consultation | Panel products, manufacturing safety, instrumentation systems, information management | NA | 30 total staff: six research, 24 management administration |
| Slovak Republic | | | | | |
| Forest Research Institute (FRIS) | Public and private, government emphasis | Information, research, consultation, testing, training | Genetics and tree breeding, silviculture, protection, game management, economics and policy, monitoring systems, harvest engineering | 56.2 million (SKK), 51% for research; 14% from contract activities | 170 total staff: 78 research, 92 support administration |
| South Africa | | | | | |
| Forestry and Forest Products Research Center (FFP) | Public and private | Information, research, consultation, education, training | Site and terrain classification, remote sensing, geographic information systems, resource evaluation, wood properties, pulp and paper analysis, software development | NA | 11 total lead staff contacts |

| Organization | Clients | Services provided | Research program directions | Budget and financing | Scientists and staff |
|---|---|--|---|--|--|
| Institute for Commercial Forestry Research (ICFR) | Public and private, owner-member emphasis | Information, research, consultation, education, training | Tree improvement, applied silviculture, wood utilization, harvesting impacts, forest management | 12.5 million (ZAR), 100% industry | 59 total staff: 40 research, 19 administration |
| Sweden | | | | | |
| Forestry Research Institute of Sweden (Skogforsk) | Public and private | Information, research | Tree improvement, silviculture, wood utilization, forest harvest technologies | 110 million (SEK), 50% services, 50% government and industry | 100 total staff: 60 research, 40 administration |
| Swedish Institute for Wood Technology (SP-TRATEK) | Public and private | Information, research, consultation, testing, training | Processing and processes, materials and products, building and housing, furniture, quality and testing | 54.6 million (SEK), 14% federal government, 35 % third party, 51% services | 56 total staff: 36 scientists, 20 support administration |
| Pulp and Paper Research Institute- Institute for Packaging and Logistics (STFI-Packforsk) | Public and private, owner-member emphasis | Information, research, consultation, testing, training | Paper, pulp, energy, packaging | 274 million (SEK) | 250 total staff (estimated): 200 research, 50 support administration |
| Swedish Wood Ultrastructure Research Center (WURC) | Public and private, owner-member emphasis | Research, consultation, training | Wood chemistry, wood mechanics | 18.1 million (SEK), 33% each industry, universities, federal government | 70 total staff (estimated) |
| Switzerland | | | | | |
| Swiss Federal Laboratories for Material Science and Testing (EMPA) | Public and private | Information, research, consultation, training | Wood structure and properties, wood composites, wood safety and durability, | EMPA Wood Laboratory 21 total staff assigned to research, 50 support administration 1.7 million (EUR); 60% government, 40% services-third party sources | 21 total staff assigned to Wood Laboratory |
| Taiwan | | | | | |
| Taiwan Forestry Research Institute | Public and private | Information, research, consultation | Forest biology, silviculture, economics, forest protection, wood utilization, wood chemistry, papermaking | NA | 338 total staff: 137 research-technical, 210 support administration |
| United Kingdom | | | | | |
| Timber Research and Development Association (TRADA) | Public and private, owner-member emphasis | Information, research, consultation, certification, training | Structural construction and engineering | 628,000 income (GPB) | 50 total staff (estimated) |

and packaging industry, manufacturers of laminated beams, wooden frame constructions and roof elements, wood preservation industry, wood preserving agents industry, suppliers of wood adhesives materials, furniture industry, paint industry, wood trade companies, governments, associations, builders and contractors, and building supervisors.

The absolute number of clients served by a research organization can be substantial. Although not all situated within the scope of the wood-based industry, the VTT reports serving more than 5,000 clients annually. Some organizations have a long tradition of serving the research needs of the wood-based industry, yet the latter may not always be the primary focus of their research programs. An example is New Zealand's SCION, which in 2003 reported that half of its top 10 clients were non-forestry companies. The clients served by research organizations often require that the information generated in response to their request be given proprietary status. Although such arrangements for confidentiality are common, they do have an impact on the extent to which the results of research enter the public domain. An example is the position of ICFR, "...since the ICFR is fully funded by private companies, our research outputs are not always placed in the public domain, rather classified as proprietary to the contributing [company] members of the ICFR."

Forest products research organizations often view the market for their services to be beyond the nation in which they happen to be formally chartered and headquartered. Organizations with a worldwide interest in clients include Australia's Ensis (seven offices in Australia, two in New Zealand), New Zealand's SCION, France's CTP, and the EMPA (Switzerland). In addition to offices in Finland, the VTT serves clients through an office in the United States (California). Approximately 25% of revenue generated by the Norwegian Institute of Wood Technology comes from projects and services performed for foreign clients. Some organizations are very bold in their future interest in clients worldwide. The PFI of Norway specifically states its aim is "to carry out research and contract work for customers world wide."

Services Provided

The case-example research organizations provide an extensive array of services. Acknowledging that a single organization may provide more than one service, major categories of service are as follows (Table 4) (see Appendix A): Research (products, processes, new technologies), 40; consultation (expert advice, guidance), 36; information (reports, synthesize information), 35; training (conferences, workshops, continuing education), 27; testing (examination of quality, performance, reliability), 12; education (basic college-level experiences), 5; certification (achievements, documentation of facts), 4; and pilot scale production (prototype guidance), 1.

None of the organizations provide services in all eight of the categories listed above. One organization provides 6 of the

services; 16 provide 5; 11 provide 4; 8 provide 3; 3 provide 2; and 1 provides services in only a single category.

The nature of the services provided in the aforementioned categories is best appreciated by illustration from an example organization.

- *Research:* Australia's CRC provides its owner-members with research generated information involving microwave processing of wood (reducing growth stress, wood drying, wood composite, fundamental science), value-added technologies (wood surface finishes, technology-led design, wood bending, extending lifespan), and raw wood enhancement (pyrolysis bio-products).
- *Consultation:* Holzforschung Austria provides consulting and expert reports in a variety of fields, including timber structures, wood residues, furniture, and adhesives.
- *Information:* Forintek Canada Corporation provides free or fee-based library research services, using its extensive library resources (access to over 500 in-house scientific and technical journals, extensive international online and CD-ROM databases, as well as a collection of over 100,000 documents).
- *Training:* The Pulp and Paper Research Institute of Canada (Paprican) offers short courses for professional development involving the engineering of papermaking, printing processes, marketing of pulp, and wet-end papermaking chemistry.
- *Testing:* The Netherlands' SHR Timber Research provides for the building industry sector on-site testing of material characteristics and testing of the performance of semi-finished and finished products for characteristics such as durability (rapid aging), wind and water tightness, resistance to burglary, and the bonding of adhesives.
- *Education:* South Africa's FFP offers graduate research study opportunities (Masters and PhD programs) in various fields in conjunction with the University of Kwa-Zulu-Natal.
- *Certification:* The United Kingdom's TRADA offers certification services in a number of areas, including CE Marking (European Trade Certification), Eco-Management Assessment Scheme (EMAS), environmental management certification to ISO 14001, health and safety management certification to Occupational Health and Safety Advisory Services (OHSAS) 18001, Integrated Management Systems (IMS) Certification, Q-Mark product certification schemes (product quality), quality management systems certification to International Standards Organization (ISO) 9001, and TRADA Trak-FSC Chain of Custody certification.
- *Pilot scale production:* Finnish Pulp and Paper Research Institute (KCL) offers pilot trials involving mechanical pulp preparation, experimental newsprint production,

coating and surface sizing, machine calendaring trials, and sheet-fed offset printing.

Research Program Directions

The research mission of forest products research and development organizations is made workable when strategies and objectives are established. It is at that time that distinct goals, external support, and organizational capacities are established and brought together—the result being a research strategy. Usually in response to issues or problems, the practical expressions of a research strategy are the programs (sets of related activities) that an organization seeks to implement. For example, the SP-Trätekt has a mission of engaging in research to strengthen the competitiveness and long-term profitability of the Swedish wood-based industry. This mission is to be accomplished by activities occurring in four major research and development program areas: processing and processes, materials and products, building and housing, and quality and testing. Similarly, the mission of Australia and New Zealand's Ensis is to address complex problems at a scale that will help the wood-based sector remain globally competitive, an intention that is brought to life by research in seven program areas: genetics, sustainable forests, environment, wood and fiber quality, biosecurity and protection, wood processing, pulp-paper-packaging.

The research programs of interest to an organization are not always uniformly labeled across the forest products research sector. Considering the case-example organizations reviewed here, some choose to label their research programs as “fields of research,” while others prefer labels such as “target areas,” “research clusters,” “core research fields,” “topical areas,” “problem areas,” and “entry portals.” In some cases, research programs align with the administrative structure of an organization, such as the departmentally grouped programs of Poland's Research and Development Centre for Wood-based Panels, or the Taiwan Forestry Research Institute, which groups its research programs into 10 divisions. Also, the specificity with which research programs are identified is quite diverse. At one extreme is Sweden's WURC, which identifies “fiber chemistry of wood polymers at the molecular level” as a research program area; at the other extreme, New Zealand's SCION reports three major research areas: “commercial forestry research and development,” “biomaterials research,” and “sustainable consumer products.” In between this range of specificity is Japan's Hokkaido Forest Products Research Institute, which labels four research program areas: “timber engineering,” “wood unitization,” “wood processing,” and “mushroom culture.”

The research program directions implemented by the case-example organizations vary significantly in focus, scale, and breadth (Table 4) (see Appendix A). To say that all such organizations are uniform in their research interests would be misleading. Yet for the most part, they tend to focus research

on forest products, forestry and forest management, or some combination of these two broad subject areas. Twenty-two of the organizations appear to have *forest products* as a primary focus, 11 have *forestry and forest management* as a primary focus, and seven conduct research in both areas. As for the 22 organizations that focus primarily on forest products, only four or five appear to engage in both solid wood products research and pulp and paper research. Some organizations have administratively divided their research programs in order to respect geographic differences in research needs. An example is Canada's FERIC, which has eastern and western operational divisions.

The organizations engaging in forest products research tend to be involved in one or more of the following subjects: Pulp and paper, France's CTP; wood composites, Poland's Research and Development Centre for Wood-based Panels; furniture, Germany's IWT; engineered structures and mechanics, United Kingdom's TRADA; and wood processing and preservation, Taiwan Forestry Research Institute.

Those with a forestry and forest management focus are concerned with the following subject matter: Fiber production, South Africa's ICFR; forest protection, Slovak Forest Research Institute [FRIS]; marketing and economics, Finland's European Forest Institute; harvest systems, FERIC (Canada); and fish and wildlife, Latvian State Forestry Research Institute (Silava).

Financing and Budgets

An activity of special importance in the administration of all research organizations is raising and allocating money (Billings and others 2004). For private research entities, the challenge is one of offering information and services for which customers are willing to pay. For public entities, financial and budget issues center on an ability to make a strong case (to legislative systems or to hierarchal leadership) that the research opportunities being recommended are in the broader public interest and therefore worthy for public investment. The case-example research organizations reviewed here have a number of special characteristics regarding financing and budgets, of which revenue sources, financial allocations, and pricing of services are especially noteworthy (Table 4) (see Appendix A).

Source of Income

Financial resources required to operate research organizations can originate from many sources, both public and private (Table 4). Indicative of this diversity is the plethora of descriptors that are used to identify income sources, including “member fees,” “contract work,” “grants,” “commissioned research,” “consulting,” “royalties,” “industry funding,” “member contributions,” and “third-part-funding.”

For purposes of analysis, however, sources of income can be meaningfully grouped into five major categories: government funding, membership fees, payments for services, investment income, and in-kind support. For private

independent research organizations, 35% to 40% of their income comes from payments for services, 20% to 25% from member fees, 15% to 20% from government, and 15% to 20% from a variety of other sources. For private independent, government-authorized organizations, the proportions are 45% to 50% government, 25% to 30% payments for services, 15% to 20% other revenue sources, and 5% to 10% member fees. Because information describing other major income categories is very limited, generalizations about their magnitude are of little value. Following is information about the income sources of forest products and related research organizations (case examples) by source, 2004–2005:

Private Independent Organizations

Organization A

- Member companies—67%
- Grants and contracts—12%
- Federal government—20%
- Royalties and other—1%

Organization B

- Owner company fees—40%
- Contract for services—51%
- Government funding—9%

Organization C

- Government (federal)—44%
- Pulp and paper industry—26%
- Other public and private contracts—30%

Organization D

- Ministry of Industry—29%
- Associated contracts—19%
- Private contracts—14%
- Diagnosis and consulting—31%

Other income sources—7%

Organization E

- Services-project fees—89%
- Member fees—11%

Organization F

- Contract for services—100%

Organization G

- Private industrial sources—72%
- Government sources—28%

Organization H

- Nationwide industry organization—50%
- Member direct funding—50%

Organization I

- Member fees—68%
- Investment Income—6%
- Other Income—26%

Organization J

- Services and commission work—50%
- Government and industry—50%

- Federal government grants—50%
- Forestry and forest industry—50%
- Fixed member fees—25%
- Research grants—75%

Organization K

- Industry funding—50%
- Public agency funding—20%

- Contract work and services—30%

Private Independent, Government Authorized Organizations

Organization A

- Government—89%
- University—7%
- Private—4% (plus in-kind contributions)

Organization B

- Industry members—47%
- Contract, grants, other—35%
- Canadian Forest Service—14%
- Provincial Governments—4%

Organization C:

- Commissioned research—40%
- Business commissions—40%
- Member contributions—3%
- Other sources—17%

Organization D

- Member assessment—66%
- Contract fees for services—32%
- Other income—2%

Organization E

- Government—58%
- Services provided—15%
- Third-party industry and government—27%

Organization F

- Industry funding—50%
- Public agency funding—20%
- Contract work and services—30%

Organization G

- Basic government funding—31%
- Private sector, domestic—33%
- Public sector domestic—25%
- Public and private foreign—11%

Organization H

- Government (operating)—56%
- Development—15%
- Research—13%
- External agencies—7%
- Investment income—3%
- Other sources—6%

Organization I

- Government—40%

- European Commission—39%
- Special project funding—13%
- Membership fees—6%
- Other sources—2%

Private-public, Joint Venture Organizations

- Organization A
- Industry—34%
 - Universities—33%
 - Federal research agency—33%

Public Government, Independent Organizations

- Organization A
- Government basic grants—25%
 - Government administrative support—12%
 - Commissioned research—41%
 - Strategic institute programs—15%
 - Fund for forestry development—5%
 - Other revenues—2%

- Organization B
- Federal funds—14%
 - Third-party funds—35%
 - Services provided—51%

Public Government Organizations

- Organization A
- Government (federal, other levels)—100%

- Organization B
- Ministry of Agriculture and Forestry—73%
 - Other ministries, service fees—27%

- Organization C
- Government competitive grants—71%
 - Government projects—23%
 - Government other sources—6%

- Organization D
- Direct government allocations—86%
 - Other sources—14%

There are a number of noteworthy features about the funding of the case-example organizations. Some rely on a stable long-term core of funding provided by government, as is the situation with the European Forest Institute (EFI), which receives 40% of its funding from the federal government of Finland. Core funding is often used for a variety of purposes, including financial support for an organization’s research programs (as is the case with EFI), support for “basic research” that would not be undertaken by the private sector (for example, university support of Sweden’s WURC), or funding (whole or in part) of basic administrative and operational activities of an organization (for example, Skogforsk and the Malaysian FRIM). Some research organizations rely on a national consortium of companies for financial support. An example is the ICFR of South Africa, which secures half of its operating funds from Forestry South Africa (a

nationwide company-sponsored industry organization). Research organizations may become discouraged with the source of their financial support. Some have become especially disheartened with the increasing uncertainty of government as a stable source of income and have set out to become financially self-sufficient. An example is the FRIM, which has a stated policy of “... achieving 70% self financing by year 2008,” doing so by increasing revenue from the sale of products and technical services and increasing income from royalties, licenses, investment, and rental property.

Research organizations can also be active competitors for research money managed by large science-promoting agencies (competitive grant programs). An example is the Latvian State Forestry Research Institute (Silava), which must seek operating and program funds from government agencies through various competitive bidding processes. Similarly, New Zealand’s IRL looks for funds from the New Zealand Ministry of Research, Science and Technology, whereas the VTT competitively seeks funds from Finland’s Ministry of Trade and Industry and from the National Technology Agency (Tekes). The latter is Finland’s main public funding organization for research and development. In addition to funding various industrial projects, the agency seeks to fund research programs that are risk-intensive but that will promote innovation in processes and products.

A greater appreciation of the funding sources accessed by forest products research organizations can be attained through examples. Consider the following.

Skogforsk, Sweden

With annual income in 2004 of approximately 110 million (SEK) (U.S. \$14.0 million), that income originated from the following sources:

| | |
|-------------------------------------|--------------------------------------|
| Services and commissioned work | 50% (55 million Swedish krona (SEK)) |
| Government and forest industry | 50% (55 million SEK) |
| Federal government grants | 50% (27.5 million SEK) |
| Forestry and forest industry sector | 50% (27.5 million SEK) |
| Fixed member fees | 25% (6.9 million SEK) |
| Research grants | 75% (20.6 million SEK) |

A “framework” agreement (for a 4-year period) guides the development of 50% of the Institute’s budget. The agreement is the result of negotiations between the federal government and the private forestry sector, with each contributing 50% of the funding necessary to cover the research activities agreed to by the two sectors (however, there is no upper limit on contributions of the private forestry sector). The portion (50%) contributed by the forestry and forest industry sectors is derived from (a) fee assessed member companies and organizations (25% of sector’s contribution; fee is based on ownership of productive forest area and site productivity) and (b) variable research grants (75% of sector’s contribution; levy of 0.60 SEK per cubic meter of harvested timber and pulpwood).

Paprican, Canada

With annual income in 2003 of \$39.4 (Canadian dollar (CAD))(U.S. \$34.0 million), that income originated from the following sources: Member companies, 67% (\$26.6 million CAD); grants and contracts, 12% (\$4.6 million CAD); federal government, 20% (\$7.7 million CAD); royalties and other, 1% (\$0.5 million CAD).

In 2003, Paprican received significant financial or other tangible support from 33 allied industry partners and from four major governments: Government of Quebec (Ministry of Science and Technology Research, Ministry of Natural Resources), Government of British Columbia, Government of Canada (Environment Canada, Industry Canada, National Research Council Canada, Natural Sciences and Engineering Canada), and the U.S. Department of Energy.

STFI-Packforsk, Sweden

With annual income in 2004 of approximately 274 million (SEK) (U.S. \$31.3 million), that income originated from the following sources (estimated): Industry funding, 50% (117 million SEK); public agency funding, 20% (47 million SEK); and contract work and services, 30% (70 million SEK).

The major part of STFI-Packforsk's research program is funded jointly by partner companies and by government. Example public funding sources are European Commission, Nordic Industrial Fund, Swedish Environmental Protection Agency, Swedish Waste Research Council, and the Foundation for Strategic Environmental Research. Primary public funding sources are the Swedish Energy Agency (STEM), and the Swedish Agency for Innovation Systems (VINNOVA). Private non-company research funding originates from sources such as the Swedish Pulp and Paper Research Foundation and the Forest Industry's Water and Air Pollution Research Foundation. STFI-Packforsk also receives service and contract revenue from a large customer base outside the partner companies.

FPRDI (Philippines)

Although specific amounts of funding by source are not available for the FPRDI, the funding sources are as diverse as the Government of the Philippines, local funding agencies, Philippine Council for Industry and Energy Research and Development, and Department of Science and Technology-Grants-in-Aid, and various International Organizations: International Tropical Timber Organization (ITTO); Australian Centre International Agricultural Research; Agri-Technological Institute.

Skogforsk, Sweden

With annual income in 2003 of approximately 76 million Norwegian krone (NOK) (U.S. \$11.4 million), that income originated from the following a variety of sources as follows: Commissioned Research (such as Ministry of

Agriculture, Research Council of Norway), 41% (31.2 million NOK); basic grants (Research Council of Norway), 25% (19.0 million NOK); Strategic Institute Programs (NFR), 15% (11.4 million NOK); national responsibilities, administrative support (Ministry of Agriculture), 12% (9.1 million NOK); Fund for Forestry Development, 5% (3.8 million NOK); and other revenues (such as teaching assignments), 2% (1.5 million NOK).

Financial Allocations

The 40 case-example organizations are challenged to effectively allocate income among many competing programs, not all of which involve research (for example, consultation, testing, training, certification). For private organizations, the allocation of income among program areas is typically decided by an organization's executive staff with guidance from research planning and technical advisory committees. In some cases, member companies have appreciable control over how their membership fees are invested. Such is the case with Paprican, which allows member companies to direct up to 35% of company fees to specific program areas and up to 15% of fees to the application of technologies in company-owned mills. For government organizations, executive staffs have considerably less flexibility in allocating income, in that legislative and other higher authorities may attempt to focus funding on specific programs.

Generalizations about the financial allocations of the case-example organizations are risky, since so few organizations report expenditures by program area (proprietary interests are often claimed) (Table 4) (Appendix A). Only two organizations report expenditures among broad program categories. They indicated 70% to 80% of their revenue was spent on research, 5% to 10% on education and technology transfer, and 10% to 20% on general administration. One of the case-example organizations reported that 28% of its revenue was spent on exploratory research, while 46% was invested in applied industrial research (remaining 26% was administration). Reporting in a detailed line-item fashion, two other case-example organizations reported spending 60% to 70% of their revenue on salaries and related benefits and 20% to 30% on laboratory and related infrastructure. Greater appreciation of financial allocation can be obtained by the examples that follow.

Forest Products and Related Research

EMPA, Switzerland: basic wood sciences, 19%; wood protection, 31%; wood technology, 31%; timber engineering, 19%.

WURC (Sweden): mechanical and physical properties of fiber materials, 31.9%; cell wall ultrastructure, 27.5%; fiber chemistry at molecular level, 15.1%; wood and pulp fiber models, 11.0%; managerial expenses, 8.2%; WURC joint expenditures, 6.3%.

SP-Trätek, Sweden: processing and processes, 18%; materials and products, 23%; building and housing, 28%; and quality testing, 31%.

Forestry and Related Research

EFI, Europe: Forest ecology and management, 30%; forest products and socioeconomics, 15%;, policy analysis, 20%; forest resources information, 35%.

COFORD, Ireland: Environmental aspects of forestry, 38%; silviculture and forest management, 35%; reproductive material and forest nurseries, 10%; socioeconomic aspects of forestry, 8%; wood products and process development, 5%; harvesting and transport, 4%.

Metla, Finland: Forest ecosystems, 31%; forest growing and utilization, 20%; forest genetics, 11%; monitoring and inventory, 9%; forest policy and economics, 9% (3.0 million); information systems, 6%; and research forest and laboratory services, 14%.

Pricing of Services

Many of the case-example research organizations enter into contractual arrangements to provide services and products to interested parties (see Appendix A). Virtually all the private independent organizations are so involved, as are many government research organizations that are authorized to engage in fee-for-service activities. In most cases, the services to be provided are configured individually and the fee-for-services to be provided is determined by negotiation. In some cases, fees are guided by state law as is the case in Finland where services provided by Metla are charged according to principles established by the Act on the Basis for Determining Payments for State Services.

The pricing of services becomes especially challenging when the services offered are many and are wide-ranging in type and complexity. For example, Finland’s KCL offers extensive laboratory services in 18 different categories (for example, testing of mechanical pulp, optical properties of paper, packaging materials safety, biofuel and waste fiber analysis, microbiological testing), some categories of which have 50 or 60 subcategories (for example, 11 subcategories within mechanical pulp testing, including testing of fiber and fines properties, sorption properties, strength properties, stiffness and compression, and pulp permanence). The Malaysian FRIM has one of the more sophisticated publicly advertised structures for service fees (which can be charged to credit cards). Fees for services are clearly specified for more than 85 service areas and more than 500 specific services within these areas. Example services are evaluation of adhesive quality, U.S. \$93 per test; fire resistance tests for doors or walls (30-minute test), U.S. \$934; prototype testing of timber structures, U.S. \$249 per structure; wood preservation consultation, U.S. \$156 per person per week; and tree improvement planning, U.S. \$93 per person per week.

Scientists and Staff

Scientists and staff are among the most important resources of a research organization. Recruiting and retaining well-educated and experienced persons that can successfully work in support of an organization’s mission is essential to attaining high levels of organizational performance. The case-example research organizations reviewed here range in staff size from less than 20 staff to Australia’s CSIRO, which can claim access to more than 6,000 staff worldwide. For the case-example organizations, the distribution of staff size (combined scientist, researcher, technician, management, administrator) is as follows (approximately 7,000 total staff) (Table 4):

| Staff members | Number of organizations | Total Staff (%) |
|---------------|-------------------------|-----------------|
| 1 to 50 | 19 | 14 |
| 101 to 200 | 9 | 20 |
| 201 to 300 | 4 | 14 |
| 301 to 400 | 4 | 20 |
| 401 or more | 4 | 32 |

On average, 65% of an organization’s staff is considered to be scientists or researchers, while the remaining portion is assigned to managerial and administrative activities. As for educational attainment of research staff, many have advance degrees. For example, 47% of the 321 researchers employed by the Metla (Finland) have a PhD degree, as do 48% of 453 scientists at the Forestry and FFPRI. Of the 75 researchers at Skogforsk, 53% have completed requirements for a PhD degree. Some organizations engage the research and educational interests of graduate students as an important part of their research program. Examples are the French Pulp and Paper Research and Technical Centre (CTP), FFP (South Africa), EMPA (Switzerland), and PFI (Norway).

Some of the case-example organizations have research programs that involve both forestry and forest products. For these few, the distribution of staff between these two major program areas is highlighted by the following examples:

| | Forest products | Forestry |
|---|-----------------|----------|
| BFH (Germany) | 55% | 45% |
| Taiwan Forestry Research Institute (TFRI) | 25% | 75% |
| FRIM (Malaysia) | 62% | 38% |

The allocation of staff research efforts among various problems or issue areas is in all likelihood quite variable for the case-example organizations reviewed here. Unfortunately, such information is not uniformly reported across these organizations. Examples will have to suffice as follows (percentage distribution of staff).

Forest products and related research, Forintek Canada Corporation

- Composites 21%
- Lumber manufacturing 12%

| | |
|-----------------------------|-----|
| ▪ Building systems | 29% |
| ▪ Drying and protection | 18% |
| ▪ Resource assessment | 6% |
| ▪ Value added manufacturing | 14% |

FPRDI, Phillipines

| | |
|---|-----|
| ▪ Furniture and handicrafts | 28% |
| ▪ Housing materials and construction technologies | 24% |
| ▪ Material science | 22% |
| ▪ Handmade paper | 13% |
| ▪ Chemical products and biomass energy | 13% |

SHR Timber Research, Netherlands

| | |
|---|-----|
| ▪ Timber products for building construction | 50% |
| ▪ Wood technology | 34% |
| ▪ Coatings | 10% |
| ▪ Furniture | 6% |

Forestry and related research, ICFR, South Africa

| | |
|---|-----|
| ▪ Administration (director, financial, personnel) | 27% |
| ▪ Functional support (publications, computers, library) | 17% |
| ▪ Forest nutrition research | 12% |
| ▪ Eucalypt tree improvement research | 10% |
| ▪ Forest productivity research | 17% |
| ▪ Plantation reestablishment research | 10% |
| ▪ Acacia tree utilization research | 7% |

Skogforsk, Sweden

| | |
|----------------------------|-----|
| ▪ Forest-timber production | 55% |
| ▪ Wood supply | 45% |

Silava, Latvia

| | |
|----------------------------------|-----|
| ▪ Forestry | 78% |
| ▪ Game management | 12% |
| ▪ Forest products and harvesting | 10% |

Administrator Perspectives

The executives and management staff of forest products and related research organizations were also asked for their insight on the administration and operation of research organizations generally. Specifically, they were asked to provide the following information about the organizations for which they were responsible: “Forest products research organizations can conduct (or carry out) their operations in many different ways. For example, special attention may be focused on clients and customers (a strong focus on service), leadership (appointment of creative and enterprising executives), sources of finances (government, private, or some combination), research and supporting staff (employment of talented and energized persons), communication (promotion of information flows within and outside the organization), risk taking (welcoming challenges and new opportunities), blend of programs (focus on research, or service, or some combination), and orientation of research (focus on basic, or applied, or some combination; forestry, or forest

products, or some combination). In your judgment, what *three features* of (...organization’s name...) administration and management enable it to effectively carry out its mission?” With only slight paraphrasing of respondent replies, the administrators identified the following.

Clients and Patrons

- Being a private, applied research institute, clients and customers needs and their satisfaction must always be focused on and given high priority. Orientation of research must harmonize with owners/members/customers demands. A research result is of little value until it is known and applied. Hence, significant efforts and measures must be taken to communicate new findings and relevant knowledge to different target/customer groups.
- Our organization is expected to contribute to real economic growth ... so attention to user needs is critical. Our program is a careful blend of research and commercialization-utilization activities that are focused on clients.
- Success requires a focus on customers, focus on competencies most needed in the future, and strong networking both inside and outside the science community and with strong global players.
- [Our national research plan] links the attributes that are demanded by clients in the marketplace to processing technologies and the characteristics of the wood resource.
- Success is embodied in a strong focus on member company satisfaction. [Our organization] has been an early adopter of what was popularly known as 3rd generation R&D management when it was first promulgated by Arthur D. Little in the early 1990s. Our governance processes ensure that we work on member company priorities, and that we actually deliver the results of our research program to our members. This was one of the big differences in 3rd generation R&D approaches compared with earlier forms in which research organizations were funded on the basis that they would do good work.
- Characteristics that enable [our organization] to effectively carry out its mission: client-focused, talented and committed staff, multidisciplinary approach to problem solving, and demonstration of valuable return on research investments.
- As an industry-related institute, our three main activity centers are clients and customers (we do quite a lot of industrial research), blend of programs (to guide our partners from the industry to relevant research programs), and risk taking (by engaging in and applying financially risky research, often through use of industrial trials and experimentation).

- Being client-focused means fully understanding the needs and priorities of [our organization's] members, including their need to see value from research and development. In addition to actively seeking input and guidance from industry and government members through a member advisory process, our organization has a market and economic group that works with universities, industry associations, and customers of wood products to examine market issues, changing customer preferences, competitive intelligence and market trends. This provides a higher level of analysis to guide [or national research program], making it proactive and responsive to change.
- Emphasis is on client-oriented user-friendliness: providing information in user-friendly databases; publishing reports, especially reports aimed at decision makers.
- To have satisfied customers is a must. We are now asking our customers to evaluate our performance (short questionnaire) in order to constantly improve our performance and our communication systems.
- Focus is on clients and customers. We have changed what we offer our members - making our membership offering much more commercially focused. This also helps when we sell our commercial services.
- It is extremely important to deliver expected results to our clients, especially when it comes to quality products and meeting client time schedules.

Communication

- Communication with clients is very important. Through our website program, we have increased the frequency and reach of our communication several fold, which is greatly increasing our ability to achieve our goals.
- We believe in communication of research results. Approximately 20% of total budget is allocated to communication of knowledge.
- All research results are communicated effectively: a special emphasis is on the dissemination of research results to various clients and target groups. Publications and seminars are an integral part of research activities.
- We place huge emphasis on communications with our member companies, including on-line, web-accessible research reports, research project plans and interim results, conference reports (we are the watchdog for many research areas on behalf of our members), and more. We also have developed a very powerful interaction reporting system which is also on-line for individual company access to [our organization]. It is like a customer relationship management system. All interactions with each member company mill (other than those of a trivial nature) are captured electronically. These are then available for all [our] research staff to see and use, and are also available for each company for their own interactions so that they will be aware of the nature, frequency, and details of all contacts with member mills, whether driven by [our] staff or member company staff.

Blend of services

- Success for us means a clear focus on basic and applied research (60% of time and budget) and a limitation of [time and resources] devoted to services testing (20%) and education (10% to teaching, workshops, conferences).
- To better orient our research, we are going into partnership with [another major research organization] so we can focus on those areas where [our] expertise is best and complementary to that of the [other organization].
- Orientation of our research is on applied research and the further refining of the results of basic research.
- By applying a multidisciplinary approach to problem solving, [our organization] is able to add more value through providing multifaceted solutions. When a particular expertise is not available in-house, [our organization] forms research alliances with others to add that capability in problem solving.
- A very important factor for our organization is balance of research and application. We often say that without research we have no product to sell, and without application, we have no customers to pay for the research. We work hard as a management team to keep these two in balance.
- Research is oriented to solving current needs of the industry connected with manufacturing processes, updating technology, applying new auxiliary measures appearing on the market (for example, adhesives, measures to make boards water-repellent), and expanding the use of wood-based panels.
- Most private companies have relatively short future time horizons (many see only the current operational year), yet the type of research we do is often of a much longer term.
- One way to ensure research relevance is to assess potential value return from a piece of research up-front, at the planning stage. This information is shared and discussed [by our advisory committees] so members could make informed decisions on a balanced portfolio of low-risk and high-risk research projects.
- Companies that are members of our institute also have significant in-house research operations. As such, there is movement of staff from institutions like ours to the companies. We therefore play a human resource development

role for industry, which has an effect of slowing progress with our own research programs (time-consuming mentoring of young researchers, lack of long-term continuity in our research skills).

- Research is conducted in consortia with the best suited partners—for each project, the best partners are looked for. Our organization plays a key role in identifying the network and bringing partners together to address a problem.
- [We work to] satisfy the requirements of clients by providing information within the scope of manufacturing technology and the usage of products; evaluating the quality of manufactured products, especially taking into consideration their compliance with [government] standards and directives; measuring and inspecting the emission of pollutants into the atmosphere; measuring values of harmful factors on particular work stations; and working out construction and implementation of unique apparatus and equipment in accordance with the needs of the industry.

Employees and Leadership

- Brains are the core of our research business—and let there be no doubt about it!
- We are a flat, non-hierarchic organization [which is administratively] demanding, but effective. All employees, including management, are measured on results every month. Good results (earnings and individual performance) will influence the wage level.
- Our staff is highly trained and committed to serving the wood sector. They welcome challenges and new opportunities and are responsive to client needs. They maintain a “can do” attitude and are ready to offer expert advice.
- [We have moved to] change our staff focus away from support staff towards a higher percentage of research persons.
- We must invest in research to have the world-class staff needed by our member companies. We also need the results of the research program as the basis for our products and applications 5 to 10 years down the road. However, without the applications, our customers will not be happy. We have managed to motivate our research staff now so that (unlike academic researchers who are recognized for their publication record) our scientists are measured by the technologies they have applied in the field. [However, we do] encourage publication so that our scientists become recognized internationally by their academic peers, and we are proud of our patent portfolio and applications which gives our applied scientists the same recognition by their counterparts in the commercial world.

- Talented research and supporting staff is a must. People make the difference—it’s true and as simple as that. To have researchers who are also able to market and sell research is absolutely necessary, but they are not so easily found.
- Our plans are to expand the scientific background of our staff, away from exclusively wood specialists toward chemists, physicists, and material scientists.
- Leadership is critical to ensuring constant development of the industry and its updates, [especially with regards to] expanding the base of raw materials, improving manufacturing technology, working out new directions for the use of manufactured products, adjusting properties of products to the needs resulting from their application, improving working conditions, and protecting the natural environment.
- A world-class research staff is critical to success. The quality of our research staff gives us both breadth of coverage over many technologies of relevance to our members, and depth for individual technical areas. The combination gives [our organization] a systems capability when it comes to applications of technology and for examples when member companies come to us with complex problems to solve. It means, for example, that we can tie an apparent low performance of a paper product back to the fundamental properties of individual fibre species, or we can relate a corrosion problem in a mill to the chemistry of the wet end of the paper machine or the bleach plant. The quality of the research staff means that we can attract scientists from all over the world to work, and we generally have a very low attrition rate with many, many staff having spent upwards of 25 years [with our organization]. This gives superb corporate memory and adds to the strengths of our scientific capabilities.

Financing and Budgets

- Our organization is a nonprofit organization that is not dependent on one financier alone. This means that we have relatively high flexibility to use funds and can act quickly to meet arising research needs.
- Public ownership of our research organization is especially important as regards funding. Without access to a continuing flow of public funds, the volume of our research would be much less.
- An adequate funding structure is essential. In our case, the model is a 4-year frame of work [program] jointly funded by the private forestry sector and government (50% of total budget). This safeguards continuity in our program. A portion of the funds is allocated to more long-term oriented research and development.

- Financing of projects for particular clients is provided directly by the clients themselves. In contrast, research and development works of general importance are carried out thanks to subsidies from forest industry, government, and from a special fund for the development of science.
- Our research has changed considerably because government funding has virtually disappeared. However, when the funding did exist, it encouraged us to research topics that weren't really the most important. Now we need to rely almost entirely on our own funds. We will be focusing on those things that most need researching, rather than those topics for which you can obtain funds.
- To have a guaranteed income from four large industrial concerns is a blessing (formerly they were ever-changing members that paid a membership fee). However, we need to find funds for projects on our own. The public sector is a source for more basic research if you are able to come up with good research proposals. It is also necessary to attract short-term projects from various customers (such gives us contact with and appreciation for their daily problems).
- We are an economically healthy private organization with no public funding. We have a large scope for maneuvering and can make allocation decisions quickly and efficiently.
- A balance of funding (long-term sustained funding versus short-term operational funding) is critical to a successful research program. Government funds need to be available to ensure long-term continuity in our research programs.
- We are a private organization that operates in a partnership structure based on shared risks, shared costs, and shared benefits. This structure allows the [...federal government, provincial governments...], and companies producing solid wood products to provide financing toward a core research program that is the heart of our organization's research effort. The original funding formula was 50% federal, 25% provincial, and 25% industry. This has changed over time—today the ratio is 33/25/42.
- The articles of our incorporation and our not-for-profit status allow industry members to benefit from any research and development tax benefits that are offered [by government]. The leveraging effect is an incentive for industry to join our research partnership and pay dues based on their product production.
- Our sources of finances are more and more private industry (now about 40%) and less government financing (about 60%).
- Although the support from our members has been excellent, the industry is subject to a range of economic pressures (global pulp price fluctuations, currency fluctuations) and local economic and political pressures (labor, environmental). This inevitably places pressure on company research and development budgets and has a direct effect on the finances of our institute.
- A split of financing (60% federal, 40% third party monies) forces us to line up part of our activities to industry and industrial research programs.
- Nearly all research and development projects are dependent on industry participation (and often leadership), and at least 50% [of our] finances are from industry. Therefore, we have to understand and identify with the research and development needs of the industry. This is crucial in order for our organization to succeed.
- Our members provide the bulk of our operating budget, although some revenue comes from contract research, some from sale of intellectual property, and some from sponsorships of various forms.
- Our organization is financed almost entirely from subscriptions. Therefore, we only have one type of stakeholder to service, making it easier to be focused.
- Our director makes final decisions on current matters concerning financial operations for the research needs of clients. Research connected with the industry as a whole is financed by subsidies on the basis of a program established periodically by an advisory committee composed of representatives of industry. [The committee] identifies current needs of both the industry and the market, including possibilities for implementation of the research products.

Performance and Outcomes

Managers of forest products research organizations and the clients that seek the services of such organizations have more than just a passing interest in how well a research enterprise performs. Their interest in performance is motivated by a number of concerns, including a desire to strengthen the planning and management of research programs, making sure that research goals are relevant to broader goals involving national development, expanding and strengthening political support for research programs, and identifying promising future directions for the investment of limited resources available for research. Interest in performance can also be motivated by a desire to learn more about an organization's operation and the goods and services it provides, an interest in controlling or influencing the behavior of those that are directly responsible for leading and directing a research organization's programs, and a desire to influence the behavior of broader collections of persons and entities that can exert influence over an organization's mission and the way it is being pursued (Bremser and Barsky 2004, Coccia 2004). In recent years, scarce resources and budget deficits have increased attention to performance, forcing public and private officials to often justify their organization's very

existence and to logically rationalize the usefulness of the programs that are included within its purview.

Measures and Standards

Performance evaluations (determining worth, value, or merit) are useful to the extent that they are systematically undertaken, are grounded in accurate information, and base their judgments on explicit standards (criteria). Often included among the latter is an organization's public acceptance (trust, integrity, fairness), adaptability (response to economic, technical, and policy changes), competence (technical and professional proficiency), decision making (consistent, participatory, representative), economic efficiency (maximizing net benefits), accountability (client, directives, higher authority), and service and product provided (usefulness, current, progressive) (Alex 1998, Billings and others 2004, Coccia 2004). These performance categories suggest the broadness with which performance is to be viewed (more than just application of analytical techniques). For research organizations, standards of this nature can be especially difficult to define, let alone measure. Given such a reality, judgments about the performance of research organizations are usually focused on research processes (appropriateness of goals, reasonableness of time schedules, adequacy of staff and funding, comparison of planned and actual accomplishments) and on the impacts that the results of research have on science, the economy and society in general (new knowledge, improved economic efficiency, increased well-being of people).

The 40 case-example organizations were not subject to a sophisticated analysis of performance, which would be far beyond the intent of the review and the resources available to it. Rather, the intent was to identify the performance measures that are commonly used by these organizations. Although far more performance standards probably exist than are publicly reported by research organizations, an effort was made to systematically identify and synthesize the performance measures that the case-example organizations publicly reported through their web sites, annual reports, and various special documents. The result was identification of more than 100 different performance standards, the most frequently cited of which were the following categories (Table 5) (see Appendix A).

| Performance Standards | Organizations (No.) |
|---|---------------------|
| List of research publications | 28 |
| Highlights of research outcomes | 16 |
| Educational offerings | 11 |
| Number and satisfaction of clients | 7 |
| Statement of assets–liabilities, profits–losses | 7 |
| Patents granted | 4 |
| Product and process adoption rates | 4 |
| Accountable to a parent organization | 3 |

Although less frequently noted, other performance standards cited by the case-example organizations were consultancy frequency, earnings targets, contribution to knowledge,

contribution to citizen skill levels, member recruitment, member retention, upholding reputation, effective resource use, superior staff performance, return per FTE, research peer review, analyses undertaken, processes developed, attainment of organization plans, statements of progress, revenue per FTE, social responsibility, number of staff, staff turnover, staff development, services delivered, accidents prevented, management advances, and research and education focused on minority or disadvantaged segments of society.

Publications and Research Highlights

Nearly all the case-example organizations draw attention to progress since their last reporting period by issuing short summaries of carefully selected accomplishments and by individually naming reports and publications that present in detail the results of research and related activities (Table 5, see Appendix A). Most highlights and publication lists are presented in annual reports, although some organizations refer readers to web sites or to special reports; for example, “Brilliant Ideas at Work” (IRL 2003) and “Progress and Achievements” issued annually to members by Forintek Canada Corporation (2005).

Some organizations present research highlights and lists of publications in newsletters and magazines that are issued periodically during the year. For example, the Norwegian NTI *Tretekhnisk Informasjon* is distributed to member companies and selected target groups three times each year. Most organizations present a combined list of publications, while some, such as the SP-Trätekt, report publications for each major program area. For example, more than 150 publications in 2003–2004 for SP-Trätekt's buildings and housing program area. Publications of some organizations are not available to the public at large. For example, distribution of Forintek Canada Corporation's publications is largely limited to Forintek members. And even though all the publications issued by Canada's FERIC are publicly listed, many are proprietary since they were prepared in response to a client's request. Of 46 FERIC publications in 2004, 26 (56%) were restricted in their distribution.

Parent Organization Performance Standards

Performance standards are in some cases imposed on research entities by an entity's parent organization (Table 5, see Appendix A). For example, Australia's Ensis is accountable to its parent organizations, SCION and CSIRO. In 1995, CSIRO and other Australia Commonwealth science agencies established six performance indicators to use as indicators of commitment to continuing organizational improvement: (a) resources are consistent (in line) with customer demands, (b) income from external earnings exceeds 30% (research, services), (c) organization is responsive and directed to customer needs, (d) practices, processes, and products are adopted by clients, (e) contributions are made to world knowledge base (publications, patents), and (f)

Table 5. Income of forest products and related research organizations (case-examples) by source, 2004–2005

| Income sources | | |
|--|--|---|
| Private independent organizations | Private independent, government-authorized organizations | Private-public, joint venture organizations |
| Organization A Member companies—67% Grants and contracts—12% Federal government—20% Royalties and other—1% | Organization A Government—89% University—7% Private—4% (plus in-kind contributions) | Organization A Industry—34% Universities—33% Federal research agency—33% |
| Organization B Owner company fees—40% Contract for services—51% Government funding—9% | Organization B Industry members—47% Contract, grants, other—35% Canadian Forest Service—14% Provincial Governments—4% | Public Government, Independent Organization Organization A Government basic grants—25% Government administrative support—12% Commissioned research—41% Strategic institute programs—15% Fund for forestry development—5% Other revenues—2% |
| Organization C Government (federal)—44% Pulp and paper industry—26% Other public and private contracts—30% | Organization C: Commissioned research—40% Business commissions—40% Member contributions—3% Other sources—17% | Organization B Federal funds—14% Third-party funds—35% Services provided—51% |
| Organization D Ministry of Industry—29% Associated contracts—19% Private contracts—14% Diagnosis and consulting—31% | Organization D Member assessment—66% Contract fees for services—32% Other income—2% | Public Government Organizations Organization A Government (federal, other levels)—100% |
| Other income sources—7% | | |
| Organization E Services-project fees—89% Member fees—11% | Organization E Government—58% Services provided—15% Third-party industry and government—27% | Organization B Ministry of Agriculture and Forestry—73% Other ministries, service fees—27% |
| Organization F Contract for services—100% | Organization F Industry funding—50% Public agency funding—20% Contract work and services—30% | Organization C Government competitive grants—71% Government projects—23% Government other sources—6% |
| Organization G Private industrial sources—72% Government sources—28% | Organization G Basic government funding—31% Private sector, domestic—33% Public sector domestic—25% Public and private foreign—11% | Organization D Direct government allocations—86% Other sources—14% |
| Organization H Nationwide industry organization—50% Member direct funding—50% | | |
| Organization I Member fees—68% Investment Income—6% Other Income—26% | Organization H Government (operating) —56% Development—15% Research—13% External agencies—7% Investment income—3% Other sources—6% | |
| Organization J Services and commission work—50% Government and industry—50% Federal government grants—50% Forestry and forest industry—50% Fixed member fees—25% Research grants—75% | Organization I Government—40% European Commission—39% Special project funding—13% Membership fees—6% Other sources—2% | |
| Organization K Industry funding—50% Public agency funding—20% Contract work and services—30% | | |

contributions are made to improving the skill levels of citizens (training, education).

Ireland's COFORD reports to the Monitoring Committee of the Productive Sector Operational Program (2000–2006) (Department of Enterprise, Trade and Employment). Among the many performance standards specified are that the research initiatives of COFORD lead to improvement in the following:

- Share of home-grown wood in export markets
- Cost-competitiveness of the forest industry
- Forest products that have local use and application
- Cost-effective production facilities inline with environmental standards
- Research competence, including researcher training
- Collaboration between research institutions in Ireland and abroad.
- Quality and effectiveness of research programs

The Swiss ETH Domain has also established system-wide performance standards that must be adhered to by each of the Domain's separate research entities. An example is the EMPA (Switzerland, part of the ETH Domain), which must adhere to standards such as excellence in teaching and research (judged by international standards), pole position in international research, attractive working conditions and equal opportunities for women and men, creation of innovative teaching programs, increased cooperation with the Swiss universities, and technological and economical implementation of new knowledge and techniques.

Asset–Liability and Profit–Loss Statements

Organizations employing asset–liability and profit-loss statements often provide significant detail about their financial performance (Table 5, see Appendix A). Whether operating as a public franchise or as an independent private entity, the intent of these statements is to promote financial accountability, and ultimately, to increase shareholder value and the promotion of a fair return on investments. As an example, the United Kingdom's TRADA publishes an annual financial report that presents detailed income and expenditures accounts (income, expenditures, operational deficit) and a balance sheet for the association (fixed assets, current assets, creditors, capital and reserves, member funds). Likewise, the VTT annually issues an internal statement of profitability that presents information (current and preceding years) about operating income (external income, government funding, adjustments), expenses (for example, personnel, travel, materials, rents, external research services), operating margins (depreciation, financial expenses, extraordinary expenses), and financial year results (profit, net income). Similarly, the annual report of Forintek Canada Corporation sets forth similar information in a consolidated balance sheet (assets,

liabilities, balance) and in consolidated statements describing cash flows, change in net assets, and in operations and fund balances. The financial statements for New Zealand's Wood Technologies Research Sector, IRL, are especially detailed. Not only do they set forth typical accounting details (financial performance, movements of equity, financial position, cash flows), they also present statements of actual versus expected financial performance (revenue, return on equity, return on assets, equity ratios).

Social Responsibility Standards

Organizations also judge their performance in meeting various social, economic and environmental standards (Table 5, see Appendix A). An example is New Zealand's SCION (prior to 2005 known as Forest Research Limited), which is required by the Crown Research Institutes Act (1992) to annually report progress in both financial and nonfinancial measures. Among the latter are such measures as avoidance of accidents, student scholarships granted, contribution to community interests (financial and volunteer support of nonprofit organizations), protection of national interests (biosecurity services provided, indigenous forest protection, Montreal Process convener), advancement of employee conditions, (health and safety, rewards and recognition, leadership training), and furtherance of various cultural matters (scholarships, awards, involvement of Maori, women, and certain ethnic groups in grant programs and research and development proposals). As a Crown Research Institute, the Wood Technologies Research Sector of IRL also is required to annually report such noneconomic performance information.

Organization Overall Health

Organizations are concerned about their management and their ability to continue as viable enterprises. Many case-example organizations have established performance standards against which to measure progress in this respect. For example, Paprican places notable emphasis on standards such as upholding a reputation for excellence and integrity, rewarding highly creative and energetic people, effectively using resources provided by member companies, and expecting superior performance of everyone (individually and collectively). Some organizations such as Canada's FERIC use recruitment and retention of members as a measure of organizational success, and prominently identify new members in their annual reports. Others monitor staff turnover as a measure of organizational health, as is the case with the Wood Technologies Research Sector of IRL. The latter annually reports turnover of permanent staff as a percentage of total staff, the rationality being that the rate at which employees leave an organization's workforce may be an indication of employee dissatisfaction with working conditions.

Sweden's WURC emphasizes a number of broad principles that are considered indicative of the center's managerial and organizational health. Such include the occurrence of

industry–academia interactions (understanding), networking leading to recruitment of quality scientists, suitable size (scale) of research projects, systematic planning of research projects, international cooperation and collaboration, progress toward long-term organizational goals, international reputation as a center of excellence, and staff mobility between academia and industry. In a similar fashion, CRC (Australia) reports on the following measures of organizational health:

- Participation by member institutions in major decisions concerning research directions of the Center
- Interchange of personnel among institutions participating in the Center
- Publications jointly authored with persons from other research groups and organizations.
- Visitors to the Center (number and duration of stay, especially from overseas)
- Interaction among scientific staff at dispersed locations, especially in regard to the Center’s core programs

Educational Offerings

Organizations with formal educational programs often report performance in terms of students supported or advanced degrees granted. An example is the FPRDI (Philippines), which reports the number of scholars supported, as does CRC, which reports the number of students seeking the Center’s Advanced Diploma in Wood Products Management. The Center also reports on students engaged in advanced degree programs (PhD and Masters) and the research guidance provided them by the Center (advanced degrees are granted in cooperation with the University of Melbourne, Swinburne University of Technology, and the University of Tasmania). Similar reporting is made by the EFI (Europe), Paprican, BFH (in cooperation with the University of Hamburg, Germany), FFP (South Africa), and the Swiss EMPA (notably the EMPA Academy). Some research organizations report important educational activities involving advanced training, although such may not lead to a formal university-granted degree; an example is Sweden’s STFI-Packforsk.

Plan-Target Accomplishment

Some of the case-example organizations judge their performance by the extent to which established plans and targets have been accomplished. Noteworthy in this respect is Indonesia’s Forest Products and Forestry Socio-Economic Research and Development Center, which documents progress in accomplishing each of the Center’s 5-year plans. Similarly, the FIRM reports progress in accomplishing each of the objectives (35 total) specified within each of its seven plan-of-action strategies. As a Crown Research Institute, New Zealand’s SCION annually provides significant detail about corporate intent and the actual accomplishment of established targets. For SCION, actual versus intent information

is provided for more than 36 target areas, including gross revenue, return on assets, patented inventions, research papers in journals, seminars and field days sponsored, and staff time in training. Also a Crown Research Institute, the Wood Technologies Research Sector of IRL (New Zealand) also reports on accomplishment of targets established for key indicators of performance (such as capital expenditures, permanent staff turnover, joint ventures established, and speaking invitations to scientists).

Administrator Perspectives

The executives and management staff of case-example research organizations were also asked to provide information about the performance of the organizations for which they were responsible. Specifically, the following request for information was made: “The performance of forest products research organizations can be judged according to attainment of various standards. For example, clients are satisfied, organization is profitable, scientific contributions are being made, products and services are numerous (publications issued, tests conducted, conferences sponsored), achievements are being recognized (publicly and professionally), and operations are being conducted in professional and ethical manners. In your judgment, what *three conditions* are most important for determining how well (... organization’s name ...) is carrying out its mission?” With only slight paraphrasing of respondent replies, the administrators identified the following.

Client Satisfaction

- Key performance indicator is delivery of successful research products that produce the economic impacts predicted for a client. Satisfied industry partners are a very important indicator of our success.
- Since education of the next generation of scientists is also part of our responsibilities, we expect to produce a cohort of industry-ready graduate researchers who will find ready employment.
- Members are satisfied with [our research and service] activities. They give positive feedback on our activities on a continuous basis.
- Client satisfaction, more particularly, member company satisfaction is critical. We have been very fortunate that over many years, most of our member companies have stayed with us. We have also been able to attract new member companies, even over the past few years where the economic climate has been so dismal that many companies have greatly restricted their expenditures on research and development.
- Most important performance criterion is client satisfaction (member–owner–customer). To enable this, products and services have to be numerous, of high quality, and well adapted to various customer categories. And of course, this can only be achieved if research and

development are conducted professionally with skilled and competent staff—and are well communicated.

- Returns on member company investments in our organization [is a very important measure of performance]. We work with member companies to develop a summary of the returns that they have actually realized from [our research developed] technologies. In general terms, the returns to our members range from 200% to 1000% annually on their net fees to our organization. We also report the average of all member returns to [our governing board and at the annual meeting of all our members].
- Because of our programs, our members' businesses have grown over and above any general increase in industry-wide growth.
- Satisfied clients are the most important measurement of how we carry out our mission.
- Successful work of our institute is to be found in satisfaction of our clients. Did the developed technology work and bring the financial success that was expected? Did the institute provide the service in a timely and cost-effective manner?

Recognition and Appreciation

- As many research organizations do, we seek world-class recognition of our research staff. For this, we track external scientific awards and recognition, numbers of publications in peer-reviewed journals, numbers of patents, invited lectures, and so on.
- Success is embodied in our organization's achievements being recognized by high-level policy makers and by policy making processes.
- Achievements of our organization are being widely recognized—satisfied customers will buy again.
- Recognition externally for some of the functions we carry out [is an important measure of performance]. For example, we are an ISO-certified research laboratory in a number of areas and maintain sole or joint responsibility for a number of world standards in our industry.
- Invitations our organization receives to international policy making processes, where we become the representative of the research community on a particular forest resource issue.
- Being a member-focused organization, the most important measure of success is member and client satisfaction. This is measured through surveys and by an ability to retain existing (paying) members and attracting new members. Clients are satisfied when they perceive that they have received something of value in return for the investment they have made. [Success also occurs] when members recognize (and are proud of) our organization's achievements.

- Preparing and presenting reports during national and international conferences, especially within the scope of activities of the European Union.
- Success means wide acknowledgment of the contribution of our scientific results (papers, presentations, reports).

Economic and Scientific Contributions

- Most important measure of success is creation of new knowledge and the successful application of new and existing knowledge to current problems.
- Did we help grow and maintain markets for timber through our research and information programs? This is the most important performance measure for us.
- Scientific quality of our products is high. This is measured by the number of peer-reviewed publications that we produce.
- Very important to contribute to visual results such as new innovative products, new processes, new market opportunities, etc. This is of interest to media and helps create pride and self-confidence in industry and in our institute.
- Scientific output is especially important to our success, especially as measured by number of patents or licenses, reviewed papers, citations indexed, and completed PhD student programs.

Operational Success

- Positive funds have been maintained for the operation of our organization (for obvious reasons). We would like to see membership increasing, which would (a) pay for more future work and (b) demonstrate that what we are doing is appreciated.
- Our organization is profitable—a condition for our very existence. We have to prove our competitiveness by showing a positive result.
- Percentage of our total budget that is provided by external sources. Such is a measure of our success in accessing and selling the products of research in the marketplace.
- Success is embodied in our mix of being a business company and an academic institution, a mix that we believe is essential to our success.
- Even if our goal is not profit maximizing, we have to have positive financial results if we are to be a profitable organization in the long run. Otherwise, we will represent [be considered] a problem to the industry and to our members.
- We are not a typical academic research and development organization. To carry out our mission, we are dependent to a large degree on our own earnings. Therefore, we are more focused on concrete results than on international

publishing with referees, etc. Nevertheless, we do not compromise on scientific requirements.

- Research alliances are important to our success, and peer recognition is important because it has a direct impact on how often and how well our organization can form meaningful research alliances with others.
- No research could be carried out without money. Financial stability and sustainability means having adequate financial resources to evolve over time and to maintain and strengthen our core competencies that enable us to deliver our mission. Despite a high degree of member and client satisfaction, our organization has found securing adequate financing to be a constant challenge.
- Carrying out orders commissioned by particular clients and achieving profits from those activities is a bottom line measure of success.
- The success of our organization is built on company values: confidentiality, neutrality, and top quality professional products and services.
- An important performance measure is the care with which we manage highly confidential information from our member companies, making sure not to divulge information as we work with one member company or another. This is so significant (given the many corporate scandals in the past few years) that we have totally updated our corporate governance guidelines, taking pride in our professional and ethical operation of all aspects of our organization's business.

Summary and Observations

Summary of Review

In 2004–2005, a review of forest products and related research organizations beyond the boundaries of the United States was carried out. The intent was to obtain a better understanding of how such organizations are structured and administered and their performance judged. Ninety-three research organizations were initially identified for consideration by the review, 40 of which were chosen as case examples (located in 23 countries) and subsequently described in substantial detail.

Organization and Governance

The case-example organizations operated primarily as private independent research organizations (25 of 40), although 11 of these private organizations were legally authorized by, but operated independently of, government. The remainder were either government organizations or government organizations operating as independent entities. As for the missions of the case-example organizations, dominant was an interest in promoting the competitiveness of industry, advancing scientific frontiers and developing new technologies, contributing to the economic and social needs of a nation, supporting the technical and managerial needs of cli-

ents, and promoting resource utilization and sustainability. The organizations were governed in various ways, including by independently empowered panels (boards, councils), larger parent organizations of which an entity was part (division, sector), and authorities exercised by chief executives and supporting staffs. Nearly all the organizations operated with one or more advisory committees. As for organizational structure, patterns included strong, traditional hierarchical (vertical) structures; horizontal structures with few layers of organization; structure oriented around skills and information resources available to clients; entities that are part of larger, very diversified research enterprises; and organizations that are units of strategic alliances such as partnerships and joint ventures.

Administration and Management

The case-example organizations serve both public and private clients (21 of 40), although many (14 of 40) emphasize service to their owners or members. Services provided to clients were many and very diverse, although most common was research and development (all 40 organizations). Other services offered by the case-example organizations were (in declining order of frequency) consultation, information, training, testing, education, certification, and pilot scale production. The programs implemented by the case-example organizations focused on the following: Forest products, 21; forest products and modest forestry, 1; forest products and forestry, 10; forestry and modest forest products, 4; and forestry, 4.

As for research programs, 22 of the organizations focused on forest products research and 11 on forest management research. Only four or five organizations engaged in *both* solid wood products research and in pulp and paper research. Those engaged in forest products research directed attention to pulp and paper, wood composites, furniture, engineered structures, and wood processing and preservation. As for forest management research, the focus was on fiber production, forest protection, economics, harvest systems, and fish and wildlife.

Financial information about research investment made by the case-example organizations is uneven and often not publicly available (proprietary). However, the 2004 combined investments in forest products and related research made by 28 of the case-example organizations was in the range of \$385 to \$425 million. Of these investments, 40% to 50% were made by private research organizations. The case-example organizations employed an estimated 7,000 to 7,500 scientists and supporting staff, most of which have less than 100 staff each, although three organizations report a staff of more than 400. Although the source of financial support for an organization can be especially diverse, dominant sources are membership dues and similar assessments, fees and related charges for services provided, core funding provided by government, in-kind services provided by government and private entities, and grants obtained from competitive

processes. Few of the organizations rely strictly on annual guaranteed funding by government. As for the pricing of services provided, some organizations have especially sophisticated sets of established fees that can be accessed through their web site.

Performance and Outcomes

Publicly reported information suggesting the degree to which the case-example organizations are accomplishing their mission and goals are dominated by annual listings of research publications and by written highlights of past research accomplishments. Other performance measures follow (in declining order of frequency): number of educational offerings, number and satisfaction of clients, statements of assets–liabilities and profits–losses, number of patents granted, rate at which processes and products are adopted, and approval expressed by the parent organization of a research enterprise. Although not especially common among the case-example organizations, some appear to be especially sensitive to accomplishment of previously established targets (patents granted, seminars sponsored, joint ventures established), managerial and administrative health of an organization (staff turnover, new members), and contributions to broad social and economic conditions that are considered important to a country’s well-being (health and safety of employees, minorities and women employed, employee leadership training, support of nonprofit organizations). In some cases, the latter two categories are part of the legal framework giving an organization the right to exist.

Observations and Interpretations

In today’s climate of scarce budgets and concern over the appropriate role of public agencies generally, how forest products and related research organizations structure themselves, conduct business, and subsequently judge performance is an especially important topic. For forest products and related research organizations in the United States, the experiences of research organizations located beyond the nation’s boundaries can be especially useful for addressing these challenges. With such a purpose in mind, what follows are observations based on information from a number of sources, including publicly available information describing the organizations reviewed here, insights provided by persons responsible for the administration of the case-example organizations, and especially noteworthy literature concerning the management of research and development enterprises in foreign countries (Ellefson 2005).

Diverse Organization Names

A plethora of names is represented across the community of research organizations operating in other countries, including institute, laboratory, center, council, and association. Some have a long tradition of use (“institute,” especially in Europe), while others are newly chosen abstract symbols (for example, Ensis in Australia, SCION in New Zealand) that are used as a way of defining an organization and the

services it is capable of providing. Because names can have different meanings in different countries, confusion regarding purpose, ownership and size of research organizations’ programs is common.

Long History of Research Involvement

Sustained involvement in forest products research is the hallmark of many research organizations in other countries (some established in the mid and late 1800s). To their credit, they have survived major social and political upheavals through the use of strong organizational leadership, perseverance in the face of hardship, and being part of a country that considers its forestry and forest products sectors to be important. Their ability to change program directions and organizational structure is impressive.

Public to Private Transfer of Ownership

Movement of responsibility for research from public to private enterprises (privatization) has been common within the research community of other countries, occurrences often promoted as government cost-saving measures or as a means of promoting a political ideology of less government. In many cases, these spin-offs to private ownership have been followed by a great deal of organizational soul searching (what is the mission, who will provide the funding), much of which is reflected in their subsequent active record of mergers and acquisitions with other organizations. Some research organizations have made the transition quite well; others seem to be steeped in tradition and lack the ability to adapt to new circumstances.

Public Versus Private Responsibilities

Clear distinctions between public and private responsibility for research are blurry in many countries. Countries tend to define a problem in the forest sector (such as high unemployment, opportunity to explore innovative technology) and then proceed to rally the necessary research support without regard (or with limited regard) to what part of the effort should be a public agency’s responsibility and what part should be assigned to a private concern. Public–private distinctions are further blurred by private research organizations that often claim to be a nation’s official or premier forest products research establishment and that government has exclusively assigned them national responsibilities for research.

Government-Authorized Yet Privately Operated

Although owned and largely funded by government, some foreign research organizations legally operate like fully independent private sector enterprises. Their governance structure (board of directors, chief executive) has full discretionary responsibility for allocating and distributing money, employing executive and research staffs (including executive directors), and changing program direction and intensity.

Complex Ownership and Partnering Arrangements

Foreign research organizations commonly engage in arrangements that involve many different partners, including government agencies, private companies, educational institutions, other research organizations (public or private), and the like. Establishing subsidiaries and engaging in joint ventures is often motivated by a desire to overcome organizational inertia. These activities are also a means by which unique research talent and equipment can be assembled, a way in which the limited research capability of any single research entity can be expanded, and a way to focus resources on especially complex problems in need of immediate research.

Scrambled Organizational Structures

Neat and tidy administrative structures are not the hallmarks of some foreign research organizations. Their approach is one of avoiding hierarchical structures and steering clear of vertically exercised lines of authority. Although seeming to defy administrative efforts to exercise control and direction (planning, budgeting), a cluttered and messy structure may simply reflect a research organization's willingness to exercise the flexibility necessary to refocus resources on new problems in need of research.

Entities Within Large Parent Organization

Forest products research organizations are in some cases subunits (divisions, centers, departments) of research enterprises that are very large and diverse in their research offerings. So positioned, these forest products entities are able to draw on a wide variety of talent, experience, and equipment that exists throughout the larger parent organization. Although the capacity of the forest products research entity within a large parent organization may appear small, in reality its capabilities are potentially quite large.

Single Major Client Group

Even though the services provided may be wide-ranging, most forest products research organizations focus on a single major client group (such as the paperboard mill and container industries, engineered and reconstituted wood industries, or the wood household furniture industry). What's more, very few foreign research organizations provide services to both forestry and forest product research sectors even though the distinction between research problems involving forestry and forest products is often unclear.

Intense Client and Customer Focus

Taking pride that they are "demand-driven," many foreign research organizations are motivated by an intense interest to provide customers with practical information that can actually be used and is available at a time when such information is actually needed. Although such a perspective may have immediate payoffs, it can skew research investments away from important long-term, more basic research needs.

Synthesizers of Information

Although research may be the major activity of most foreign research organizations, many assume the broader mantle of being providers of information – regardless of source and form. They see a major role in synthesizing existing information (from various sources, not just their own efforts) and presenting it in a form that is useful to clients. In so doing, many have acquired extensive databases and have developed sophisticated ways of managing information that originates from many sources.

Services Provided for a Price

Offering research and related services for a fee is a regular practice of many research organizations (public and private) operating in other countries. In the case of government research enterprises, payment for services (governed by law) is often part of a broader government effort to promote efficiency, redirect programs, and cover budgetary shortfalls.

International Client Orientation

Having an interest in the information needs of clients operating beyond the country in which they are headquartered, many research organizations in other countries vigorously promote the worldwide orientation of their operations. This promotion often makes good business sense, as many of these research organizations have members (owners) that operate in global markets. The organizations must orient their research programs in a global manner that will meet their members' worldwide information needs.

Educational Degree-Granting Activities

Professional education activities, including graduate education in cooperation with degree-granting universities, are clearly within the purview of some research organizations operating in other countries (especially common in the field of pulp and paper research). By affiliating with universities and related organizations that engage in educational pursuits, the clients of research enterprises have access to a ready-made supply of talented researchers over whose research and education they have had considerable influence.

Multiple Sources of Income and Revenue

Although charging fees for services is increasingly done as a revenue source, most research organizations in other countries rely on multiple sources of income for their operations. Because of uncertainties over government funding, some organizations have set goals of being financially self-sufficient. For basic research (unlikely to be undertaken by the private sector), some organizations have a stable nucleus of funding that is provided by a core group of members or by government. Both public and private research organizations are active competitors for research money controlled by large federal science agencies.

Diverse Standards for Judging Performance

Performance information guiding investment in research organizations operating in other countries is diverse in

both type and substance (such as listing of publications and conferences sponsored, detailed set asset and liability statements, and contribution to public well-being). In some cases, however, performance-type information is virtually nonexistent (at least to the general public), a condition that makes it very difficult to judge the efficiency and effectiveness of some organizations.

Adept Response to Broad Economic-Social Changes

Comfortably accommodating change in the broader economic and political environments of which they are a part seems to occur with ease for some research organizations operating in other countries. In part, their ability to do so lies with visionary leadership, flexible organizational structure, and creative management and administration. Lacking these traits, some research organizations have experienced great difficulty in responding to broad swings in the economy and the country's changing political sentiments.

Multiple Location of Physical Facilities

Although most research organizations operating in other countries have a headquarters office in a single location, many have research facilities spread across a nation or in other nations. Some organizations argue that such a dispersed structure places programs closer to clients and to the unique resource and processing problems they face. University campus locations are favorably looked upon because they provide for certain synergisms between the academic community and the research organization.

Communication Between Executive-Level Administrators

Although scientists commonly communicate on technical and procedural matters involving their research interests, executive-level administrators of research enterprises are less apt to do so, even though such administrators have common interests (and challenges) that are quite different from those facing scientists (organizational purpose and mission, agency structure and governance, program planning and financing, performance and redirection). Many administrators of research organizations in other countries would seem to welcome more worldwide communication on such subjects, through either some formal connection (existing or new umbrella organization) or through existing informal means (electronic communication).

Publicly Available Information About Organizations

Forest products research organizations operating in other countries differ greatly in the extent to which the public has access to information about their operations (how organized, size of budgets, sources of income, expertise of staff). In some cases, they are private enterprises and information about them is proprietary (except for certain legally prescribed reporting requirements), while in other cases organizations simply do not have the resources that are necessary to make public the type of information that accurately describes their operations (web sites, annual reports).

Literature Cited

- Aldwell, P. 1998. Restructuring of forest research in New Zealand: review, impact and prognosis. In: Enters, T.; Nair, C.T.S.; Kaosaard, A. Emerging institutional arrangements for forestry research. FORSPA Pub. No. 20/1998. Forestry Research Support Program for Asia and the Pacific. Rome, Italy: Food and Agriculture Organization, United Nations. 229–276.
- Alex, G. 1998. Assessing agricultural research: towards consensus on a framework for performance and impact assessment. Special Report No. 6. Agricultural Research and Extension Group. Washington, DC: World Bank. 43 p.
- Alston, J.M.; Pardey, P.G.; Smith, V.H. 1997. Financing agricultural R&D in rich countries: what's happening and why? EPTD Discussion Paper No. 29. Environment and Production Technology Division. Washington, DC: International Food Policy Research Institute. 52 p.
- Arnold, E.H.; Bessant, Rush J.; Hobday, M. 1998. Strategic planning in research and technological institutes. *R&D Management* 28(2): 89–100.
- Bain, J.S. 1959. *Industrial organization*. New York, NY: John Wiley and Sons, Publishers. 643 p.
- Bengston, D.N.; Gregersen, H. 1988. Forestry research capacity in developing countries: a review of issues and findings. Working Paper No 4. Center for Natural Resource Policy and Management Studies. St. Paul, MN: University of Minnesota. 39 p.
- Billings, B.A.; Musazi, B.G.N.; Moore, J.W. 2004. The effects of funding source and management ownership on the productivity of R&D. *R&D Management* 34(3): 281–294.
- Blyth, M.J.; Midgley, S.J.; Kile, G.A. 1998. The changing face of Australia's forest research. In: Enters, T.; Nair, C.T.S.; Kaosaard, A. Emerging institutional arrangements for forestry research. FORSPA Pub. No. 20/1998. Forestry Research Support Program for Asia and the Pacific. Rome, Italy: Food and Agriculture Organization, United Nations. 189–288.
- Bremser, W.G.; Barsky, N.P. 2004. Utilizing the balanced scorecard for R&D performance measurement. *R&D Management* 34(3): 229–238.
- Burley, J. 1989. Options for forestry research networking. In: Lundgren, A.L., ed. *The management of large-scale forestry research programs and projects*. General Technical Report NE-130. Northeast Forest Experiment Station. Broomall, PA: U. S. Department of Agriculture, Forest Service. 185–199.
- Carayannis, E.G.; Laget, P. 2004. Transatlantic innovation infrastructure networks: public-private, EU-US R&D partnerships. *R&D Management* 34(1): 17–31.

- Carnevale, D.G. 2003. Organizational development in the public sector. Boulder, CO: Westview Press. 154 p.
- Coccia, M. 2004. New models for measuring the R&D performance and identifying the productivity of public research institutes. *R&D Management* 34(3): 267–280.
- Cohen, D.H.; Kozak, R.A. 2002. Research and technology: market-driven innovation in the twenty-first century. *Forestry Chronicle* 78(1): 108–111.
- Consultative group on international agricultural research (CGIAR). 1997. Policy and management and research strengthening research and service in the CGIAR. TAC Secretariat. Rome, Italy: Food and Agriculture Organization, United Nations. [Not paged]
- Duysters, G.; Kok, G.; Vaandrager, M. 1999. Crafting successful strategic technology partnerships. *R&D Management* 29(4): 343–351.
- Eliadis, P.; Hill, M.M.; Howlett, M. 2005. Designing government: from instruments to governance. Montreal, Canada: McGill-Queens University Press. 454 p.
- Ellefson, P.V.; Ek, A.R. 1996. Privately initiated forestry and forest products research and development: current status and future challenges. *Forest Products Journal* 46(2): 37–43.
- Ellefson, P.V. 2005. Bibliography of forestry and forest products research programs in foreign countries with special focus on organizational structure and program administration. Unpublished Report. Department of Forest Resources. St. Paul, MN: University of Minnesota. 30 p.
- Ellefson, P.V.; Kilgore, M.A.; Skog, K.E.; Risbrudt, C.D. 2006. Forest products research and development organizations in a worldwide setting: a review of structure, governance, and measures of performance. Staff Paper Series Number 187. St. Paul, MN: University of Minnesota, Department of Forest Resources. 187 p.
- Food and Agricultural Organization, United Nations. 2005. *FAO yearbook 2003: forest products*. Rome, Italy: Department of Forestry, United Nations. 243 p.
- Food and Agricultural Organization, United Nations. 2004. Trends and current status of the contribution of the forestry sector to national economies. Working Paper FSFM/ACC/07 (Arvydas Lebedys). Forest Products and Economics Division. Rome, Italy: Department of Forestry, United Nations. <http://www.fao.org/docrep/007/ad493e/ad493e00.htm#TOC> [Date accessed: July 2006].
- Food and Agricultural Organization, United Nations. 2001. Global forest resources assessment. Report No. 140. Rome, Italy: Department of Forestry, United Nations. 479 p.
- Forintek Canada Corporation. 2005. Progress and achievements: 2004. Publication Services. Vancouver, BC: Forintek Canada Corporation. 30 p.
- Fryk, J.; Nordansjo, I. 1998. Private forest research in Sweden. In: Enters, T.; Nair, C.T.S.; Kaosaard, A. Emerging institutional arrangements for forestry research. FORSPA Pub. No. 20/1998. Forestry Research Support Program for Asia and the Pacific. Rome, Italy: Food and Agriculture Organization, United Nations. 117–131.
- Gassmann, O.; von Zedtwitz, M. 1998. Organizations of industrial R&D on a global scale. *R&D Management* 28 (3): 147–161.
- Gibson, J.L.; Ivancevich, J.M.; Donnelly, J.H. 1994. Organizations: behavior, structure, and processes. New York, NY: Richard D. Irwin Publishers. 802 p.
- Goldman, M.; Ergas, H.; Ralph, E.; Felker, G. 1997. Technology institutions and policies: their role in developing technological capability in industry. Technical Paper 383. Washington, DC: World Bank. 44 p.
- Gordon, G.J. 1992. Public administration in America. New York, NY: St. Martin's Press. 560 p.
- Grier, D. 1996. Best practices for management of research and technology organizations. Berhad, Malaysia: World Association of Industrial and Technological Research Organizations. [Not paged]
- Hellstrom, E.; Pallo, M.; Solberg, B. 1998. Financing forest sector research: theory and European experiences. IUFRO Occasional Paper No. 10. Wein, Austria: International Union of Forestry Research Organizations. 33 p.
- Howard, J.L. 2003. U.S. timber production, trade, consumption, and price statistics: 1965–2002. FPL–RP–615. Forest Products Laboratory. Madison, WI: Forest Service, U.S. Department of Agriculture. 90 p.
- Hughes, O.E. 2003. Public management and administration: an introduction. New York, NY: Palgrave Publishers. 303 p.
- Hyde, W.F.; Newmann, D.H.; Seldon, B.J. 1992. The economic benefits of forestry research. Ames, IA: Iowa State University Press. 249 p.
- Hytonen, M. 2001. Overview of social forestry research and education in northern Europe. In: Hytonen, M., ed. Social sustainability of forestry in northern Europe: research and education. 15–96. Helsinki, Finland: Finnish Forest Research Institute. 404 p.
- Ingham, M.; Mothe, C. 1998. How to learn in R&D partnerships. *R&D Management* 28(4): 249–261.
- International Task Force on Forestry Research. 1998. A global research strategy for tropical forestry. Sponsored by Rockefeller Foundation, United Nations Development Program, World Bank, and Food and Agriculture Organization of the United Nations. Washington, DC: World Bank. 88 p.
- IRL. 2003. Brilliant ideas at work. Information Services. Auckland, New Zealand: Industrial Research Limited. 56 p.

Johnson, W. C. 1992. Public administration: policy, politics and practice. Guilford, CT: Dushkin Publishing Group. 554 p.

Lundgren, A.L.; Josiah, S.J.; Gregersen, H.M.; Bengston, D.N. 1994. Planning and managing forestry research. Volume I-VI. Vienna, Austria: International Union of Forestry Research Organizations. [12 modules in six volumes]

Nair, C. T. S.; Enters, T.; Thomas, D. 1998. Institutional changes in forestry research: Quo Vadis. In: Enters, T.; Nair, C.T.S.; Kaosaard, A. Emerging institutional arrangements for forestry research. FORSPA Pub. No. 20/1998. Forestry Research Support Program for Asia and the Pacific. Department of Forestry. Rome, Italy: Food and Agriculture Organization, United Nations. 377–403.

National Research Council. 2002. National capacity in forestry research. Washington, DC: National Academy Press. 249 p.

Parker, J.K.; McFadden, M.W. 1990. Forestry research networks: a preliminary survey of factors influencing success and sustainability. Report to the Agency for International Development by Tropical Research and Development, Inc. Washington, DC: Agency for International Development. 136 p.

Ranson, S.; Hinings, B.; Greenwood, R. 1980. The structuring of organizations. *Administrative Science Quarterly* 25:1–17.

Rosenbloom, D.H.; Goldman, D.D. 1986. Public administration: understanding management, politics, and law in the public sector. New York, NY: Random House. 510 p.

Rush, H.; Hobday, M.; Bessant, J.; Arnold, E.; Murray, R. 1996. Technology institutes: strategies for best practice. London, England: International Thomson Business Press. [Not paged]

Spilsbury, M.J.; Kowero, G.S.; Tchala-Abina, F. 1999. Capacity for forestry research in selected countries of West and Central Africa. Occasional Paper No 24. Jakarta, Indonesia: Center for International Forestry Research. 37 p.

U.S. Government Accountability Office. 2006. Wood utilization: federal research and product development activities, support, and technology transfer. GAO–06–624. Washington, DC: U. S. Government Accountability Office. 118 p.

Von Zedtwitz, M. 2003. Initial directors of international R&D laboratories. *R&D Management* 33(4): 377–393.

Appendix A—Comprehensive Description of the Organizational and Operational Characteristics of Case-Example Forest Products and Related Research and Development Organizations

Australia

Cooperative Research Centre for Sustainable Production Forestry (CRC)*¹

Date Established: 1997. The CRC for Sustainable Production Forestry ceased operations on 30 June 2005. On 1 July 2005 the new CRC for Forestry commenced operations.

Public-Private Sector: The center is a combination public–private organization coordinated by the CRC of the Australian Ministry of Education, Science and Training. The intent of program is to strengthen collaborative research links between industry, research organizations, educational institutions, and relevant government agencies. The CRC for Sustainable Production Forestry is one of about 70 centers (including, medicine, manufacturing, agriculture, environment) that operate as collaborative entities for Australian forestry companies, the Commonwealth Government, State Government enterprises and Universities. The center has 19 members (11 private, four universities, and four governments). The Center accomplishes its mission by coordinating the research efforts of a variety of research organizations, keeping its in-house staff researchers at a minimum.

Mission: To ensure the long-term viability of Australia’s forestry industry through high quality, relevant research in sustainable plantation forestry; produce research outcomes which improve the competitiveness of industry partners through cooperative research; improve the efficiency and effectiveness of applied research and development carried out by industry partners; provide access to international science so as to ensure that relevant new approaches and techniques are available in Australia; provide innovative education that meets the skill formation needs of forestry industry and national forestry objectives; and ensure that all stake holders capture the benefits of research through technology transfer.

Primary Research Focus: The center focuses on forestry, especially on plantation species, with particular emphasis on genetic improvement, sustainable management, and resource protection.

Governance and Organization: The CRC’s governing board (the executive director is ex officio) is comprised of 15 member organizations. Advice and counsel is provided by an advisory panel (7 members give overall scientific advice, including three coordinating committee chairs), a

management committee (8 members provide center operation advice), and program advisory committees (one for each of the three program areas; nine to 10 members each, plus program directors). Three organizational units are for research, and one is for education and technology transfer. Center operation is the responsibility of a center director, and the organization’s headquarters are located in Hobart, Tasmania.

Strategic Program Directions: The CRC research is focused on genetic improvement (tree breeding, wood quality), sustainable management (site productivity, silvicultural systems), and resource protection (insects and diseases). In addition, the program is focused on education and technology transfer.

Client Groups: The CRC serves public and private organizations, with special emphasis on owner–members.

Services Provided: The CRC provides information (library, software), research (direct delivery of products, joint research activities), consultation (advice), and training. The center’s special emphasis is on technology transfer and meeting the needs of clients and members.

Budget and Funding Sources in 2004 Australian dollars (AUD)

- A. Income[#]
 - \$ 0—Members
 - \$ 2,468,000—CRC grant
 - \$ 99,000—Other
 - \$ 2,993,000—Total (U.S. \$2.2 million)
 - [#]Additional \$6.9 million in-kind contributions.
- B. Source of income
 - 89%—Government
 - 7%—University
 - 4%—Private
 - 100%—Total
- C. Expenditures[#]
 - \$2.7 million—cash (including carryover cash)
 - [#]Additional \$6.9 million in-kind contributions.
- D. Focus of expenditures (cash)
 - Research—82% (\$2.2 million)
 - Education—7% (\$0.2 million)
 - Administration—11% (\$0.3 million)

Scientists and Supporting Staff: The CRC has a total staff of 52, with 89% research and 11% administration. Twenty-eight staff members are cash-funded and 24 represent in-kind contributions.

Measures of Performance: The CRC measures its performance by the number of clients seeking services, the extent to which research is properly planned (expected research outcomes defined, acquired and delivered on time), client satisfaction with research, the extent to which research results are adopted, the number of consultancies occurring, and the number of research publications prepared.

¹Asterisk indicates that information describing an organization was reviewed by the organization’s staff for errors in fact or interpretation.

Cooperative Research Centre for Wood Innovations (CRC)

Date Established: 2001

Public-Private Sector: The center is a combination public–private organization coordinated by the CRC of the Australian Ministry of Education, Science and Training. The intent of the program is to strengthen collaborative research links between industry, research organizations, educational institutions, and relevant government agencies. The CRC for Wood Innovations is one of about 70 centers (including medicine, manufacturing, agriculture, environment) that operate as collaborative entities for Australian forestry companies, the Commonwealth Government, state government enterprises, and universities. The center has 12 members (seven private, two universities, and three governments). The center accomplishes its mission by coordinating the research efforts of a variety of research organizations, keeping its in-house staff researchers at a minimum.

Mission: To develop functional applied technologies to benefit the forest products industries. Its intent is to establish wood as the sustainable product of choice by making available improved processing technologies using microwaves, technologies that add value to wood products, and products from raw wood.

Primary Research Focus: The CRC research focuses on forest products.

Governance and Organization: The CRC is governed by a board of nine member organizations and a chief executive officer. The center directs its research and commercial operations through its management company, IWM Center Management Limited. The IWM has been assigned background intellectual property and owns all new intellectual property on behalf of the CRC partners. The organization's headquarters are located in Melbourne, Victoria.

Strategic Program Directions: Center research is focused on microwave processing of wood (reducing growth stress, wood drying, wood composite, fundamental science), value-added technologies (wood surface finishes, technology-led design, wood bending, extending lifespan), and raw wood enhancement (pyrolysis bio-products).

Client Groups: The CRC serves public and private organizations, with special emphasis on owner–members.

Services Provided: The CRC provides information (library, software), research (direct delivery of products, joint research activities), consultation (advice), and training.

Budget and Funding Sources in 2001/2002 Australian dollars

A. Income[#]

\$ 2,300,000—CRC grant
 \$ 8,600,000—Other sources
 \$10,900,000—Total (U.S. \$8.1 million)

[#] Total of \$76.4 million (\$16.3 million CRC grant) over 7-year period

B. Source of income (unknown)

C. Expenditures (unknown)

D. Focus of expenditures (unknown)

Scientists and Supporting Staff: Full-time equivalent research staff of 28, with a total of 12 lead researchers.

Measures of Performance: The CRC measures its performance on the number of research publications prepared and the adoption of products and processes.

Ensis*

Date Established: 2004

Public-Private Sector: Ensis was established as an unincorporated joint venture of Australia's CSIRO and New Zealand's SCION (formerly Forest Research, Ltd.). The CSIRO was formally organized by the Australian federal government in early 1900s and was given independent statutory authority in 1949 (Science and Industry Research Act of 1949). Ensis is a private independent organization accountable to CSIRO and SCION, its parent organizations.

Mission: To enable formation of large expert teams capable of tackling complex problems at a scale that will help the sector (forestry and forest products) remain globally competitive. The mission of CSIRO (one of Ensis's parent organizations) is to carry out scientific research for purposes of assisting industry, furthering community interests, contributing to national objectives, and facilitating and encouraging the application of new science that results from research.

Primary Research Focus: Ensis research focuses on forestry (tree improvement and germplasm, wood and fiber quality) and forest products (wood and wood products; pulp, paper, and packaging).

Governance and Organization: Ensis is governed by a management committee composed of members from the parent organizations (SCION and CSIRO). It is lead by a chief executive and a lead team (eight persons), of which six persons are also SCION unit leaders. Ensis is organizationally grouped into the following units (each lead by a lead team manager): PAPRO unit, Forests unit, Wood Processing Unit, Environment unit, Ensis Biosecurity and Protection unit, Wood Quality unit, and Genetic unit. Ensis also engages in research through various cooperatives (for example, Douglas-fir Cooperative, Forest Site Management Cooperative, Wood Drying Multi-Client Group). Ensis is headquartered in Rotorua, New Zealand.

An important business unit of Ensis (and SCION) is PAPRO, which is a unit engaged in supplying pulp, paper, and packaging technology. The PAPRO's mission is to develop value-adding solutions for the pulp, paper, and packaging industries through innovative science, applied research, and specialized professional services. Its strategic aims are to

(a) perform long-term research in key science areas for the fiber-based industries, (b) seek innovation in wood fiber, paper and packaging products from New Zealand resources, and (c) maintain internationally recognized science capability in fiber-based technology and product development. PA-PRO is organized into three key business areas: mechanical fiber processing, chemical and enzymatic technologies, and paper and paperboard. Staff numbers unknown.

Strategic Program Directions: Engaged in research and service in seven major areas: genetics, sustainable forests, environment, wood and fiber quality, forest biosecurity and protection, wood processing and products, and pulp, paper, and packaging.

Client Groups: Ensis serves public and private organizations.

Services Provided: Ensis provides information (library, software), research (direct delivery of products, joint research activities), testing, consultation (advice), and training.

Budget and Funding Sources:

A. Operating Income: Not available.

B. Source of Income: Not available.

C. Focus of expenditures: Not available.

In 1996–1997, the CSIRO Division of Forestry and Forest Products (merged in 2005 to form Ensis) budget was estimated to be \$26.7 million (AD), all of which was from external sources. For CSIRO's Environment and Natural Resources Group (of which the Division of Forestry and Forest Products was a part in 2003), revenue sources (total of \$246 million) were as follows: government revenues, 6%; sale of goods and services, 30%; and other sources, 5%. Seventy-one percent of the CSIRO parent organization's total income in 2003 was from the Australian federal government.

Scientists and Supporting Staff: We estimate that Ensis has 300 staff located at eight different sites (six in Australia, two in New Zealand). Staff includes the CEO of Ensis, nine members of lead team, and five key contacts (CEO CSIRO Forestry and Forest Products, CEO SCION, marketing manager, and human resources advisor). The number of researchers and supporting staff assigned to various Ensis units is not available. The parent organization CSIRO has over 6,500 staff in 21 research divisions (for example, health, minerals, transportation) located throughout the world.

Measures of Performance: Ensis is accountable to its parent organizations, SCION and CSIRO. In 1995, CSIRO and other Commonwealth science agencies established six performance indicators to be used and an indication of commitment to continuing organizational improvement: (a) resources are consistent (in line) with customer demands, (b) income from external earnings exceeds 30% (research, services), (c) the organization is responsive and directed

to customer needs, (d) practices, processes, and products are adopted by clients, (e) contributions are made to world knowledge base (publications, patents), and (f) contributions are made to skill levels of citizens (training, education).

Austria

Holzforschung Austria

Date Established: 1953

Public-Private Sector: Holzforschung Austria is a private independent nonprofit organization. The Austrian Wood Research Society (established in 1948) (formerly the Austrian Institute of Wood Research) is the supporting organization of Holzforschung Austria.

Mission: To strengthen innovations in the wood industry through research and development, promotion of quality assurance through testing and supervision, and the transfer wood-technology know-how to the wood-based industry.

Primary Research Focus: The research focus of Holzforschung Austria is forest products.

Governance and Organization: Administered by an institute head and an institute director (presumably responsible to a governing board of directors). Organized into 11 working modules, each of which is lead by a program director.

Strategic Program Directions: The organization groups its activities into 11 working modules, each of which encompasses various activities (including, research, testing, expert reports, standardization and certification). The modules are as follows:

- Round wood and sawn timber (for example, wood anatomy, wood drying, wood storage)
- Timber construction (for example, laminated construction, timber connectors)
- Timber housing (for example, construction physics, multistoried housing)
- Windows and doors (for example, performance evaluation, thermal insulated profiles)
- Furniture and joinery (for example, gluing and lacquers)
- Wood-based products and adhesives (for example, glues, discoloration, tropical timbers)
- Surface (for example, electronic scanning, wood floor surfaces)
- Wood preservation (for example, insects and fungi, wood preservative evaluation)
- Ecotoxicology and analysis (for example, biological degradability, anaerobic treatments)
- Pulp and paper (for example, bleaching processes, deinking procedures)
- Bioenergy and environment (for example, transport of wood pellets, recycling residues)

Client Groups: Holzforschung Austria serves public and private organizations.

Services Provided: Holzforschung Austria provides information (library, software), research (direct delivery of products, joint research activities), consultation (advice), and training. The organization groups its activities into six major service packs: research and development, testing and supervising, expertise, standardization, seminars, library, publications, and quality management.

Budget and Funding Sources:

- A. Operating income in 2003 euros
3.69 million—Total (U.S. \$4.4 million)
(2002: 3.73 million; 2001: 2.97 million)
- B. Source of income in 2003 euros (estimated)
Commissioned research—40% (1.5 million)
Business commissions—40% (1.5 million)
Member contributions—3% (0.2 million)
Other—17% (0.7 million)

Total expenditures and focus of expenditures by program areas not available.

Scientists and Supporting Staff: Total of 58 employees in 2003. Distribution by functions (research, extension, supporting staff) is not available.

Measures of Performance: Holzforschung Austria measures its performance with research highlights and listing of publications.

Canada

Forest Engineering Research Institute of Canada (FERIC)*

Date Established: 1975

Public-Private Sector: FERIC is a private independent, nonprofit research and development organization constituted under the *Canada Corporation Act* (Part II). In 2007, Canada's FERIC, Forintek, and Paprican merged to form FPInnovations.

Mission: To provide members with the knowledge and technology needed to conduct cost-competitive, quality operations that respect the forest environment. An organizational goal is to improve Canadian forestry operations related to the harvesting and transportation of wood, and the growing of trees, within a framework of sustainable development. The program is known for being intensely practical and field-oriented.

Primary Research Focus: FERIC's research focus is forestry, with special emphasis on problems encountered by small-scale forestry operations.

Governance and Organization: FERIC is governed by a president-chief executive office and a governing board of

directors (8 appointed and 12 elected) that represent the organization's membership. The membership consists of the following: 92 industrial members, which represent 70% of wood harvest in Canada, 21 associate members, Canadian Forest Service, and nine provinces and territories. In 2004, FERIC had advisory committees as follows: Strategic Advisory Committee, Eastern Region, 18 members, Advisory Committee on Forest Engineering Research, Western Region, 93 members; and Advisory Committee on Wildland Fire Operations Research, Western Region, 25 members. Organized into an Eastern Division near Montreal, Quebec, (location of head office) and a Western Division in Vancouver, British Columbia.

Strategic Program Directions: FERIC research and development covers various engineering, human, operational, and environmental aspects of forestry operations. In 2005, the program areas were as follows:

- Eastern Division
Harvest and regeneration systems, partial cutting systems, stand tending, environmental impacts, value recovery, bioenergy, transportation systems, road construction and maintenance, decision support software and logistics, data acquisition and monitoring, and exploratory research.
- Western Division
Harvest engineering, silvicultural operations, harvesting operations, transportation and maintenance, wildland fire operations, and extension services.

Client Groups: FERIC serves public and private groups, with an owner–member emphasis.

Services Provided: FERIC provides information (library, software), research (direct delivery of products), consultation (advice), and training. It puts special emphasis on technology transfer, especially extension staff located in the field and regional liaison officers.

Budget and Funding Sources in 2004 Canadian dollars

- A. Income
\$11.8 million—Total (U.S. \$10.2 million)
- B. Source of income
Industry Members—47% (\$5.5 million)
Contract, grants, other—35% (\$4.1 million)
Canadian Forest Service—14% (\$1.7 million)
Provincial Governments—4% (\$0.5 million)
- C. Expenditures
\$11.8 million—Total

Expenditures by program area are not available, although allocation between the Eastern Division and the Western Division is about equivalent.

Scientists and Supporting Staff: Approximately 140 staff members, of which an estimated 100 are forestry and engineering professionals. In addition to seven administrative

staff at FERIC's headquarters office, staff (by area of emphasis) in regional offices is as follows. Each division also accommodates students and trainees, the number of which varies each year.

Eastern Division: FERIC staff of 45 members are assigned variously to multidisciplinary teams to the division's 12 program areas (harvest and regeneration systems, partial cutting systems, stand tending, environmental impacts of forestry operations, value recovery from forestry operations, transportation systems, road construction and maintenance, decision-support software and logistics, data-acquisition and monitoring systems for forestry equipment, and exploratory research (energy efficient operations). Division staff also includes an estimated 13 administrators (for example, division vice president, research director, technical communications director, director of administration) and regional liaison staff assigned to the division.

Western Division: Forty-eight Ensis staff members are grouped as follows: harvest engineering, 8 researchers; silvicultural operations, 3 researchers; harvesting operations, 7 researchers; transportation and maintenance, 7 researchers; and wildland fire operations, 7 researchers; extension, 6 extension specialists. In addition, are an estimated 10 administrators and technicians assigned to the division.

Measures of Performance: Ensis measures its performance by a general description of research results and listing of publications. Success in member recruitment and retention is also used as a measure of success.

Forintek Canada Corporation (Forintek)*

Date Established: 1979

Public-Private Sector: Private independent, nonprofit research and development organization established as a result of the Government of Canada's decision to privatize the government-owned Canadian Forest Products Laboratory. The latter was established in 1915, and through privatization initiatives, became Forintek Canada, Corporation (**F**orest, **I**ndustry, **T**echnology).

Mission: Forintek seeks to be a leading force in the technological advancement of the wood products industry, doing so through the creation and application of innovative concepts, processes, products, and education. Forintek will improve the quality of forest products, add value in the manufacturing chain, reduce production costs, expand market share, and monitor market trends. This will be achieved through applied research and development projects, common-good contracts, and client-specific proprietary contracts. Forintek's goals are to (a) lead in the development and balanced application of knowledge and technology to support member sustainable development goals (economic, environmental and social), and (b) deliver research products and services to the satisfaction of members and clients. The organization also has established a set of "core values."

Primary Research Focus: Forintek's primary research focus is forest products, notably adding value for wood products and systems, from resource assessment (resource characteristics affecting processing and marketing), lumber manufacturing (sawmilling, wood drying, and wood protection), composites products manufacturing (veneer, plywood, oriented strandboard, particleboard, and medium density fiberboard), value-added products (product design and manufacturing), building systems (acoustics, fire resistance, and structural performance), codes and standards (grading, durability), and marketing and economics (global trade, market potential research).

Governance and Organization: Forintek is governed by a chief operating officer (President and CEO) and a 26-member board of directors. Its research direction is provided by a national research program committee (between 15 and 20 members) consisting of four technical advisory committees with various number of members. In 2003–2004, committee members were as follows: resource assessment, 54 members; lumber manufacturing, 160 members; composite products manufacturing, 67 members; and building systems, 91 members; a value-added research advisory committee, 24 members; and a hardwood manufacturing working group administratively organized into seven program areas. In 2004, the organization had more than 200 member organizations, classified as primary-secondary wood processing companies (141), associate (54), and government (10). Member organizations pay annual fees based on product production or percentage of gross sales. Extensive partnering occurs with various organizations (150+ organizations). Major facilities are located in Vancouver, British Columbia, and Quebec City, Quebec. Satellite centers are situated at 11 other locations (some on university campuses).

Strategic Program Directions: Forintek's program focus is on key program areas: resource assessment, lumber manufacturing, composites products manufacturing, value-added products, building systems, codes and standards, and marketing and economics. A strategic plan (stated as mission, goals, and purpose) is developed by the Board of Directors, a national research program committee, and technical advisory committees, working with Forintek management and staff. At the project level, strategies and plans are guided by representatives of member companies through their interactions with Forintek's management and research staff.

Client Groups: Forintek serves public and private clients, with an owner-member emphasis.

Services Provided: Forintek provides research (direct delivery of products, joint research activities), technology transfer (implementation of research results in mills), consultations (mill visit program, technology monitoring, special technical missions, commercialization of technologies), training sessions (seminars, workshops, software demonstrations). Preferential member rates for services provided. Fee-for-service available to nonmembers.

Budget and Funding Sources

- A. Revenue in 2004 Canadian dollars, for the fiscal year ending March 31, 2004
 \$28.3 million (U.S. \$24.4 million)
 (\$1.4 million excess of revenue over expenditures)
- B. Source of revenue in 2004 Canadian dollars
 Government contributions and industry member assessment—66% (\$18.8 million)
 Contract fees for services—32% (\$9.1 million)
 Other income—2% (\$0.4 million)
- C. Expenditures in 2004 Canadian dollars, for the fiscal year ending March 31, 2004
 \$15.5 million—Staff
 \$8.3 million—Laboratories
 \$2.1 million—Premises
 \$1.0 million—Administration
 \$26.9 million—Total

Expenditures by program area and services provided are not available.

Scientists and Supporting Staff: Although a complete listing is proprietary, Forintek has a staff of about 210 people. The estimated professional staff distribution is as follows (2002–2003): composites (21%) lumber manufacturing (12), building systems (29), drying and protection (18), resource assessment (6), and value added manufacturing (14). Staff competencies include wood science and technology; wood products engineering; mechanical, civil, and electrical engineering, physical chemistry microbiology, organic chemistry, environment, forestry and forest economics; and library science. Extensive expertise in forest resource characterization, wood product manufacturing (for example, lumber, panels, engineered wood product, flooring, furniture), woods drying and protection, wood product development and performance evaluation (for example, structural and appearance), building systems (for example, structural performance, fire resistance, seismic, durability and environmental attributes), and wood product markets and economics.

Measures of Performance: Research highlights, asset–liability and profit–loss statement, and patents granted (69) of which 44 are being maintained. The listing on these patents is proprietary.

Pulp and Paper Research Institute of Canada (Paprican)*

Date Established: 1925

Public-Private Sector: Paprican is a private independent nonprofit research and educational organization that has existed in some form for 80 years. Its membership is open to companies producing pulp and paper. In 2003, the organization had 32 member companies, three associate member companies, and one program element partner.

Mission: Within the context of a mission to deliver innovative economic solutions through research, the organization's mission is to create competitive advantages by working in partnership with global members and clients in the pulp and paper and related renewable resource industries through the generation and application of knowledge. Paprican's mission is to be accomplished by providing superior returns on member company investments in the organization; integrating research programs with the strategies of member companies; relentlessly pursuing member company satisfaction; sustaining excellence in science, technology, and education; promoting links between fundamental science and business value and needs; and empowering the employees of the organization.

Primary Research Focus: Paprican researches forest products, especially pulp and paper. This research has a modest emphasis on forestry, through the Fibre Quality and Value research program, in which specific attributes of individual species and their growing environments can add value to targeted pulp and paper products.

Governance and Organization: Paprican is governed by a 21-person board of directors and administered by a chief executive officer (president and chief operating officer) and two vice presidents (research and education, administration–secretary treasurer). The research program is advised by a 30-person research program committee. Paprican's research programs are located in Quebec and British Columbia (two programs) and education programs located at McGill University (Montreal, Quebec), University of British Columbia (Vancouver, British Columbia), and École Polytechnique (Montreal, Quebec).

Strategic Program Directions: Paprican focuses on fiber supply and quality, chemical and mechanical pulping, papermaking, environmental performance, product performance, development engineering, analytical sciences, and education. In partnership with three universities and member companies, the educational program is focused on advanced training in pulp and paper sciences and on professional career development. The overall research program reflects virtually all technologies relevant to pulp and paper manufacturing from the forest to final products, including processes related to the environment and sustainability.

Client Groups: Paprican serves public and private clients, with an owner–member emphasis.

Services Provided: Paprican provides information (library services), research, testing (calibrations, quality assurance services), consultation (advice), pilot plant applications, and education and training (short-courses, postgraduate education).

Budget and Funding Sources

- A. Income in 2003 Canadian dollars
 \$39.4 million—Total (U.S. \$43.0 million)

B. Source of Income (Canadian dollars)

- Member companies—67% (\$26,600,000)
- Grants and contracts—12% (\$4,600,000)
- Federal government—20% (\$7,700,000)
- Royalties and other—1% (\$500,000)

Member companies are allowed to direct their membership fees to specific program areas (up to 35% of company fees) and to applications of technologies in company mills (up to 15% of company fees).

The organization received significant financial or other tangible support from 33 allied industry partners and from four major governments: Government of Quebec, Ministry of Science and Technology Research, Ministry of Natural Resources; Government of British Columbia, Government of Canada, Environment Canada, Industry Canada, National Research Council Canada, Natural Sciences and Engineering Canada; and the U. S. Department of Energy.

C. Focus of expenditures

- Employee salaries and benefits—70%
- Services—12%
- Utilities and taxes—6%
- Travel—5%
- Supplies—5%
- Royalty repayment—2%

D. Program Focus of Expenditures: Expenditures are distributed approximately equally across organization's eight major strategic research program directions: \$5 million (Canadian Dollars) or 12.5% in each program area (fiber supply and quality, chemical and mechanical pulping, papermaking, environmental performance, product performance, development engineering, analytical sciences, and education).

Scientists and Supporting Staff: Approximately 340 scientists, engineers, and support staff distributed approximately equally across organization's eight major strategic research program directions: 42 staff or 12.5% in each program area (fiber supply and quality, chemical and mechanical pulping, papermaking, environmental performance, product performance, development engineering, analytical sciences, and education). The expertise represented is partially reflected by the organization's strategic direction and project plans.

Measures of Performance: Paprican's performance conditions specifically place high priority on customer needs, uphold reputation for excellence and integrity, reward highly creative and energetic people, effectively use resources provided by member companies, and expect superior performance of everyone (individually and collectively).

China

Chinese Research Institute of Wood Industry (CRIWI)*

Date Established: 1957

Public-Private Sector: The CRIWI is a public government organization. The institute is a branch of the Chinese Academy of Forestry. Other units within the Academy involved in forest products research are the Research Institute of Chemical Processing and Utilization of Forest Products, National Bamboo Research Center, National Engineering Research Center of Wood Industry, and the National Engineering and Technology Research Center of Forest Chemical Industry.

Mission: To develop technologies for utilizing wood raw materials rationally and economically so as to make better use of forest resources and meet the needs of national economy and people's livelihood.

Primary Research Focus: The CRIWI researches forest products.

Governance and Organization: The CRIWI is administered by a director and three deputy directors. In addition to four administrative staff persons (office of general affairs, and divisions of personnel and education, planning and management, finances), the organization is structured into five research divisions: division of wood properties, wood-based panels, adhesives and panel surface finishing, wood protection, and equipment and automation. The institute also has other administrative parts: Department of Civil Engineering Design, National Quality Monitoring and Testing Center for Wood-based Panels, Technical Committee for Wood-based Panels Standardization, Chinese Society of Wood Industry, and the Basic Committee of China Technical Committee for Wood Standardization. The institute is headquartered in Beijing, China.

Strategic Program Directions: Primary fields of research focused on by the Institute are

- Wood science (including wood anatomy, wood chemistry, wood mechanics, and wood physics as well as the relationship between silviculture and wood processing)
- Wood processing technology (including wood drying, wood preservation, wood fire-retardation, wood modification and wood finger-jointing)
- Wood-based panels manufacturing technology (including plywood, fiberboard, particleboard, medium density fiberboard, laminated veneer lumber, wood-based composite materials and recycling of wood-based materials)
- Wood resource utilization policy and market research

Client Groups: The CRIWI serves public and private clients.

Services Provided: The CRIWI provides research (direct delivery of products) and consultation (advice). The institute is also offers programs leading to Masters and PhD degrees.

Budget and Funding Sources: Not available

Scientists and Supporting Staff: In 2003, CRIWI had 161 staff persons, including 140 research and technical personnel. Of 15 highly qualified researchers identified, areas of their research were as follows: wood and nonwood-based panels (5 researchers), wood properties (3), forest machines (2), wood adhesives (2), wood composites (2), and wood preservation (1).

Measures of Performance: The CRIWI measures performance by listing publications.

Finland

European Forest Institute (EFI)*

Date Established: 1993

Public-Private Sector: The EFI is a private independent organization authorized by Finnish federal law (legally identified as an association). Twenty European governments signed the Convention on EFI in 2003, and as of May 2005, six countries have ratified the Convention. Once ratified by 8 countries, the Convention will enter into force and the EFI will become an international organization established by European countries.

Mission: To conduct, promote, and cooperate in research involving forests, forestry, and forest products at the pan-European level so as to advance the conservation and management of forests for producing goods and services in a sustainable way. Also, to make the results of research known to all interested parties, focusing especially on information needs in areas of policy formulation and implementation.

Primary Research Focus: The EFI researches forestry, with limited forest products research.

Governance and Organization: The EFI is governed by a council of 9 persons, an institute director, and a scientific advisory board (10 persons) that counsel on research directions for the Institute. In addition to the headquarters (Joensuu, Finland), the Institute has seven regional centers through which research can be focused on special regional problems. Centers do not receive funding from the Institute. As of 2004, the Institute had 136 member organizations from 37 countries.

Strategic Program Directions: The institute has more than 30 research and development priorities occurring in four major program areas: forest ecology and management (nine projects, including carbon sequestration, forestry impacts of environmental changes, management of forests under various pressures, forests as an energy source, and forest biodiversity); forest products and socioeconomics (seven projects, including rural development, economics of multi functional forest uses, supply and demand of timber and

forest products, forest products trade analysis, and forest sector competitiveness); policy analysis (five projects, including efficiency and effectiveness of public policies; forest science and policy making interface; forest policy development processes, goals, and values of shareholders; and cross-sector policy impacts on forest and environment); and forest resources information (seven projects, including future development options for European forest resources and information for decision-making in forestry).

Client Groups: The EFI serves public and private clients, with an owner–member emphasis.

Services Provided: The EFI provides information, research (direct delivery of products), consultation (advice), and training activities. Specifically, the Institute provides information for forest policymaking in European countries, develops research methods and conducts research, compiles and maintains data, organizes and participates in training activities and scientific meetings, and publishes and disseminates knowledge. The institute acts as a European coordinator for research activities.

Budget and Funding Sources

A. Income in 2004 euros
2.5 million – Total (U.S. \$3.0 million)

B. Source of income in 2004 euros
Government#—40% (1,000,000)
European Commission—39% (986,000)
Special project funding—13% (341,000)
Membership fees— 6% (149,000)
Other sources (seminars, publications) —2% (58,000)

#Core annual funding by the government of Finland, an amount that has been nearly constant from 1998 through 2004. Funding from other sources has increased about 1.8 million euros during the same period.

C. Focus of expenditures

Although focus of research investments varies considerably according to annual projects undertaken, the estimated distribution for 2002 (excludes regional centers) was as follows:

Forest ecology and management—30%
Forest products and socioeconomics—15%
Policy analysis—20%
Forest resources information—35%

Scientists and Supporting Staff: In 2004, institute staff was 53 persons from 15 different countries (for a total of 34 person years). Although staff research focus varies considerably according to annual projects undertaken, allocation of staff by major research area and research support in 2002 was estimated to be as follows:

- Forest ecology and management—31 staff (12 researchers and 19 scholars, research associates, and trainees)

- Forest products and socio-economics—14 staff (7 researchers and 7 scholars, research associates, and trainees)
- Policy analysis—12 staff (4 researchers and 8 scholars, research associates, and trainees)
- Forest resources information—14 staff (five researchers and nine scholars, research associates, and trainees)
- Research administration and communication—18 staff

Measures of Performance: Research highlights and listing of publications

Finnish Forest Research Institute (Metla)*

Date Established: 1917

Public-Private Sector: Metla is a public government organization authorized by Finnish federal law.

Mission: Through research, to promote economically, ecologically and socially acceptable management and utilization of forests. Metla's mission is pursued by focusing on five target areas: research activities, research forests and laboratory activities, communication and information services, international activities, and administrative services.

Primary Research Focus: Metla researches forestry, with a modest forest products emphasis.

Governance and Organization: The organization is responsible to the Ministry of Agriculture and Forestry and the Ministry of Environment. A management board provides strategic direction to a director general that is the organization's lead administrator. In addition, a 6-person management team provides assistance to the administrator, and a research expert group (appointed by the director general) evaluates project proposals and gives advice and support on research matters. An international scientific advisory board serves as a generator for new research ideas and promotes cooperation and networking with other leading forest research organizations around the world. Research is conducted at nine different locations (two centers and seven research stations) throughout Finland. General management and coordination of programs are conducted from the headquarters office in Helsinki, Finland.

Strategic Program Directions: The organization focuses on four target areas: research, research forest and laboratory activities, international activities, and administrative services. Research is organized into problem-oriented projects (each managed by a principal research officer) oriented toward the information needs of customers and the problems they face. In 2003, Metla had 5 to 15 individual projects each for a total of 150 total projects. Program research areas involved market potential for roundwood products, socioeconomic implications of carbon pools in Finnish forests, planning for management of forest resources, monitoring and inventory, and the effect of silvicultural practices on forest production.

Examples of past research involving forest products involve timber trade (sector worldwide outlooks), wood processing and energy use (energy-wood harvesting), and wood use and measurement (hardwood utilization, structure of wood).

Client Groups: Metla serves public and private clients, with a government emphasis.

Services Provided: Metla provides information (library, photo-archive, software for forest statistics, timber prices, forest growth), research (direct delivery of products); consultation (expert services, forecasting, presentations); laboratory services; testing and inspection (pesticides, tree breeding); and training and education. The organization is also responsible for a number of research forests. Commissioned services are charged according to the principles established by the Finnish "Basis for Determining Payments for State Services Act."

Budget and funding sources

- A. Income in 2004 euros
49 million—Total (U.S. \$58.9 million)
- B. Source of income in 2004 euros
Ministry of Agriculture and Forestry—73% (36 million)
Foundations, other ministries and commissioned services—27% (13 million)
- C. Focus of expenditures in 2005 euros
 - Forest ecosystems and changes of environment—31% (11.0 million)
 - Forest growing and utilization—20% (7.0 million)
 - Forest genetics and forest tree breeding—11% (4.0 million)
 - Monitoring and inventory of forest resources—9% (3.0 million)
 - Forest politics and international affairs—9% (3.0 million)
 - Information systems and services—6% (2.0 million)
 - Research forest and laboratory services—14% (5.0 million)

Scientists and Supporting Staff: in 2004, Metla had a total staff estimated to be about 875 persons, of which 321 are researchers (150 with PhDs). Two-thirds of the researchers hold a degree in forestry, while the remaining portion has academic expertise in fields such as business economics, social sciences, natural sciences, and various technologies. The organization has 21 professors that are senior scientists responsible for developing their own disciplines or related fields of expertise.

Measures of Performance: In addition to research highlights and listing of publications, research projects and programs are evaluated (set intervals and at the end of project) by recognized national and international experts.

Oy Keskuslaboratorium-Centrallaboratorium Ab (KCL)*

Date Established: 1916

Public-Private Sector: The KCL is a private, independent organization (company).

Mission: In the context of a vision to be the leading research company for the global paper and pulp industry, the organization's mission is to support the competitiveness of its owners by delivering innovations, knowledge, and technology to its customers. The mission is based on a set of five key values: innovativeness, customer confidentiality, mutual respect, environmental responsibility, and exceeding customer expectations. To accomplish the KCL mission, the organization's goal is to develop, maintain, and command the knowledge and skills required to

- Acquire unique top-level expertise in selected areas of the pulp and paper industry supply chain.
- Secure comprehensive knowledge and know-how across the entire spectrum of the forest industry.
- Maintain the wide range of skills demanded by unique approaches to research.

Primary Research Focus: The KCL researches forest products, especially pulp and paper.

Governance and Organization: The KCL is governed by a board of directors (seven persons from owning companies) and a managerial group comprised of a president and two vice presidents. The vice presidents are in research (KCL Science and Consulting) and research services (KCL Services). In addition, KCL has an administrative support unit. The organization is advised by a research committee of seven persons affiliated with owner companies and nonmember organizations (for example, universities). The KCL is owned by four major Finnish companies: Metsäliitto-Group, Myllykoski Oyj, Stora Enso Oyj, and UPM-Kymmene Corporation. KCL is headquartered in Espoo, Finland.

Strategic Program Directions: The KCL focuses on three cores areas: research, services, and information.

The research program is formalized by KCL Science and Consulting. Philosophies guiding research include a focus on challenging technical and scientific problems, and on solutions that directly address the priority needs of clients in a meaningful way. The research program focuses on

- Fibers (for example, physical and chemical processing of fibers, and evaluation of new fibers and pulp).
- Papermaking solutions (processes) (for example, detecting process disturbance conditions, and process operational efficiency).
- Printing surface (for example, behavior of paper and board webs in various end uses, and interaction between paper and color coatings).

- End-use (products) environment (for example, printing technology, and food products packaging).

The services program is formalized by KCL Services (including administrative units involving marketing, patents, and standardization), and is composed of two major groups:

- Pilot plant services (for example, integrated machine trials starting with wood chips and ending up with 4-color printed products).
- Laboratory services (for example, mechanical and chemical pulp testing, cooking and bleaching testing, and print quality testing, chemical characterization of pulp, paper and board, suitability of packaging materials for food, and laboratory trials from pulping to printing).

The research services program also engages in advice on standardization. In this respect, KCL has its own products; for example, KCL Eco (life cycle assessment), KCL Wedge, and KCL Printing School.

The information and library program provides extensive information resources, including publications, journals, and patent information. Specific prices are specified for access to information sources.

Client Groups: The KCL serves public and private clients, with an owner–member emphasis. The organization's research program is focused primarily on the information needs of KCL owners, while KCL services are geared toward a broader array of clients, such as other research companies, suppliers of raw materials and equipment, engineering and design companies, and the pulp, paper, and board industry generally. One of the reported cornerstones of the organization's business success is tailor-making information to fit client needs.

Services Provided: The KCL provides information (library, software), research (direct delivery of products, joint research activities), consultation (advice), testing, and training and education.

Budget and funding sources

- A. Income in 2004 euros
23.8 million—Total (U.S. \$28.6 million)
- B. Source of income in euros
Owner companies' fees—40% (9.5 million)
Contract for services—51% (12.1 million)
Government funding[#]—9% (2.2 million)

[#]Government funding consists of project specific funding from various Finnish, Nordic, and European sources.

Total expenditures and focus of expenditures by program areas not available.

Scientists and Supporting Staff: In 2004, KCL employed 300 persons that were assigned to its main operating units as follows: 130 staff, KCL Science and Consulting (43%); 140 staff, KCL Services (47%); and 30 staff, administration

and other units (10%). The staff breakdown by education is as follows: 47 PhD and 18 licentiate degrees, 124 other academic degrees, 129 technical and vocational college degrees.

Measures of Performance: The KCL measures its performance by consolidated profit and loss statements and consolidated balance sheets (assets and liabilities).

Technical Research Centre of Finland (Valtion teknillinen tutkimuskeskus, VTT)*

Date Established: 1942

Public-Private Sector: The VTT is a private independent contract research and development organization authorized by Finnish federal law. Originally responsible to the Ministry of Trade and Industry, the center was granted nearly full autonomy in 1972.

Mission: Through the creation and application of technology, VTT actively seeks to enhance the global competitiveness of industry and other business sectors, and thus increase the welfare of society.

Primary Research Focus: The VTT researches forest products, with modest emphasis on forestry

Governance and Organization: The VTT is governed by a seven person board of directors, including a chair and a vice chair. The organization has an executive staff of eight, including a director general, administrative director, and six executive directors (electronics, information technology, industrial systems, processes, biotechnology, building and transport). Organizationally, VTT has eight major research institutes (including electronics, biotechnology, building and transport) and eight major knowledge portals through which expertise in these various institutes can be accessed (VTT Environment, VTT Materials, VTT Pulp and Paper, VTT Information Technology, VTT Nuclear, VTT Renewables, VTT Transport, and VTT Life Science). Each research institute has a research advisory committee. The center's research institutes are located mainly at Espoo, Tampere, Oulu, and Jyväskylä, Finland, and in Palo Alto, California, USA.

Strategic Program Directions: Research involving forestry and forest products focuses on a number of topical areas (portals), of which the following are especially relevant:

- Pulp and paper—raw materials and chemicals, paper and printing products, control and operations (measurements, process control), and process development
- Materials—structural design, services (testing, analyses), production and manufacturing (building materials, machines and equipment), and materials performance (wear, corrosion, fire).
- Renewables—bioenergy (forest biomass), wind energy, systems (energy saving systems), waste to energy (recoverable fuels).

- Environment—clean products and processes (closed water cycles), environmental technologies (waste treatment), environmental services (biodegradability), environmental management (environmental modeling)
- Life science (biotechnology for health, bioproducts, safety, food design).

Client Groups: The VTT annually serves 5,000 public and private customers. Clients are worldwide, with specific interest in serving information needs regarding building products industries, the wood-based industry, public agencies, and research institutes and universities.

Services Provided: The VTT provides information (library services), research (direct delivery of products), consultation (advice), testing (certification, quality control), and training (sponsorship of seminars and conferences).

Budget and Funding Sources

Income and source of income information is not available for the forest products research and service activities of the Technical Research Centre of Finland. As such, the information below describes information for the Center generally.

A. Income in 2003 euros
\$218.5 million—Total (U.S. \$262.6 million)

B. Source of income in 2003 euros
Basic government funding—31% (67.7 million)
Private sector, domestic[#]—33% (72.2 million)
Public sector domestic—25% (54.6 million)
Public and private foreign—11% (24.0 million)

[#]Of the center's total income, 6% originates from the forest industry sector and 2% from the building and construction sector.

Total expenditures and focus of expenditures by program areas not available.

Scientists and Supporting Staff: The center employs over 2,800 persons, of which over 80% are considered research scientists or research staff. Forty-two research staff are identified as "contact staff" and are assigned to the following portals: VTT Pulp and paper, 9; VTT Materials, 5; VTT Renewables, 12; VTT Environment, 10; and VTT Life Science, 6.

Contact staff are but a portion of the total research staff employed by the organization. For just the VTT pulp and paper portal, the organization's administrators report employment of about 200 scientists and technicians. The total number of staff assigned to other portals is not available. Support staff are not included in any of the aforementioned estimates.

Measures of Performance: The VTT measures its performance through extensive reporting of services rendered (research, education, publications, patents granted) and detailed accounting of the organization's financial condition (operating income and expenses, fixed assets, long-term investments, liabilities).

France

Association of Forest Cellulose (AFOCEL)

Date Established: 1962

Public-Private Sector: The AFOCEL is a private independent organization, governed by the French Law on Associations of 1901.

Mission: To increase competitiveness of the industry's fiber supply and of the overall wood and paper sector. The AFOCEL is committed to a long-lasting relationship to clients by offering top-quality services.

Primary Research Focus: The AFOCEL researches forestry and forest products.

Governance and Organization: The AFOCEL is governed by a board of directors (15 representatives) and a director general. The director general is also the general-research manager of the French Pulp and Paper Research and Technical Centre (CTP). The board is comprised of an at-large chair, three persons representing member companies, nine persons in a personal capacity, and two other members (assistants). The organization's headquarters is in Paris, France. In 2004, membership in AFOCEL was made up of 14 pulp and paper industry companies. Organizationally, AFOCEL is structured as follows:

- Management: Director General, General Manager, Manager Administration and Finance
- Regional Stations: Four regional stations
- Specialist Laboratories: Wood Process, Biotechnology, and Economics and Competitiveness

Strategic Program Directions: The organization engages in research and development, provision of various services, and education and training activities. The AFOCEL's research program is strategically focused around four macro-objectives: (a) wood supply (trade, energy wood, mechanization of logging, logistics and transportation), (b) processes and products (paper quality, fiber processes), (c) forest (forest plantations, forest management, breeding and biotechnology, field-testing networks), and (d) territories (stakeholder needs in a local, national or international geographic setting). These macro-objectives are expressed as cross-disciplinary fields of activity in which AFOCEL carries out applied research: biotechnology, silviculture, tree improvement, forest harvesting, procurement and transport, wood processing, economics, forest resource studies, and sustainable forest management.

Client Groups: The AFOCEL serves private clients, with an owner emphasis.

Services Provided: The AFOCEL provides information (library, publications), research (direct delivery of products), software development, and consultation (advice).

Budget and Funding Sources

- A. Income in 2003 euros
\$6.5 million—Total (U.S. \$7.8 million)
- B. Source of funds[#] in 2003 euros
Government (federal)—44% (2.9 million)
Ministry of Agriculture, Food, Fisheries, and Rural Affairs—20% (1.6 million)
Ministry of the Economy, Finance and Industry—24% (1.3 million)
Pulp and Paper Industry—26% (1.7 million)
Other Contracts (public and private)—30% (1.9 million)

[#]AFOCEL has a strong public dimension that is explained by the responsibilities state and regional authorities have assumed in the “forest-wood-paper” sector. The result is a mixed and balanced funding from both public and private sources.

- C. Expenditures in 2003 euros
Salary expenses—64% (4.2 million)
Operating Expenses—28% (1.8 million)
Depreciation—8% (0.5 million)
- D. Focus of expenditures in 2003 euros
Wood supply—28% (1.8 million)
Process and products—14% (0.9 million)
Forest—50% (3.3 million)
Territories—8% (0.5 million)

Scientists and Supporting Staff: Staff of 96 permanent employees (2003), 46% of which were researchers. Allocation of staff among program areas is not available.

Measures of Performance: Clients served and listing of publications. Strong statements of seeking to be a “value creation” organization with an interest in strengthening of a “result-oriented organizational culture.”

French Pulp and Paper Research and Technical Centre (Centre Technique du Papier, CTP)*

Date Established: Not available

Public-Private Sector: The CTP is a private independent organization.

Mission: To provide the pulp, paper, and board industries technical and scientific support that will increase their productivity and competitiveness, in due respect of the environment and of European and French laws and regulations. To accomplish this mission, CTP has established the following objectives: bring scientific and technical support to the papermaking industry, maintain a strong potential for specific research at the laboratory level, develop high-performance semi-industrial pilot plants, have experts on call at production sites, provide technical monitoring for machine builders and suppliers, and promote cooperation within broader business and social environments.

Primary Research Focus: The CTP researches forest products, especially pulp, paper, and board.

Governance and Organization: The CTP is governed by a board of directors and a chief executive officer. The CTP is organized into four divisions: fiber resources, product quality, environment, and control processes. In addition, administrative services for the organization are assigned to two units: functional services (documentation, communication, human services, data processing, and engineering and security services) and research and development services (quality management, contacts management). Specializing in the marketing of software and instruments, TechPap is a subsidiary of the French Pulp and Paper Research and Technical Centre. The Center is headquartered in the Grenoble University Campus, Saint-Martin d'Herès, France.

Strategic Program Directions: The organization focuses on research and development, provision of various services, and education and training activities. The research program is focused on four major areas (consistent with the organization's divisional structure) as follows:

- Fiber Resources—Chemical and mechanical pulping, naturally diverse virgin fibers, fractionation and refining, paper and board recycling, de-inking, and pollutants and contaminants.
- Product Quality—Coating and calendaring, technologies of impression, and paper and board properties.
- Environment—Waste and emission control, environmental health and hygiene, chemical analysis, and energy management.
- Process Control—Sensor and simulation technology, software development, and analyses and data processing. Once developed, instruments are passed into TechPap.

Client Groups: The CTP serves public and private clients worldwide.

Services Provided: The CTP provides information (library, software), research (direct delivery of products, joint research activities), consultation (advice), testing, and training and education. The testing and analysis services of CTP are provided by four major laboratories: Physical Testing Laboratory, Chemical Analyses Laboratory, Microbiological Laboratory, and Paper Fiber Characterization Laboratory (the Physical Testing Laboratory is accredited by the French Committee of Laboratory Accreditation). The CTP also offers extensive training courses and seminars focusing on the science and technology of papermaking.

Budget and Funding Sources

- A. Income in 2004 euros
\$11.3 million—Total (U.S.\$ 13.6 million)
- B. Source of income in 2004 euros
Collective research—69% (7.8 million)
French Ministry of Industry—42% (3.3 million)

- Associated contracts—27% (2.1 million)
- Private contracts—21% (1.6 million)
- Diagnosis and consulting—10% (0.8 million)
- Other income sources—31% (3.5 million)

C. Expenditures in 2004 euros
\$11.3 million—Total (including 1.3 million for equipment and renovation)

- D. Focus of expenditures (estimated) (2004 euros):
Research programs—69% (7.8 million)
Fiber resources—44% (3.4 million)
Product quality—20% (1.6 million)
Environment—17% (1.3 million)
Other#—19% (1.5 million)
Other programs—31% (3.5 million)

Basic research (3%), technology watch (3%), standards (2%), and quality insurance (2%)

Scientists and Supporting Staff: In 2004, CTP employed 155 persons: 49 research scientists, including 8 doctoral students and doctoral trainees (32%), 62 research technicians (40%), and 44 managers and administrators (28%). In 2001, the research staff (engineers and technicians) were distributed across the organization's divisions approximately as follows: fiber resources, 35%; product quality, 20%; environment, 21%;, and process control, 24%.

Measures of Performance: The CTP measures its performance through an extensive listing of publications, customers served, analyses undertaken, pilot processes developed, private contracts initiated, and educational activities conducted. Also, CTP uses reports about the organization's receipts and expenditures.

Germany

Federal Research Centre for Forestry and Forest Products (BFH)

Date Established: Not available

Public-Private Sector: Public government organization

Mission: To assist the federal government by providing a scientific basis for political decisions involving forests and scientifically reliable information of benefit to the forestry and forest products industry as well as to society as a whole.

Primary Research Focus: The BFH researches forest products and forestry.

Governance and Organization: Governance for BFH resides organizationally within the portfolio of the Federal Ministry of Food, Agriculture and Consumer Protection. The center is administered by a head who is advised by a board of directors and a research advisory panel. The center is organized into seven institutes plus two administrative units (information and documentation and administrative services). The seven research institutes are the institutes for world forestry, forest genetics and forest tree breeding, economics, wood biology and wood protection, wood chemistry and chemical

technology of wood, wood physics and mechanical technology of wood, and forest ecology and forest assessment. The center is located in Hamburg, Germany, and cooperates with teaching and research programs at the University of Hamburg.

Strategic Program Directions: The center's research programs are organized in accord with the center's institutes as follows: world forestry (forest ecosystems, forest development, forest management); genetics and tree breeding (provenance research, ecological genetics, resistance research, genomics); economics (policy, marketing, business economics); wood biology and wood protection (wood formation, structure and quality, biodeterioration, protection); chemistry and chemical technology (cellulose, lignin, adhesives, pulp, paper and fiber boards); and forest ecology and forest assessment (ecological fundamentals, forest inventories, wildlife ecology). The center and the University of Hamburg have established a joint research and teaching program for the period 2002–2005.

Client Groups: The BFH serves public and private clients, with a government emphasis (especially federal government).

Services Provided: Information (library resources, on-line data bases), research (direct delivery of products), consultation (advice), and education and training.

Budget and Funding Sources: Not available

Scientists and Supporting Staff: Information on this subject is not available, although the number is estimated to be more than 120 persons (research and support staff). The number of researchers assigned to each institute is estimated to be as follows:

- World forestry—one researcher
- Forest genetics and forest tree breeding—16 researchers
- Economics—16 researchers
- Wood biology and wood protection—26 researchers
- Wood chemistry and chemical technology of wood—18 researchers
- Wood physics and mechanical technology of wood—17 researchers
- Forest ecology and forest assessment—17 researchers

Measures of Performance: The BFH measures research highlights, sponsored conferences, and a listing of publications.

Institute of Wood Technology, Germany (Institute für Holz- und Papiertechnik, IWT)*

Date Established: The IWT was established in 1952 as a government research organization.

Public-Private Sector: The IWT is an independent organization that was privatized in 1992. It is owned by Trägerverein

Institut für Holztechnologie Dresden e. V. (a share holding organization), which is comprised of more than 72 companies, associations, and institutions.

Mission: To undertake application-related research on the use of wood and its processing. The organization's focus is on small and medium-sized enterprises in the wood and furniture industries and related branches.

Primary Research Focus: The IWT researches forest products.

Governance and Organization: The institute is governed through the parent organization by a four-person board of directors and is administered by an institute managing director plus a financial manager and a manager of marketing and sales. The IWT is organized into nine program areas, including the Development and Test Laboratory for Wood Technology (subsidiary), which provides testing services involving materials and products (for example, adhesives, flooring material, windows and doors), chemicals (for example, glues, wood protection materials), and biological conditions (for example, wood durability, preservatives). The Development and Test Laboratory for Wood Technology works as a notified body for testing and technical approvals worldwide. The organization's headquarters is located in Dresden, Germany.

Strategic Program Directions: The institute's research programs focuses on nine major areas:

- Wood anatomy, preservation, modification (for example, wood structures, wood drying)
- Wood-based materials (fiberboard, laminated board, particleboard, orientated strandboard, plywood, and solid wood panels)
- Binder and additives for wood-based materials
- Processing technology (cutting, smoothing, joining)
- Surface coating and material (varnishes, veneers)
- Chemical analytics (volatile emissions)
- Furniture (design, construction, recycling)
- Construction products (shape, stability, fire resistance)
- Biotechnology testing (mechanical testing of products)

Client Groups: The IWT serves public and private clients, with an owner–member emphasis.

Services Provided: The IWT provides information (library, software), research (direct delivery of products), consultation (advice), data bases, and testing and certification of products. The institute publishes the professional periodical *Holztechnologie*.

Budget and Funding Sources: Total IWT's 2004 expenditures were 5 million Euro (U.S. \$6 million), of which 60% was from public sources and 40% from industry for research and services provided.

Scientists and Supporting Staff: The total staff (administrative and technical) of IWT is estimated at 75 to 80.

Measures of Performance: Not available.

Indonesia

Forest Products and Forestry Socio-Economic Research and Development Center

Date Established: 1983

Public-Private Sector: The Forest Products and Forestry Socio-Economic Research and Development Center is a public government organization.

Mission: To coordinate and to conduct research and development on forest products utilization and socioeconomics of forestry. In pursuit of this mission, the center is to conduct and coordinate research, evaluate research programs and projects, and distribute information that results from research activities.

Primary Research Focus: The center researches forest products, with modest emphasis on economics.

Governance and Organization: The center is organizationally one of two centers (the other being the Forest and Nature Conservation Research and Development Center) within the Federal Agency for Forestry Research and Development (FORDA) within the federal Ministry of Forestry and Estate Crops. The center is headed by a director who oversees two divisions:

- Operational System of Research Division
Subdivisions of research planning, reporting, administration, and service
- Research and Development Division
Subdivisions of development of research results, publications and library management, monitoring and evaluation, and 12 researcher groups

The center is located in Bogor, Indonesia. The Agency Forest Research and Development operates 10 regional research institutes.

Strategic Program Directions: The research program focuses on the following areas: wood anatomy, wood biodeterioration, wood preservation, wood physical and mechanical properties, wood drying, sawmilling and wood working, wood based panels, fiber technologies, wood chemistry and energy, non-wood forest products, forest engineering and harvesting, and economics and forest administration.

Client Groups: The center serves public and private clients.

Services Provided: Information (library), research (direct delivery of products), testing, consultation (advice), and training.

Budget and Funding Sources: Not available.

Scientists and Supporting Staff: As of 1999, the center had an estimated staff of more than 160 persons (includes

administrators, researchers, and support staff). The center has a library staff of four. The research staff totaled 143, with 74 researchers (12 PhDs) and 69 technicians and was divided among disciplines as follows:

- Wood anatomy—3 researchers and 5 technicians
- Wood biodeterioration—7 researchers and 5 technicians
- Wood preservation—6 researchers and 6 technicians
- Wood physical and mechanical properties—2 researchers and 5 technicians
- Wood drying—3 researchers and 5 technicians
- Sawmilling and wood working—5 researchers and 9 technicians
- Wood based panels—7 researchers and 6 technicians
- Fiber technologies—4 researchers and 8 technicians
- Wood chemistry and energy—6 researchers and 4 technicians
- Non-wood forest products—5 researchers and 3 technicians
- Forest engineering and harvesting—14 researchers and 7 technicians
- Economics and forest administration—13 researchers and 6 technicians

Measures of Performance: Research results are documented according to each of the center's 5-year plans.

Ireland

National Council for Forest Research and Development (COFORD)*

Date Established: The COFORD was established in 1993 as an initiative of the Irish government and funded under the European Commission's STRIDE program.

Public-Private Sector: The COFORD is a government organization funded by the Irish government through the National Development Plan 2000–2006.

Mission: To conduct research that will promote the competitiveness of the forest products industry and allow it to become a major economic resource for future generations. Emphasis is also on research that will lead to environmental safeguards and practices to ensure continued and sustainable development of forest resources. The COFORD pursues its mission primarily by competitively granting money in support of various research (categorized as applied, strategic, or desk studies) and technology transfer activities. The organization also plays a major role in the coordination of research and technology transfer activities generally.

Primary Research Focus: The COFORD researches forestry and forest products.

Governance and Organization: The COFORD is organizationally situated within the federal Department of Agriculture and Food. A council of 14 persons is responsible for developing and prioritizing research policy and funding areas, and organizational management is the responsibility of COFORD's director. Supported by an operations manager, the director oversees an administrative unit, technical support unit, and a research program (tree improvement and nonwood products, wood products and processing, and forest environment). The organization is headquartered in Dublin, Ireland.

Strategic Program Directions: Research is directed at six major problem areas: reproductive material and forest nurseries (birch tree improvement), silviculture and forest management (birch stand improvement), harvesting and transport (harvesting systems for small scale forestry), wood products and process development (heat treatment of fast-grown softwood, treating of roadway posts), socioeconomic aspects of forestry (development of marketing cooperatives), and environmental aspects of forestry (carbon sequestration). Research in these areas is promoted primarily by competitive grant making oriented around strategically important information needs within the aforementioned areas.

Client Groups: The COFORD serves public and private clients.

Services Provided: The COFORD provides information (publications, software), research (direct delivery of products), advice to government, and training (seminars, conferences, workshops)

Budget and Funding Sources

- A. Income in 2003 euros
\$1.75 million—Total (U.S. \$2.1 million)
- B. Source of income in 2003 euros
Irish Government under the Operational Program for the Productive Sector of the National Development Plan of 2000–2006—100% (1.75 million).
- C. Expenditures in 2003 euros
Research—68% (1.19 million)
Technology transfer—10% (0.18 million)
Salaries—22% (0.38 million)
- D. Focus of expenditures in 2003 euros (estimated)
Environmental aspects of forestry—38% (0.66 million)
Silviculture and forest management—35% (0.61 million)
Reproductive material and forest nurseries—10% (0.18 million)
Socioeconomic aspects of forestry—8% (0.14 million)
Wood products and process development—5% (0.09 million)
Harvesting and transport—4% (0.07 million)

Scientists and Supporting Staff: In addition to administrative staff (estimated at 5 persons), research and related activities

of COFORD involved employment of 143 persons, equating to more than 70 full-time equivalents.

Measures of Performance: The COFORD measures performance with research highlights, sponsored conferences, and listing of publications. The COFORD also reports to the Monitoring Committee of the Operational Program for the Productive Sector against a set of financial, impact, social, and other performance measures.

Japan

Forestry and Forest Products Research Institute of Japan (FFPRI)*

Date Established: 1905

Public-Private Sector: The FFPRI is a government research organization. After various name and organizational changes, the institute was designated an incorporated administrative agency in 2001 as part of nationwide administrative reform.

Mission: Through research on forest, forestry, and forest products, to contribute to development of science and technology that will promote sustainable forest management and resource utilization.

Primary Research Focus: The FFPRI researches forestry and forest products.

Governance and Organization: The unit is within the federal Ministry of Agriculture, Forestry and Fisheries. Supported by vice-presidents for research planning, forest research, and forest products research, an institute president is responsible for organization's administration. The institute is organized into divisions: research planning and coordination division (responsible for planning, coordination, and evaluation of research) and general affairs division (responsible for accounting, human resource management), and 23 research departments: Plant Ecology Forest Vegetation, Forest Site Environment, Soil and Water Conservation, Meteorological Environment, Forest Microbiology, Forest Entomology, Wildlife Biology, Forest Genetics, Molecular and Cell Biology, Forest Chemistry, Applied Microbiology, Forest Operations & Techniques, Forest Machinery, Chemical Utilization, Wood-based Materials, Wood Properties, Wood Improvement, Wood Processing, Wood Engineering, Forest Management, Forest Policy and Economics, and Global Forest Research.

Eight principal research coordinators are responsible for coordinating the organization's research activities. Institute facilities include a headquarters location (Tsukuba, Ibaraki Prefecture, Japan) and six regional research centers.

Strategic Program Directions: Research is focused on 11 core areas of research: conservation of biodiversity in forests; conservation of land, water resources, and living environments; techniques to avoid and control biological agent damages and meteorological disasters; remote sensing, inventory, and modeling; conservation and rehabilitation

of forests in changing global environments; construction of efficient timber production and harvesting systems; public concern involving development of rural communities; recycling and eco-friendly technologies for the utilization of wood resources; processing and utilization technologies for wood materials intended to enhance safety and comfort; mapping biological functions for developing new materials (genome analysis); and analysis required for the formulation of forest sector policies.

Client Groups: The FFPRI serves public and private clients.

Services Provided: The FFPRI provides information (wood properties, inventory data bases), research (direct delivery of products), consultation (wood identification), and training.

Budget and Funding Sources

A. Income (budget) in 2003 Japanese yens
\$10.4 billion—Total (U.S. \$90.0 million)

B. Source of income in 2003 Japanese yens
Government—86% (8.9 billion)
Other Sources—14% (1.5 billion)

Scientists and Supporting Staff: In 2005, FFPRI had 453 scientists and 208 supporting staff. Academic attainment of scientist staff is estimated to be distributed as follows: PhD, 48%; Master of Science, 26%; Bachelor of Science, 24%; and other degrees, 2%.

Measures of Performance: The FFPRI measures performance with research highlights and listing of publications.

Hokkaido Forest Products Research Institute (HFPRI)

Date Established: 1950

Public-Private Sector: The HFPRI is a government research organization.

Mission: Through research, to promote the effective utilization of forest resources and support the information demands of the wood-based industry.

Primary Research Focus: The HFPRI researches forest products.

Governance and Organization: A director general and a deputy director general are responsible for the organization's operations. The institute is headquartered in Asahikawa, Hokkaido Prefecture, Japan. Responsibilities and activities of the Institute are divided among six divisions (some of which are further divided into sections), each of which is headed by a senior researcher. The divisions are as follows:

- General Affairs (operations, accounting, personnel)
- Planning and Coordination (design, extension, information)
- Timber Engineering (sections on timber construction, fire protection, wood preservation, gluing and finishing, wood product development)

- Wood Utilization (sections on wood anatomy and physics, physical utilization, wood chemical components, wood recycling, chemical treatment and processing)
- Wood Processing (sections on sawmilling and drying, wood processing, plywood, board, wood working machines)
- Mushrooms (sections on breeding, cultivation)

Strategic Program Directions: Research is focused on four major areas:

- Timber engineering—Development of synthetic technology for housing and related materials, development of stable and comfortable wooden structures, development of decay-resistant wooden materials, development of technologies for fire improving resistance, and development of gluing and surface treatment technology for wood
- Wood utilization—Development of high-level technology using charcoal products and biomass resources, development of technology for outdoor application wood chemical treatments, development of technology for recycling resources from waste wood
- Wood processing—Improvement of technology involving generic production processes, development of new technologies for sawmills, drying, wood processing, plywood, and boards, and development and promotion of more efficient wood manufacturing techniques on an industrial scale
- Mushroom culture—Culture of edible mushrooms and the development of efficient cultivation technologies

Client Groups: The HFPRI serves public and private clients.

Services Provided: The HFPRI provides information and research.

Budget and Funding Sources: Not available

Scientists and Supporting Staff: Staff total in 1999 was 91 distributed as follows: 16 PhDs, 19 Masters, 53 Bachelors, 3 other degrees.

Measures of Performance: Not available

Latvia

Latvian State Forest Research Institute (Silava)*

Date Established: Silava was established in 1946, with earlier history to 1928.

Public-Private Sector: Silava is a public government organization operated as an independent nonprofit organization under supervision of the Ministry of Education and Science.

Mission: To perform research on forest ecosystems and their components, especially the development of recommendations for sustainable forest management and rationales for effective utilization of forest resources and forest products.

Primary Research Focus: Silava researches forestry, with some forest products emphasis.

Governance and Organization: The institute is independent, although responsible in a limited way to the Ministry of Education and Science. An institute director, guided by a council of scientists, is responsible for overall institute administration, including research carried out in nine project groups (forest ecology and silviculture, forest tree breeding and genetics, forest regeneration and establishment, forest protection, forest operations, game management, forest products processing, woodworking, forest economics). The institute has eight operating stations and laboratories, including a woodworking laboratory and a laboratory of forest products processing. The institute is located in Salaspils, Latvia.

Strategic Program Directions: The institute carries out research in nine subject areas: ecology and silviculture, tree breeding and genetics, regeneration and stand establishment, forest protection, forest operations and machinery (logging technologies and machinery evaluation), game management, forest biomass processing (bark chemical composition), hydrothermal and chemical processing of wood, (low toxicity antipyrine compounds), forest economics and forest policy (for example, calculation of optimal harvesting ages), and forest resources monitoring.

Client Groups: Silava serves public and private clients.

Services Provided: Silava primarily provides research and direct delivery of information.

Budget and Funding Sources: The total budget is not available. The institute does not receive annual and automatically allocated funding from government. The institute funds results from competitive government-sponsored grants (71%), government-ordered projects (23%), and other miscellaneous sources (6%).

Scientists and Supporting Staff: Total staff of about 100, of which about 80 are researchers or research assistants. The research staff (and assistants) are distributed among the following research subject areas: forestry, 62; game management, 10; and forest products and harvesting, 8 staff.

Measures of Performance: Silava measures performance with its listing of publications.

Malaysia

Forest Research Institute of Malaysia (FRIM)

Date Established: The FRIM was established in 1929. In 1985, the Institute became a statutorily authorized body governed by the Malaysia Forestry Research and Development Board under the Ministry of Primary Industries. Since 2004, the Institute has been a statutory body governed by the Ministry of Natural Resources and Environment.

Public-Private Sector: The FRIM is authorized by the federal government under authorities specified in national statutes.

Mission: To promote the sustainable management and optimal use of forest resources by generating, through research, knowledge, and technology and their application. Within the mission, objectives are to provide research-based services to meet the needs of clients, to commercialize research and development results, to acquire and disseminate information, to create awareness of environmental and conservation roles of forestry, and to generate knowledge and technologies for the conservation, management, development and forest resources. The FRIM is committed to excellence in scientific research.

Primary Research Focus: The FRIM researches forestry and forest products.

Governance and Organization: The director general is responsible to the Malaysian Forestry Research and Development Board (16 members, including a chair), who are in turn responsible to the Ministry of Natural Resources and Environment. The director general is supported by the deputy director for research and development and a deputy director for operations. The FRIM is organized into three research divisions: forestry and conservation (data and standards for managing forests); product development (development of forest-based industries); and biotechnology (improved plant material through tree improvement and molecular techniques). In addition is a division focused on research management (planning, publications, consulting). Six field research centers are located throughout Malaysia, including a national research center and headquarters (Kuala Lumpur, Malaysia).

Strategic Program Directions: The institute overall direction is guided by seven strategies (specified in extensive detail, including time lines for their implementation): financial self-finance of programs; expanded research and development (including wood processing and utilization technologies, development and utilization of bio-composite technologies); commercialization of research and development products (procedures for commercialization, collaborations with other institutions); development of centers of excellence (timber technology center, wood composite center, forest biotechnology center); enhancement of research and development infrastructures (including forest research information system); development of human resources (including research skill enhancement, technology transfer processes); and growth in support for ecotourism.

Client Groups: The FRIM serves public and private clients, with an owner–member emphasis.

Services Provided: Information (library services), research, testing, consultation, education and training. Examples of services offered by divisions is as follows:

- Forestry Division
 - Research and development* (ecological assessment of recreation impacts, cost effective and ecologically sound

harvesting systems, regeneration patterns of commercial tree species), *Consultancy* (revision of public forest revenue systems, environmental impact assessment, production of charcoal using special combustor),

Testing (forest mapping with satellite imagery, aerial photo interpretation), and *training* (geographic information systems concepts, timber tree identification, road engineering)

▪ **Product Development Division**

Research and development (resistance of timber to marine borers and fungi, development of oriented strand-board from plantation thinnings, quality development of high-valued bamboo material),

Testing (wood anatomy density assessment, quality control of wood preservative applications, mechanical properties of structural lumber),

Training (kiln operation, wood preservation techniques, pulp and paper technology)

▪ **Biotechnology Division**

Research and development (genetic transformation of herbicide resistance, chemical and biological properties of certain timber species, performance of selected tree progenies)

Testing (seed germination levels, nuclear magnetic resonance, identification of disease infected seedling samples)

Training (tree improvement practices, molecular marker techniques for conservation, development of herbal medicines)

Budget and Funding Sources

A. Income in 2004 Malaysian ringgits
\$28.2 million—Total (U.S. \$7.5 million)

B. Source of Income in 2004 Malaysian ringgits
Government (operating)—56% (15.7 million)
Development—15% (4.3 million)
Research—13% (3.7 million)
External agencies—7% (2.0 million)
Investment income—3% (0.9 million)
Other sources—6% (1.6 million)
Total expenditures and program focus of expenditures are not available.

The Institute is strategically focused on being 70% self-financed by year 2008. This will be accomplished by increases in revenue from technical services, sales of products, rental property, royalties and licenses, and return on investment of short term funds. Fees for services are clearly specified for more than 85 service areas and more than 500 specific services within these areas. For example, evaluation of adhesive quality, 330 (MYR) per test; fire resistance tests for door or wall (30 minutes), 3,300 (MYR); prototype testing of timber structures, 880 (MYR) per structure; wood

preservation consultation, 550 (MYR) per person per week; and tree improvement planning, 330 (MYR) per person per week.

Scientists and Supporting Staff: An estimated 160 researchers and experts are distributed as follows:

- **Forestry Division**
60 researchers in 24 different fields, including silviculture of natural forests, forest hydrology, and natural resources planning and policy analysis
- **Product Development Division**
35 researchers in 14 different fields, including wood identification and timber engineering, pulp and paper and wood composite technologies, and furniture technology and primary wood processing
- **Biotechnology Division**
65 researchers in 22 different fields, including tree breeding and improvement, chemistry of natural products, and tissue culture and toxicology

Measures of Performance: The FRIM measures its performance by a general description of research results and number of publications. Also, the organization considers general statements regarding progress in achieving institute-wide strategies.

Netherlands

Stichting Hout Research (SHR) Timber Research*

Date Established: 1991

Public-Private Sector: The SHR is a private, independent nonprofit organization.

Mission: To carry out research and testing as requested by industry, branch associations, government, and private individuals.

Primary Research Focus: The SHR researches forest products.

Governance and Organization: Governance of the SHR is provided by a board of directors and administered by a director and a vice director. The SHR Timber Research is organized into four major sections: coatings, furniture, wood technology, and timber products for building industry. The organization's headquarters are located in Wageningen, The Netherlands.

Strategic Program Directions: Organization focuses on four major areas:

- Product research (adhesives, sheet materials, windows and doors)
- Wood technology (wood preservation, wood modification, wood anatomy)
- Coating (radiation coatings, paint testing, and application)
- Damage assessment and arbitrage

Client Groups: The organization serves public and private groups and specifically identifies its main target groups as the joinery industry (windows and doors), board material industry, pallet and packaging industry, manufacturers of laminated beams, wooden frame constructions and roof elements, wood preservation industry, wood preserving agents industry, suppliers of materials (wood adhesives and sealing profiles), furniture industry, paint industry, wood trade, governments, branch associations, builders, contractors, and building supervisors.

Services Provided: The SHR provides research (direct delivery of products, joint research activities), testing, and consultation (process and quality control).

Budget and Funding Sources

- A. Income in 2004 euros
\$2.4 million (U.S. \$2.9 million)
- B. Source of income
Contract for services sought by industry and government—100%

Scientists and Supporting Staff: In 2005, SHR Timber Research had a total staff of 35 persons (administrative, technical, administrative support). Although staff may have expertise in more than one section, staff (managers and project assistants) is distributed as follows:

- Timber Products for Building Construction—50% (18)
- Wood Technology—34% (11)
- Coatings—10% (4)
- Furniture—6% (2)

Measures of Performance: Not available

New Zealand

Forest Research, Ltd. (SCION)

Date Established: This organization was established in 1947 as part of New Zealand Forest Service. In 1992, it was authorized as a Crown Research Institute by the Crown Research Institutes Act of 1992. Other institutes include AgResearch; Industrial Research Ltd.; Institute for Crop and Food Research, Ltd.; Institute of Water and Atmospheric Research, Ltd.; Institute of Geological and Nuclear Research, Ltd.; Institute of Environmental Science and Research, Ltd.. The SCION is part of a three-segment New Zealand Science and Technology System: Ministry of Research, Science and Technology (MoRST), which provides science policy advice; Foundation for Research, Science and Technology (FRST) (responsible for funding science outputs); and Crown Research Institutes (CRIs) (perform actual scientific research). Prior to 2005, it was known as Forest Research, Ltd. (FRL).

Public-Private Sector: The SCION is a private, independent organization authorized by national statute, and it operates through various joint ventures, notably Ensis.

Mission: Through applying the creative intelligence of researchers, to advance the widespread utilization of renewable materials and products from plants for economic, environmental, and social returns. To create plant-based biomaterials and new manufacturing processes as a basis for sustaining the consumer markets of future generations.

Primary Research Focus: The SCION researches forestry (commercial forestry) and forest products (biomaterials, consumer products).

Governance and Organization: The SCION is governed by a seven-member board of directors, a chief executive officer, and an executive management team (seven persons, including chief executive officer). The SCION is organizationally grouped into the following units (each lead by a unit leader), of which seven persons are also member of Ensis's lead team: Ensis PAPRO, Built Environment, Ensis Forests, Biomaterials Engineering, Ensis Wood Processing, Ensis Environment, Ensis Biosecurity and Protection, Ensis Wood Quality, Cell Wall Biotechnology, Eco-Smart Technologies, and Ensis Genetic. SCION considers the following to be commercial business units: COHFE, Vigil, VERITEC Laboratories, and ATLAS Technology. The SCION is headquartered in Rotorua, New Zealand.

The SCION has established or become affiliated with the following subsidiaries, joint ventures, or business units that operate in concert with, but with significant autonomy, from the parent organization:

- Vigil (Vigil Forest Health Advisory Services, Ltd.)
A wholly owned subsidiary engaged in forest health monitoring, forest pest detection, and eradication of forest pests with a staff of nine persons.
- Atlas Technology
Software development subsidiary engaged in the development of software tools spanning the entire forestry value chain (forest land management, resource assessment, harvest planning).
- COHFE (Centre for Human Factors Ergonomics)
Business subsidiary of engaged in research and services that promote workplace safety, health, and performances, with a staff of four persons.
- Veritec Laboratories
Analytical chemistry laboratory specializing in forestry and biomaterial related activities. Provides a variety of component level tests focused on soil, foliage, waste water, wood and wood preservation.
- Ensis
Unincorporated joint venture of SCION and Commonwealth Scientific and Industrial Research Organization-Forestry and Forest Products (CSRIO-FFP). Ensis is engaged in research and service in the following strategic business areas: genetics, forests, environment, wood and fiber quality, forest biosecurity and protection, wood

processing and products, and pulp, paper, and packaging. Ensis employs approximately 300 persons at eight sites in Australia and New Zealand.

The SCION is also affiliated with PAPRO (through Ensis), which is a business unit engaged in supplying pulp, paper, and packaging technology. The PAPRO's mission is to develop value-adding solutions for the pulp, paper, and packaging industries through innovative science, applied research, and specialized professional services. Its strategic aims are the following: to (a) perform long term research in key science areas for the fiber-based industries, (b) seek innovation in wood fiber, paper, and packaging products from New Zealand resources, and (c) maintain internationally recognized science capability in fiber-based technology and product development. PAPRO is organized into three key business areas: mechanical fiber processing, chemical and enzymatic technologies, and paper and paperboard.

In addition to the above subsidiary entities, SCION in 2004 reported involvement with the following subsidiaries: FHS, Ltd.; Liro, Ltd.; N-Fix Technologies, Ltd.; Forest Research Pty Ltd. (Australia); Forest Research #2 Pty, Ltd. (Australia); Atlas Technology Ltd.; FR Properties, Ltd.; Forest Research Trans-Tasman, Ltd.; and associate arrangements in three other organizations (Centre for Advanced Composite Materials, Ltd., Frontline Biosecurity, and Beacon Pathway, Ltd.).

The SCION also is responsible for administering four national organizations or facilities: National Forestry Herbarium, National Forestry Library, National Quarantine Centre, and the National Wood Collection unit.

Strategic Program Directions: Research focus is on three major areas, as follows:

- **Commercial Forestry Research and Development**
Activities are carried out through the Ensis subsidiary (including PAPRO) with a focus on genetics, forests, environment, wood and fiber quality, forest biosecurity and protection, wood processing and products, and pulp, paper, and packaging. Various cooperatives also engage in research (Douglas-fir Cooperative, Forest Site Management Cooperative, Wood Drying Multi-Client Group).
- **Biomaterials Research**
Activities are carried out in biomaterials engineering (composite materials), eco-smart technologies (molecular bioprocesses, intra-cell research), and cell wall biotechnology (gene discovery and screening).
- **Sustainable Consumer Products**
Activities are carried out in the built environment (product development, life cycle assessment), and bioenergy (wood pellet manufacturing, energy systems analysis).

Client Groups: The SCION serves public and private clients, and half of the top 10 clients in 2003 were non-forestry companies.

Services Provided: The SCION provides research services (direct delivery of products), physical products (fertilizer dispensers, testing devices), material testing (pulp and paper), consultations (advice and guidance), education and training (workshops, seminars), information (image library of timber frame construction, wood processing hi-tech control systems), publications (trade and marketing, resource facts and figures), video (cable logging), and software (kiln drying, pre-harvest assessment).

Budget and Funding Sources

A. Revenue (2005) (NZD)

\$35.2 million (US\$ 26.2 million)

B. Source of Revenue (2005) (NZD)

Government—46% (16.2 million)

Commercial—44% (15.4 million)

Other income (interest, joint ventures)—10% (3.6 million)

Total expenditures and program focus of expenditures are not available.

Scientists and Supporting Staff: Staff of approximately 348 (researchers and supporting staff), including 5 principal scientists, 11 unit leaders, and 4 key contacts (human resources, sales, legal, and information management). The number of researchers and supporting staff assigned to various SCION units is not available.

Measures of Performance: The SCION measures performance in multiple ways: financial (revenue, equity ratio, return on equity and total assets); staff co-position (research staff); science output (reviews, papers, books, confidential reports); technology (patents, licenses); scientific application (seminars, workshops, field days); human resources (full-time-equivalents, staff turnover, staff professional development), social benefits (time in training, avoidance of accidents); and contribution to Maori culture (consultation, scholarships, proposals incorporating Maori). Yearly performance targets are established and compared with actual accomplishments.

Wood Technologies Research Sector, Industrial Research Limited (IRL)*

Date Established: 1992. This organization was authorized as a New Zealand Crown Research Institute by the Crown Research Institutes Act of 1992. Other institutes include AgResearch, Industrial Research, Ltd.; Institute for Crop and Food Research, Ltd.; Institute of Water and Atmospheric Research, Ltd.; Institute of Geological and Nuclear Research, Ltd; and Institute of Environmental Science and Research, Ltd. The IRL is part of a three-segment New Zealand Science and Technology System: The Ministry of Research, Science and Technology (MoRST) provides science policy advice; the Foundation for Research, Science and Technology (FRST) is responsible for funding science outputs; and the Crown Research Institutes (CRIs) perform actual scientific research.

Public-Private Sector: The IRL is a private independent organization authorized by national statute.

Mission: To be innovation-focused businesses based on world-class science from which can be created globally competitive market viable technologies. As a unit within Industrial Research, Ltd. (IRL), Wood Technologies Research focuses on inventing new technologies and adapting existing technologies so clients or partners can gain a competitive advantage.

Primary Research Focus: The IRL has eight industry sectors, including forest products (Wood Technologies Research Unit), energy, marine, health and communications. Technology areas applied to these sectors are materials and materials performance, sensing and detecting, biochemical technologies, energy technologies, and measurement and analysis.

Governance and Organization: The Wood Technologies Research Unit is governed by a board of directors (6 persons) and an executive management team (9 persons, including a chief executive officer) of parent organization Industrial Research, Ltd. The Wood Technologies Research Sector is one of nine research and development sectors (other sectors are health sector, food sector, marine sector, technologies sector, energy sector, assets and infrastructure sector, manufacturing and processing sector, information and communications sector). Organization-wide offices are in New Zealand (Auckland, Christchurch, and Wellington).

Strategic Program Directions: Wood technology research applied in the wood industry sector draws from various scientific disciplines (biochemistry, physics, mathematics, mechanical engineering, chemical and biological engineering, organic and inorganic chemistry, electrical engineering, metrology and information technology) and areas of expertise (materials performance, intelligent systems, communication, biochemical technologies, energy technologies, measurement and analysis). The disciplines and expertise are then applied within the various research and development sectors.

Client Groups: The IRL serves public and private clients.

Services Provided: The IRL provides information (literature searches), research, consultation, pilot scale production (electro-mechanical devices), and training (conferences and workshops).

Budget and Funding Sources: Information about the funding level and source for IRL's Wood Technologies Research Unit is proprietary and therefore not available. The IRL budget in total for 2002 is \$61,512,000 (New Zealand Dollars) (U.S. \$42.5 million), a sum originating from 54% government (competitive bidding), 46% customers, and less than 1% interest income.

Scientists and Supporting Staff: The number of staff assigned to IRL's Wood Technologies Research Unit is proprietary and therefore not available. The IRL has a total staff of 400 (320 researchers), and the number of forest products staff is publicly unknown (probably 10 to 15). The IRL's stated expertise in wood technology includes materials properties and materials performance, acoustic responses, biochemical technologies, and measurement and analysis. Specific past research in wood technologies has included sawblade design, measurement of wood fiber properties, kiln moisture sensors, and tree and log stiffness sensing devices.

Measures of Performance: Yearly performance targets are established and compared with actual accomplishments. Measures include science (papers, monographs, books, technical reports), technology (workshops, joint ventures established, licenses granted), human resources (staff turnover, professional development, avoidance of accidents), staff composition (teams, support), and financial (gross revenue, earnings performance, return on assets, return on equity, debt, capital expenditure, revenue per FTE).

Norway

Norwegian Forest Institute (Skogforsk)*

Date Established: 1917

Public-Private Sector: Skogforsk is a public government organization operating autonomously, although organizationally located in the Ministry of Agriculture. In 2006, it became the Norwegian Forest and Landscape Institute after merger with the Norwegian Institute for Land Inventory.

Mission: To strengthen the scientific basis for the management of forest resources, creation of wealth and economic well-being from forests, and develop countermeasures against environmental problems involving forests.

Primary Research Focus: Skogforsk researches forestry and forest products.

Governance and Organization: Although it is administratively located in the Ministry of Agriculture, Skogforsk is a research organization operating with special independent credentials. The institute is guided by a 7-member board of directors and is administered by an institute director. The institute is organized in five departments: the Departments of (a) Forest Ecology and Environment, (b) Forest Operations and Processing, (c) Economy and Internal Services, (d) Forest Production, (d) Marketing Contact and Research Support. Research facilities are located at Ås (headquarters) and Bergen Norway.

Strategic Program Directions: Research is focused on problem areas involving establishment of forests, growth conditions for existing forests, forest ecology and silviculture, and the economy and utilization of wood.

Client Groups: Skogforsk serves public and private clients.

Services Provided: Skogforsk provides information, research (direct delivery of information), consultation (advice and counsel), and education (conferences and workshops)

Budget and Funding Sources

A. Income in 2003 Norwegian kroner

\$76 million—Total (U.S. \$11.4 million)

B. Estimated source of income in 2002 Norwegian kroner
Commissioned Research (such as Ministry of Agriculture, Research Council of Norway)—41% (31.2 million)

Basic Grants (Research Council of Norway)—25% (19.0 million)

Strategic Institute Programs (NFR)—15% (11.4 million)
National responsibilities, administrative support (Ministry of Agriculture)—12% (9.1 million)

Fund for Forestry Development—5% (3.8 million)
Other revenues (such as teaching assignments)—2% (1.5 million)

Total expenditures and program focus of expenditures are not available.

Scientists and Supporting Staff: Staff in 2003 was 107, with full-time research staff members estimated to be 75 (40 PhDs, 35 Masters degrees).

Measures of Performance: Research highlights, sponsored conferences, and detailed listing of publications (such as articles, client reports, book chapters).

Norwegian Institute of Wood Technology (NTI)*

Date Established: 1949

Public-Private Sector: The NTI is a private independent organization (association).

Mission: Promote member companies' profitability by using updated knowledge about the properties, use, and processing of wood. This is to be accomplished by research, diffusion of knowledge, counseling, and quality documentation.

Primary Research Focus: The NTI researches forest products and production processes.

Governance and Organization: The managing director is responsible for administering four major institute sections: information resources, financing and personnel, utilization and durability, and quality and processing technology. Headquartered in Oslo, Norway, the organization has 152 company members representing general sawmilling, woodworking, glulam, and the timber frame industry.

Strategic Program Directions: Research and development activities are focused on two major topical areas: utilization and durability of wood (roof trusses, wood-based panels,

glulam, timber bridges, wood preservation, multistory timber buildings) and wood production technology (machine grading, flooring and paneling, wood drying, sawmilling, and wood working machinery).

Client Groups: The NTI serves private owner-member emphasis (companies and trade organizations, especially information needs of member companies).

Services Provided: Information (library access), research and development projects (direct delivery of information), individual company consultations (for example, quality control schemes), testing service (for example, mechanical testing, glue testing, chemical analysis, microscopy, testing of preservatives), and training. In detail, the organization provides the following services: management and execution of research and development projects, establishment of quality control schemes, marking and certification of wood-based products, educational courses, standardization work, library literature searches, export-oriented assistance, laboratory materials testing, and general consultancy services. The Institute serves as the inspection agency for various quality control schemes in Norway and elsewhere (for example, strength grading, wood preservation treatments, glulam, dry kiln operations, and Europallet control system). The organization is approved for testing, inspection, and certification as a basis for CE-marking of wood panels and timber construction products. It is also the only registered organization in Europe for JAS-certification (Japan) of glulam and load-bearing constructions.

Budget and Funding Sources

A. Income in 2004 Norwegian kroner

30.8 million—Total (U.S. \$4.6 million)

B. Source of income in 2003 Norwegian kroner

Services-project provided fees—89% (27.4 million)

Member fees—11% (3.4 million)

Approximately 25% (5.9 million Norwegian kroner) of revenue from contracts and projects comes from services performed for foreign clients.

Total expenditures and program focus of expenditures are not available.

Scientists and Supporting Staff: The NTI has a total staff of 36, of which an estimated 9 are support or managerial. Seventeen project staff work on utilization and durability and 10 on production technology and quality. Staff competency is asserted in quality control management, material and production management, timber and wood drying, biomass energy sources, timber processing and cutting tools, technology for timber grading, gluing and adhesive technology, wood preservation, structural timber and timber framing, and mechanical wood fasteners.

Measures of Performance: The NTI measures performance by the number and quality of services delivered.

Paper and Fiber Institute (PFI)*

Date Established: The PFI was established in 1923 as a private foundation.

Public-Private Sector: This private independent organization became a shareholding company jointly owned by STFI-Packforsk AB (95%), Norske Skogindustrier ASA (1%), Borregaard Industries, Ltd. (1%), M. Peterson & Søn (1%), Södra Cell Tofte AS (1%) and the PFI foundation (1%).

Mission: To enhance the competitiveness of clients, doing so by being known worldwide (world brand) in pulp and paper research. This is to be accomplished by being a technological and scientific center of expertise, an innovator in the development of new and improved processes and products, and by assisting the industry in international research cooperation and standardization work, and using the resources of cooperating partners to deliver the best technologies available.

Primary Research Focus: The PFI researches forest products, especially pulp and paper technologies and novel materials based on wood fibers.

Governance and Organization: The institute is governed by a 6-person board of directors (3 represent STFI-Packforsk, 1 represents the PFI foundation, 1 represents the four largest industry owners, and 1 represents PFI employees). It is administered by a director and organized into three departments: pulp and novel materials, fiber and pulp, and financial and administration. The PFI is located at the campus of the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. The institute cooperates worldwide with a number of organizations, including main cooperators such as STFI-Packforsk AB, NTNU, and SINTEF (Foundation for Scientific and Industrial Research), and other cooperators including various universities.

Strategic Program Directions: Institute research is focused on two major research groups and four core activities: fiber and pulp (mechanical pulping and fiber characterization, and adsorption and hygiene), and paper and novel materials. The institute also engages in various contractual work and supports the education of students in the fields of pulp and paper.

Client Groups: The NTI serves public and private clients, with an owner–member emphasis. Nordic mills constitute a main customer group, although clients do exist throughout the world with customers on all five continents.

Services Provided: The NTI provides information (library resources), research (direct delivery of products), consultation and advice (quality control assessment), and training and education (cooperation with Norwegian University of Science and Technology). Examples of contractual work include characterization of pulp and paper processes, new product evaluation, pilot trials, image analyses, and literature studies.

Budget and Funding Sources

- A. Income in 2004 Norwegian kroner
\$27.1 million—Total (U.S. \$4.1 million)
- B. Source of income in 2004 Norwegian kroner
Private industrial sources—72% (19.4 million)
Government sources—28% (7.6 million)

Total expenditures and program focus of expenditures are not available. However, the institute's research program accounts for 75% of its activities, with the remaining 25% provided by contract and consulting services.

Scientists and Supporting Staff: The total staff members of 25 are distributed as follows: research scientists, 12; engineers and technicians, 9; and administrative personnel, 4. Research scientists and research engineers are distributed 50% to paper and novel materials and 50% to fiber and pulp. The institute has the capacity to supervise 8 to 10 diploma students.

Measures of Performance: Not available

Philippines

Forest Products Research and Development Institute (FPRDI)*

Date Established: This organization was originally established in 1954 as the Forest Products Laboratory, a Division of the Bureau of Forestry under the Department of Agriculture and Natural Resources. However, 1957 is considered as the organization's founding year when it was reorganized into the Forest Products Research Institute (FPRI), a semi-autonomous unit located at the University of the Philippines.

Public-Private Sector: The FPRDI is a public government organization. The institute is the research and development arm for forest products utilization of the Department of Science and Technology (DOST). The latter is responsible for coordinating and managing the Philippines' national science and technology system. The institute is one of seven research and technology units within the DOST system.

Mission: To generate, improve, and transfer appropriate technologies and information on efficient utilization of forest-based products to make local industries more competitive in the domestic and global markets and to benefit the general public. This mission is grounded in the belief that a sustainable forest-based industry that is able to produce economically competitive and environmentally friendly commodities can contribute to socioeconomic development and can support the disadvantaged sectors of Philippine society. The mission is accomplished by (a) conducting basic and applied research required to improve the utility and value of wood and non-wood products, (b) transferring research generated and technologies, and (c) providing services and training in various technical field. Specific objectives are the following:

- To generate scientific knowledge on forest-based materials critical to the development of production technologies.

- To ensure the global competitiveness of ecologically friendly forest-based products.
- To enhance efficiency and effectiveness of existing forest-based industries and assist in the establishment of new enterprises.

Primary Research Focus: The FPRDI researches wood and nonwood forest products.

Governance and Organization: The institute consists of the office of the director, supported by a planning staff, technical services staff, and an information and communications staff. Three divisions are responsible for research and development: materials properties evaluation division (three sections), mechanical processing and product development division (four sections), and chemical processing and product development division (three sections). In addition is a division for finance and administration (three sections). The technical services staff serves as the technology transfer arm of the institute. The institute is located at the University of the Philippines Los Banos Campus in College, Laguna, Philippines.

Strategic Program Directions: Research is conducted in five major areas: furniture and handicrafts (for example, product development, codes and standards), construction materials and utility structures (for example, design and development, fire resistance), material science (for example, chemical properties of wood), handmade paper (for example, alternative fiber material for paper), and chemical products and biomass energy (for example, utilization of resins and oils). The organization's medium-term plan 2005–2010 gives emphasis to the forest two major areas.

Client Groups: The FPRDI serves public and private clients.

Services Provided: The FPRDI provides information (library resources, software), research (direct delivery of products), consultation (waste reduction methods, structural design), testing and calibration of materials, training (wood identification, bamboo preservation, production planning and control). Specific reference is to technology transfer in the following areas: promotion and public assistance regarding new technologies, technology assessment and piloting of new products and processes, development of manpower around new technologies, and approaches to assessing economic and marketing issues.

Budget and Funding Sources: Specific amounts of funding are not available. However, funding sources are the Government of the Philippines, International Tropical Timber Organization, Australian Centre International Agricultural Research, Agri-Technological Institute, local funding agencies, Philippine Council for Industry and Energy Research and Development, and Department of Science and Technology-Grants-in-Aid.

Scientists and Supporting Staff: In 2005, the Institute had a total staff of 238 distributed as follows: 5 managerial (2%);

72 administrative (30%); and 161 technical research (68%). Academic degrees of staff include 13 PhDs, 41 Masters of science, and 113 Bachelors of Science. The project allocation of project leaders to major research areas is estimated to be as follows:

- Furniture and handicrafts—19 (28%)
- Housing materials and construction technologies—16 (24%)
- Material science—15 (22%)
- Handmade paper—9 (13%)
- Chemical products and biomass energy—9 (13%)

Measures of Performance: The FPRDI measures performance with research highlights, sponsored conferences, listing of publications, number of services provided (tests and calibrations, training sessions conducted), and scholars supported

Poland

Research and Development Centre for Wood-Based Panels*

Date Established: 1974

Public-Private Sector: The Research and Development Centre for Wood-Based Panels is a public government organization.

Mission: To provide research and development services for the wood industry.

Primary Research Focus: Forest products, especially panel and composite products.

Governance and Organization: The Research and Development Centre for Wood-Based Panels is organizationally located within the federal Ministry of the Economy, and the center is governed by a director and organized into four major units (each lead by a manager):

- Technical and Technological Laboratory
- A Research Laboratory accredited by the Polish Centre for Accreditation (including laboratories for product testing and industrial harmfulness)
- Designing and Prototypical Laboratory
- Scientific-Technical Information Centre (and foreign cooperation)

The center's headquarters is located in Czarna Woda, Poland.

Strategic Program Directions: The center's research and related initiatives are strategically grouped within its major administrative units:

- Usefulness of lignocellulose raw products (wood waste, annual plants) to produce wood-based panels (energy requirements, waste disposal, cost reduction)

- Restriction of factors harmful to manufacturing personnel (noise absorption, ventilating systems, toxic substances, and vibration)
- Design and implementation of measurement systems (strength testing apparatus, formaldehyde emissions detection)
- Collecting and distributing information related to wood-based panels (including patent information, assessment of product market demand)

Client Groups: The center serves public and private clients.

Services Provided: The center provides information, research (direct delivery of products), testing, and consultation (advice).

Budget and Funding Sources: Not available

Scientists and Supporting Staff: The center has a total staff of 30, 16 with university degrees (including 3 PhDs and 12 Masters). The center's managerial staff are distributed as follows: Administration, 1 center director; Technical and Technological Laboratory, 2; Research Laboratory, 2; Center for Scientific and Technical Information, 1; and Designing and Prototypical Laboratory, 1. In addition, the center has 13 staff classified as workers.

Measures of Performance: Not available

Slovak Republic

Forest Research Institute (FRI)

Date Established: The FRI was established in 1948 after a reorganization. Research by predecessors of the Institute is documented as having occurred since the late 1890s.

Public-Private Sector: The FRI is a public government organization.

Mission: To obtain new scientific knowledge on forest ecosystems and their management, doing so by undertaking research activities in the fields of biology, forest management, forest technology, and economics. Also, the institute serves a coordinating function for forestry research occurring in the Slovak Republic.

Primary Research Focus: The FRI researches forestry, with a modest forest products emphasis.

Governance and Organization: The Forest Research Institute is responsible to the Ministry of Agriculture. It is led by an institute director who is advised by three boards (scientific, operational, and overall planning). The institute is organized into a research section and a special activities and services section (extension, administration, information, transportation, standards). Research programs are administered by seven departments: departments of forest genetics and tree breeding, silviculture, forest protection and game management, forest environment, economics and policy, management and monitoring, and forest technology and

engineering. Research is conducted at four research stations and the Institute's national headquarters in Zvolen, Slovak Republic.

Strategic Program Directions: Research focuses on topics that are consistent with the institute's departmental structure: forest genetics and tree breeding, silviculture, forest protection and game management, forest environment, economics and policy, management and monitoring, and forest technology and engineering.

Client Groups: The FRI serves public and private, government emphasis.

Services Provided: The FRI provides information, research (direct delivery of products), consultation (advice), testing, and training and education (workshops and conferences).

Budget and Funding Sources

- A. Income in 2001 Slovak korunas
\$56.2 million—Total (U.S. \$1.8 million)
- B. Source of income in 2001 Slovak korunas
Contract for work (not all for research)—14%
(7.9 million)
Government (an assumed source)—86% (48.3 million)

C. Focus of Expenditures

Scientific and technical projects accounted for 51.3% of expenditures. 126 projects were supported by funds provided as contract for work.

Total expenditures and program focus of expenditures are not available.

Scientists and Supporting Staff: The institute has a staff of 170, 78 of whom are researchers (51 PhDs) and 92 are supporting staff (assistants, administrators, overhead staff).

Measures of Performance: The FRI measures performance with research highlights, sponsored conferences, and a listing of publications.

South Africa

Forestry and Forest Products Research Centre (FFP)*

Date Established: Not available

Public-Private Sector: This public-private combination is a joint venture between the University of KwaZulu-Natal and the Division of Water, Environment and Forestry Technology of the Council of Scientific and Industrial Research (CSIR). The CSIR was established as a science council in 1988 by an act of the South Africa Parliament.

Mission: To bring academia and industrial research together with a focus on maximizing value extraction for plantation-grown timber required by the pulp and paper processing industry. Achieve the mission by aligning research activities with market needs for research, improving knowledge base (forest resource and processing industries) through excellent

scientific research and development, and advancing transfer of knowledge to client groups. The mission also includes establishment and promotion of a thriving postgraduate research facility that works in close collaboration with established research teams from the Center and CSIR.

Primary Research Focus: The FFP researches forestry and forest products.

Governance and Organization: The FFP is staffed by a center director and staff from the University of KwaZulu-Natal and CSIR's Division of Water, Environment and Forestry Technology. Information about the governing boards and advisory committees is unknown. The FFP is administratively organized in a manner consistent with center's six research programs: chemical wood properties, physical wood properties, pulp and paper properties, forestry and tree physiology, remote sensing, and IT and solid wood. The center also participates in two cooperatives: the eucalypt research cooperative and fiber research processing cooperative. Center administrative offices (CSIR) are located in Durban, South Africa. The FFP also sponsors two cooperatives: Eucalypt Research Cooperative and Fiber Research Processing Cooperative.

Strategic Program Directions: Research at FFP focuses on the following major categories: site and terrain classification, site species matching, remote sensing, geographic information systems, resource evaluation, wood properties, pulp and paper analysis, and software and database development.

Client Groups: The FFP serves public and private clients.

Services Provided: The FFP provides information, research, consultation (advice), and training and education. Special consultations focus on site and terrain classification (species recommendations, fertilizer applications), site-species matching (spatial limitations technology), remote sensing (tree biomass estimations), geographic information systems (spatial data integration), resource evaluation (resource characteristics, processing requirements, market demand), wood properties (wood image analysis), pulp and paper analysis (pulp analysis, strength testing), and software and database development (decision-guiding software). The center supports a thriving post graduate research faculty (more than 10 faculty members) and provides various short courses (example topics are wood quality for pulp and paper, and production planning and sawmill simulation).

Budget and Funding Sources: Not available

Scientists and Supporting Staff: Information describing total staff and its responsibilities are not available. The 11 contact staff listed in public documents are as follows: director and support staff (2), chemical wood properties (2), physical wood properties (2), pulp and paper properties (2), forestry and tree physiology (1), remote sensing (1), and operations research (1).

Measures of Performance: The FFP measures performance through a limited listing of research publications.

Institute for Commercial Forestry Research (ICFR)*

Date Established: Formally established in 1984, the ICFR evolved from the Wattle Research Institute, which was established in 1947.

Public-Private Sector: The ICFR is a private independent organization sponsored by 14 member companies and cooperatives (primarily owners of small woodlots).

Mission: To contribute to the global competitiveness of Institute sponsors through excellence in technical innovation in sustainable plantation silviculture. The ICFR accomplishes its mission by maintaining a forestry research infrastructure that is available to member companies and by conducting industry-directed forestry research.

Primary Research Focus: The ICFR researches forestry.

Governance and Organization: The institute director (administrator) is responsible to a board of control (11 person), plus three steering committees and a management committee. The research is administratively organized into four units complementing the organization's research programs (acacia bark research, tree improvement, applied silviculture, forest productivity). Although located on the Pietermaritzburg campus of the University of KwaZulu-Natal, the Institute is fully autonomous from the University. Two regional centers are also engaged in research (Sabie and Kwambonambi).

Strategic Program Directions: Research priorities are established in response to recommendations from the Board of Control, Management Committee, and three Steering Committees. Research focuses on tree improvement (genetic improvement of pines, eucalyptus, and wattle), acacia bark utilization, applied silviculture (nutrition and vegetation management), and forest productivity (harvest impacts, site classification, soil-water relations). Research is conducted in close collaboration with timber growers. Strong emphasis is on the application of scientific findings, hence the institute focuses on developing technologies to grow trees in a profitable, sustainable, and responsible way.

Client Groups: The ICFR serves private clients, with an owner-member emphasis.

Services Provided: The ICFR provides information, research, consultation (advice), education, and training. Sponsors have free access to services such as literature and reference searches, content pages of current journals, access to data bases, books and journals, and access to ICFR papers and publications.

Budget and Funding Sources: The ICFR is funded by direct contributions from sponsoring (member) companies and a nationwide forest industry organization. The ICFR is the only privately funded forestry research institute in South Africa.

A. Income in 2005 South Africa rands
\$12.5 million—Total (U.S. \$2.0 million)

B. Source of Income in 2005 South Africa rands
Nationwide industry organization[#]—50% (6.25 million)
Member direct funding—50% (6.25 million)
[#] Forestry South Africa, a national consortium of industrial forestry companies

Total expenditures and program focus of expenditures are not available.

Scientists and Supporting Staff: As of 2004, the total staff of 59 are distributed as follows:

- Administration (director, financial, personnel)—27% (16)
- Functional support (publications, computers, library)—17% (10)
- Forest nutrition research—12% (7)
- Eucalypt tree improvement research—10% (6)
- Forest productivity research—17% (10)
- Plantation re-establishment research—10% (6)
- Acacia tree utilization research—7% (4)

Measures of Performance: Success is measured in terms of organization's ability to provide applicable technical solutions to operational problems. Performance measures include list of publications, projects in process, conference proceedings, and workshops and presentations.

Sweden

Forestry Research Institute (Skogforsk)*

Date Established: Skogforsk was formally established in 1992 by forest landowner associations and industrial forestry companies. Research programs historically go back to 1936 (sponsored by Tree Breeding Association).

Public-Private Sector: Skogforsk is a combination public and private organization. It may be viewed as a private foundation that is defined by various Swedish federal laws that govern private companies (laws prescribing legal responsibilities, prerequisites for membership, financing and accounting, governing board representation).

Mission: To provide forestry in Sweden with knowledge that contributes to forestry's international competitiveness and the ecological sustainability of Swedish forests. To pursue research results that are demand-driven and capable of being readily applied by forest industry and forest landowners.

Primary Research Focus: Skogforsk researches forestry.

Governance and Organization: Skogforsk is run by a governing board of directors and a managing director. Also, various advisory committees are engaged in setting research directions and priorities. Two directors are responsible for research organized into two units: the wood supply research

program and forest production research program. Extension is also formalized as a unit within the organization. Organization headquartered in Uppsala, Sweden, with offices in Ekebo and Savar, Sweden.

Strategic Program Directions: The research program (2005–2008) focuses on two principal areas: forest production (tree improvement, silviculture, conservation management, seedling production), forest management (silviculture, planning, and conservation management), and wood supply (logistics, raw material utilization, and forest operations technologies). A three-tiered planning process (influenced by research advisory committees) is used to establish priority research areas. The institute serves various coordinating functions, including actions to transform results of basic research done in universities into practical uses to be applied by landowners and forest industry.

Client Groups: Skogforsk serves public and private clients.

Services Provided: Skogforsk provides information (manuals, videos), research (reports, software), consultation and training (conferences, seminars, excursions). Special emphasis is placed on disseminating the results of research (estimated 15%–20% of budget).

Budget and Funding Sources:

A. Income in 2004 Swedish kronas
Approximately 110 million—Total (U.S. \$14.0 million)

B. Source of income in 2004 Swedish kronas
Services and commissioned work—50% (55 million)
Government and forest industry*—50% (55 million)
Federal government grants—50% (27.5 million)
Forestry and forest industry sector—50% (27.5 million)
Fixed member fees—25% (6.9 million)
Research grants—75% (20.6 million)

A “framework” agreement (for 4-year period) guides the development of 50% of the institute's budget. The agreement is the result of negotiations between the federal government and the private forestry sector, with each contributing 50% of the funding necessary to cover the research activities agreed to by the two sectors (however, there is no upper limit on contributions of the private forestry sector). The portion (50%) contributed by the forestry and forest industry sectors is derived from (a) fee-assessed member companies and organizations (25% of sector's contribution; fee is based on ownership of productive forest area and site productivity) and (b) variable research grants (75% of sector's contribution; levy of 0.60 SEK per cubic meter of harvested timber and pulpwood).

Total expenditures and program focus of expenditures are not available.

Scientists and Supporting Staff: The institute has a staff of 100, of which approximately 60 are researchers.

Approximate staff is distributed (2005) among principal research areas as follows: forest productions, 55% of staff; and wood supply, 45% of staff. The importance of transferring results of research into practical use is reflected by the reality that communication skills are an integral part of processes used to recruit researchers.

Measures of Performance: Research highlights and listing of publications

Swedish Institute for Wood Technology (Statens Provningsanstalt SP-Trätekt)*

Date Established: Trätekt was established in October 2004, when it became part of the SP, the Swedish National Testing and Research Institute. As an organization, Trätekt's roots can be traced to the mid-1800s.

Public-Private Sector: SP-Trätekt is a private independent ("limited company"), government-authorized organization. However, all of the company's shares are owned by the government.

Mission: To strengthen the competitiveness of wood as a material and to enhance the long-term profitability of various sectors of the Swedish wood-based industry. Research and development programs are to benefit the wood working industry through their application either in-house or in the marketplace.

Primary Research Focus: SP-Trätekt researches forest products, especially sawmilling, joinery, housing, furniture, and board products.

Governance and Organization: SP-Trätekt is one of three subsidiaries and one cooperative of the SP. Other subsidiaries of the SP are the Swedish Board of Housing, Building and Planning, and Swedish Board of Physical Planning and Building, which works on products and person certification in the construction sector, and the Swedish Machinery Testing Institute, which does machinery testing, inspection and certification and one cooperative, the European Association of National Metrology Institutes, which coordinates metrological programs. SP-Trätekt is organized into four different development areas: processing and processes research, materials and products research, building and housing research, and quality and testing research. Advisory committees provide counsel for each of these development areas. SP-Trätekt is headquartered in Stockholm, Sweden, with operations in Skelleftea, Boras, and Vaxjo, Sweden.

Strategic Program Directions: The organization's programs embrace fundamental research, applied research, development work, investigations, production of information (reports), consulting services, testing and monitoring, and various forms of training and education. Activities in these areas span a range of activities, from felling and handling timber in a forest setting through to the processing and distribution of finished wood products to consumers. The work of SP-Trätekt is carried out in four major areas of research and development:

- *Processing and processes*
Develop methods of more cost-effectively producing and processing timber products. Activities occur in the key areas of sorting, drying, production, and logistics.
- *Materials and products*
Develop ways of improving the durability, lifetime, and reliability of wood. Activities occur in the key areas of environmental durability and computer-supported product development.
- *Building and housing*
Develop products, processes, and methods that enhance the advantage of wood used in buildings. Activities occur in the key areas of fire safety, moisture resistance, building products, and international standardization.
- *Quality and testing*
Develop improved approaches to product testing, production management, and the certification of processes and products. Activities occur in the key areas of stress grading and quality sorting of lumber, laboratory testing of furniture, and national and international standardization procedures.

SP-Trätekt carries out its activities in close collaboration with companies, universities, and colleges, as well as industrial and scientific organizations both in Sweden and abroad.

Client Groups: SP-Trätekt has public and private customers, including sawmills, joinery companies, furniture manufacturers, producers of various board products, equipment manufacturers, and builders of homes and commercial buildings.

Services Provided: SP-Trätekt provides information (library, software), research (direct delivery of products, joint research activities), consultation (advice), testing, and training and education.

Budget and Funding Sources

- A. Income in 2004 Swedish kronas
\$65 million—Total (U.S. \$8.3 million)
- B. Source of income in 2004 Swedish kronas
Federal funds—14% (9.2 million)
Third-party funds*—35% (22.5 million)
Services provided—51% (33.3 million)
* For example, European Union, national research funds
- C. Expenditures in 2005 Swedish kronas
\$54.6 million—Total budgeted
Personnel—66% (36.0 million)
External costs—24% (13.0 million)
Property costs (laboratories)—4% (2.3 million)
Depreciation and interest—4% (2.4 million)
Internal costs—2% (0.9 million)
- D. Expenditure by program area in 2005 Swedish kronas
\$62.6 million—Total budgeted
Processing and processes—18% (11.0 million)

- Materials and products—23% (14.4 million)
- Building and housing—28% (17.5 million)
- Quality testing—31% (19.7 million)

The organization's fiscal philosophy is not to generate profits for distribution to SP-Tråtek owners, but rather to invest any financial surpluses back into the organization's programs. A substantial part of SP-Tråtek's work consists purely of assignments commissioned and paid for entirely by industrial clients. Among the funding sources for the organization's programs are Swedish Wood (Swedish Wood Exporters' Association, Swedish Timber Council, and Association for Swedish Wood Products Research); VINNOVA, KK-stiftelsen (Knowledge Foundation), the Nordic Industrial Fund, Swedish Council for Forestry and Agricultural Research, Brandforsk (Fire Research Council), and various European Union programs.

Scientists and Supporting Staff: In 2004, SP-Tråtek reported the employment of 56 persons, allocated among program areas as follows:

- Processing and processes—6 scientists, 4 support (18%)
- Materials and products—10 scientists, 1 support (20%)
- Building and housing—15 scientists (27%)
- Quality testing—5 scientists, 13 support (32%)
- General organization management—1 director, 1 deputy director (3%)

Measures of Performance: SP-Tråtek measures performance through its listing of publications.

Swedish Pulp and Paper Research Institute/Institute for Packaging and Logistics (STFI-Packforsk)

Date Established: STFI-Packforsk was established in 2003 after merger of merger of the Swedish Pulp and Paper Research Institute and the Institute for Packaging and Logistics. The organization will eventually become one of four super institutes through which the Swedish government promotes industrial research.

Public-Private Sector: STFI-Packforsk is a private independent research organization. The ownership of STFI-Packforsk is as follows (2004): industry companies, 51% (six companies); government (IRECO, a government holding company), 29%; STFI Association of Interested Parties, 10% (10 companies); and Private Owners Association Packforsk, 10%. STFI-Packforsk has extensive formal and informal cooperative relations with various universities and industrial research institutes, both within Sweden and internationally. In 2004, STFI-Packforsk became the dominant shareholder (95% ownership) of the Paper and Fiber Research Institute of Norway (PFI).

Mission: To provide outstanding knowledge, solutions, and expertise that will give partners and clients a competitive advantage. Furthermore, to contribute to the productivity

and profitability of clients by (a) carrying out research at the highest international level, (b) implementing research results in contract assignments, consultations, and educational services, and (c) providing services utilizing efficient pilot plant and laboratory equipment. The research program is asserted to be characterized by high competency, significant commitment, and high ethical standards.

Primary Research Focus: STFI-Packforsk researches forest products, with a special emphasis on packaging and on pulp and paper.

Governance and Organization: STFI-Packforsk is governed (in 2005) by a 15-person board of directors (chair, 10 members and 4 deputy members) and administered by two officers and eight directors (president, executive vice president and six directors, one from each of STFI-Packforsk's divisions). Executive management staff also includes a market coordinator and a chief financial officer (finances and human resources). STFI-Packforsk is advised by a research council (eight persons) that advises on research program directions and performance, and by a committee of scientific advisors (eight persons) that work directly with the organization's scientific staff. STFI-Packforsk is headquartered in Stockholm, Sweden, with the organization's Division of Packaging Logistics located in Kista, Sweden.

The organization's structure is arranged into six divisions (plus a market coordination and a finance unit and human resources unit):

- Fiber, Pulp and Energy (chemical analysis, chemical and mechanical pulp, mill systems and energy, and wood, fiber and mechanical pulp)
- Papermaking (measurement, paper chemistry and microbiology, paper physics, processing technology)
- Paper as an Information Medium (appearance and imaging, printability, printing processes, and surface treatment)
- Packaging and Logistics (new materials and composites, packaging development and testing, packaging materials, and packaging systems)
- EuroFEX (general services, IT services, operation and maintenance, physical testing, research and project management, sales and workshops)
- Strategic Information (ChemSource, information and training, information center, standardization and quality control, sustainability and foresight studies)

Strategic Program Directions: STFI-Packforsk's activities are carried out in interdisciplinary projects under four headings: (a) research, contract work and consulting (focused on wood and fiber, pulp, papermaking, paper, converting, and testing), (b) specialized services (use of special equipment and instruments), and (c) training and education (workshops, conferences, and graduate education). The

organization's research activities are grouped into 19 different research clusters, each bringing together projects that have a common theme or direction (clusters are selected by matching what is scientifically and technically promising against the product and marketing interests of STFI-Packforsk's customers). In 2003–2005, the research clusters were as follows:

- *Tools for wood and fiber streaming* (develop tools for optimal allocation of wood and fibers)
- *Biorefinery* (novel technologies for valorization of pulp mill residues)
- *Extended use of mechanical pulps* (increase the use of mechanical pulps by lowering energy demand and improving finished properties)
- *Chemical pulp research* (develop economically viable, technically feasible, and environmentally sound processes that fully utilizes the potential of Nordic wood species)
- *Funcpack* (visual and interactive functionality of packaging)
- *New fibers for new materials* (widen the application span of cellulose fibers and to achieve fiber qualities with a higher added value)
- *Advanced fiber management in papermaking* (improve paper quality and improve utilization of natural resources)
- *Control of detrimental substances in papermaking* (enhance papermaking process by reduction in the amount of damaging material in the papermaking system)
- *Microbiology* (control the microflora responsible for slime deposits and toxin-producing bacteria)
- *Paper chemistry* (enable the manufacture of paper/board materials with superior optical and mechanical properties)
- *Mechanical dewatering* (improve the efficiency of mechanical dewatering processes)
- *Improved formation* (better formation for coating and printing)
- *Engineered sheet structure* (make stratified forming a viable technique for improving product properties)
- *Engineered board* (strengthen markets packaging paper-board)
- *Paper mechanics* (increase paper fracture toughness, stiffness and creep resistance)
- *New surfaces* (understand application of new coating strategies and related analytical methods)
- *Newsprint* (strengthen multicolor print capacity and better run ability)

- *Printability* (develop high-quality print surfaces for graphical papers and packaging boards)
- *Sensory analysis* (devise methods to evaluate importance of quality perception of paper and board)

STFI-Packforsk partner members (committed to long-term research agreement with the institute) can choose cluster involvement; nonpartner members require leadership approval to participate in a cluster. STFI-Packforsk engages in extensive cooperation with public and private research organizations in Sweden and internationally.

Client Groups: STFI-Packforsk serves public and private clients with an owner–member emphasis.

Services Provided: STFI-Packforsk provides information (SFI Information Centre—searches, data bases, library collection), research, consultation (advice and counsel), testing (pulp testing, paper structure measurement, chemical analysis, process simulation) and education and training.

Budget and Funding Sources

A. Operating income in 2004 Swedish kronas
\$274 million—Total (U.S. \$31.3 million)

B. Source of income in 2003 Swedish kronas
The exact portion of operating income provided by various sources is not publicly available, although in 2003 such is estimated to be distributed as follows:

Industry funding—50% (117 million)
Public agency funding—20% (47 million)
Contract work and services—30% (70 million)

The major part of STFI-Packforsk's research program is funded jointly by partner companies and by the government. Example public funding sources are the European Commission, Nordic Industrial Fund, Swedish Environmental Protection Agency, Swedish Waste Research Council, and the Foundation for Strategic Environmental Research. Primary public funding sources are the STEM and the VINNOVA. Private non-company research funding originates from sources such as the Swedish Pulp and Paper Research Foundation and the Forest Industry's Water and Air Pollution Research Foundation. STFI-Packforsk also receives service and contract revenue from a large customer base outside the partner companies.

C. Expenditures in 2004 Swedish kronas
\$259 million—Total Operating Expenses#
#Net profit of seven million SEK in 2004

D. Focus of expenditures in 2003 and 2004

In 2004, the organization's expenditures (turnover) was divided into three business areas: exploratory research, 28%; industrial research, 46%; and consulting, 26%.

The portion (percentage) of funding from various sources for each division is estimated (based on 2003 Annual

Review) to be as follows (NA = not available):

| Division | Industry-funded research | Publicly funded research | Contract work and services |
|------------------------------------|--------------------------|--------------------------|----------------------------|
| Fiber, Pulp and Energy Papermaking | 33 | 33 | 33 |
| EuroFEX | 65 | 20 | 15 |
| Paper as Information Medium | 50 | 15 | 35 |
| Packaging and Logistics | 50 | 15 | 35 |
| Strategic Information | 45 | 10 | 45 |
| | NA | NA | NA |

Scientists and Supporting Staff: STFI-Packforsk employs about 250 persons (130 with university degrees), of which approximately 30 are PhD students and 20 are professors (full and associate). Approximately 80% of the organization's employees work with research. The distribution of employees among STFI-Packforsk's eight divisions and by employee type of expertise (researchers and support staff) is not available.

Measures of Performance: STFI-Packforsk measures performance through profit and loss statements specify operating income (for example, sales, contract income), operating expenses (for example, personnel, depreciation), and net revenue. Also, STFI-Packforsk provides a detailed statement of assets (fixed and current) and liabilities, in addition to a listing of the number and quality of services delivered (for example, publications, tests conducted).

Swedish Wood Ultrastructure Research Centre (WURC)*

Date Established: Established in 1996 by the VINNOVA; previously known as the Swedish National Board for Industrial Technology and Development.

Public-Private Sector: The WURC is a private independent organization affiliated with a university.

Mission: The WURC's mission is to promote industrial utilization of wood fibers by significantly increasing the basic knowledge of wood and wood fibers, especially regarding their chemical structure, physical properties, and morphological ultrastructure. The WURC undertakes research of the type that its industrial partners are unable conduct themselves (for such reasons as high up-front costs, uncertainty of success, very distant future payout). The results of the center's research are to be used in further research and development activities. The center seeks to accomplish its mission by focusing on two major sets of objectives:

- *Organizational Objectives:* (a) Provide an inventive and stimulating environment for high quality research and postgraduate education, (b) create a research environment where companies within the forest industry actively participate, (c) furnish industry with competent researchers, (d) become an internationally recognized research unit which attracts foreign researchers, and (e) promote interdisciplinary research.

- *Research Objectives:* (a) Significantly increase the basic knowledge of wood and wood fibers as regards their chemistry and morphology; (b) determine the effects of chemical, mechanical, and enzymatic treatments on the ultrastructure of wood and the influence of such effects on wood fiber properties; (c) be based on cooperation between universities, industrial research institutes, and forest industry companies; (d) build up and maintain a source of knowledge to support further research and development in the Swedish forest industry; and (e) contribute to the development of new industrial processes, new fiber-based materials, and new consumer products.

Primary Research Focus: Forest products, especially the morphological structure and chemical characteristics of wood

Governance and Organization: Governed by an 11-member board of directors (including 3 deputy directors), and administered by a center director (assisted by a managing group of 3 additional persons). Program direction and research design advice is provided by an international advisory group of 3, an industrial advisory group of 10, and a well identified list of contact 11 persons. Organization is administratively divided into six research projects.

The Wood Ultrastructure Research Centre is owned by a federation organizations composed of the (a) VINNOVA, (b) five research organizations SLU, STFI-Packforsk, KTH, CTH, and Uppsala University (UU), and (c) nine member companies (SCA, Stora Enso, Sveaskog, Eka Chemicals, Södra Cell, Korsnäs, Holmen, Kappa Kraftliner, and M-Real). The WURC is headquartered at the Swedish University of Agricultural Sciences in Uppsala, Sweden.

Strategic Program Directions: The Center's research program is focused on the basic elements of wood fiber and how they are influenced by external factors such as chemicals, enzymes, and mechanical actions. Specifically, the research at WURC is concentrated on the morphological structure of wood and wood fiber in the range of 500 nm to less than 1 nm (close to atomic and molecular bonding distance). Among the areas currently being researched are wood and pulp fiber models, cell wall ultrastructure, fiber chemistry of wood polymers (molecular level), physical properties of fiber materials, fiber defects and structural changes, and ultrastructural modeling of wood (with respect to metal ions).

Client Groups: The WURC serves public and private clients, with an owner–member emphasis.

Services Provided: The WURC provides research (direct delivery of products), consultations, and sponsorship of seminars and conferences.

Budget and Funding Sources:

- A. Income in 2004 Swedish kronas
Cash—9.90 million

In-kind—8.20 million
Total—18.10 million (U.S. \$2.3 million)

B. Source of income from 2004 budget in Swedish kronas

Industry—34% (6.1 million)
Cash—3.9 million
In-kind—2.2 million
Universities—33% (6 million)
Cash—0 million
In-kind—6 million
VINNOVA—33% (6 million)
Cash—6 million
In-kind—0 million

C. Focus of 2004 cash and in-kind expenditures

Mechanical and physical properties of fiber materials—31.9%
Cell wall ultrastructure—27.5%
Fiber chemistry at molecular level—15.1%
Wood and pulp fiber models—11.0%
Managerial expenses—8.2%
WURC joint expenditures—6.3%

Scientists and Supporting Staff: During the period 2002–2004, approximately 60 to 70 persons were involved wholly or part-time in WURC activities. The center's staff was approximately as follows:

Senior scientist staff (professors and associate professors), 14
Technical staff (post doctoral, technician), 8
Administrative staff (secretary, accounting), 6
Students (PhD, Licentiate), 18
Industry staff and scientists in active or advisory capacity, 20–25

Measures of Performance: Listing of publications, conferences sponsored, educational products (degrees granted), management and administrative consequences (more cooperation, expanded industry capacity, improved research focus, improved research networks).

Switzerland

Swiss Federal Laboratories for Material Science and Testing (EMPA)*

Date Established: Established in 1938 as the Swiss Federal Laboratories for Materials Testing and Research for Industry (known for some time prior to 1938 by the acronym EMPA). EMPA as an organization can be historically traced to 1880 (ETH Zurich Institute for Construction Materials Testing) when focus was on quality testing of building and structural materials, subsequently evolving into a general purpose testing institute for the construction and mechanical engineering fields.

Public-Private Sector: Chartered by the Swiss federal government, EMPA is a quasi-private independent organization within the Swiss ETH Domain (Swiss Federal Institutes of

Technology). The latter is composed of two Federal Institutes of Technology (ETH Zurich and EPF Lausanne) and four independent federal research institutions, one of which is EMPA.

Mission: The legally established purpose of the Swiss ETH Domain is to educate students in science, expand scientific findings through research, cultivate scientific junior staff, render scientific and technical services, perform public relations, and facilitate the exploitation of research findings. Within the ETH Domain, the following missions have been established: (a) EMPA is to serve society by improving the quality of life and the environment. Such is to be accomplished by promoting the environmental, economic, social, and economic aspects of sustainability and their optimization relative to materials and system engineering, (b) EMPA Wood Laboratory is to promote the use of wood and its application through applied research and development, ambitious provision of services, and the transfer of high quality knowledge. The mission of the Laboratory and of EMPA generally is facilitated by its status as an independent, neutral research institution.

Primary Research Focus: The EMPA Wood Laboratory researches forest products, especially wood structure, wood properties, wood protection, and timber engineering.

Governance and Organization: The EMPA is governed by the ETH Council (board) (9 members, including a chair and vice-chair) and is responsible for overall management of the Swiss ETH Domain. The EMPA has semi-autonomous status from the Swiss Federal Department of Home Affairs. The EMPA is one of ETH Domain's four independent research institutions.

Overall governance of EMPA is the responsibility of a director general and a deputy director. A consultative commission of eight provides counsel on general EMPA management activities and a research commission of ten advises on research priorities, procedures, and program evaluation. In addition to selected EMPA senior staff, the research commission consists of researchers and heads of research organization from around the world. The EMPA Academy is responsible for most of the organization's technology transfer activities.

The EMPA is organized into six departments. One department is responsible for communication, personnel, and financial management. Five departments are engaged in research, development, and testing work:

- Advanced materials and surfaces
- Materials and systems for civil engineering
- Materials for protection and well-being of human body
- Information, reliability, and simulation technology
- Mobility, energy, and environment

Departments with special relevance to forest products research are the Department Advanced Materials and Surfaces and the Department of Materials and Systems for Civil Engineering. Within the latter is situated the EMPA Wood Laboratory (located in Dubendorf, Switzerland). The Laboratory is organized into four basic groups: wood basic science, wood technology, wood protection-microbiology, and timber engineering. Other laboratories within the Department that conduct research relevant to forest products are structural engineering, polymers and composites, and building technologies.

Strategic Program Directions: The EMPA's overall strategy focuses on three core areas: (a) research and development into innovative, structural and functional materials, composites and systems; (b) integrated development and evaluation of products, processes, and systems for the capital and consumers' goods markets, with particular reference to sustainability; and (c) measurement and analytical methods, simulation and modeling with computational and experimental verification. Within EMPA's overall strategic directions, the EMPA Wood Laboratory seeks to

- Extend the knowledge on material properties (micrometer and nanometer scale) to foster added-value utilization of wooden resources and to enable possible transfer of adapted biological structures and functions into the technosphere.
- Improve the technical, economical, and environmental quality of wood, wood composites, and combinations of wood and other materials including renewables, with special emphasis on the principle of sustainability.
- Ensure the safety, fitness for use, and durability of timber applications with regard to the expected requirements and impacts.
- Present parameter, criteria, and strategies to highlight the potentials of the forestry-timber sector for a future sustainable development.
- Analyze microbiological and hygienic problems related to all materials used in civil engineering.

Client Groups: The EMPA serves public and private clients and its most important stakeholders are considered to be business and society, institutes of higher education and universities, and public authorities. The EMPA Wood Laboratory focuses specifically on services to industry, associations, federal agencies, nongovernment organizations, and various private customers. The EMPA strives to combine targeted applied research and development with high quality services and to exploit its interdisciplinary skills to ensure integrated approaches to problem solving.

Services Provided: Information (library, software), research (direct delivery of products, joint research activities), consultation (advice), and teaching and training. Specifically, the EMPA Wood Laboratory provides the following services

(clients are charged according to EMPA's current hourly rates):

- Characterize the behavior of wood and wood composites in single use or in combination with other materials, particularly in building applications with load-bearing, separating, and/or aesthetically function
- Evaluate the effect and effectiveness of products and methods to protect, refine, or combine timber
- Make use of modern and efficient testing and analytic equipment and include the extensive know-how and state-of-the-art infrastructure of other EMPA Laboratories

As part of the EMPA Wood Laboratory's interest in technology transfer, the following example activities are carried out: workshops, lectures, and symposiums; publication of scientific and technical results of research; research program coordination and research procedure standardization; and consulting and conferring with individual clients. The Wood Laboratory also hosts the offices of the Swiss Association of Wood Research and the Center of Excellence for Wood.

Budget and Funding Sources

The ETH Domain total income in 2003 was 2,203 million Swiss francs, with expenditures totaling 1,900 million (75% personnel). In 2003, the financial condition of EMPA Department of Materials Research and Technology was as follows: Expenditures totaled 115.7 million Swiss francs: Personnel, 75% (87 million); materials, 4% (4.4 million); 21%, 24.3 million. The department's funding (117.2 million) originated from the federal government, 69% (80.8 million);, third-party funds, 17% (19.5 million); services rendered, 12% (14.0 million); and other income, 2% (2.9%). Financial information for is not available for the EMPA Department of Advanced Materials Surfaces.

In 2003, the EMPA Wood Laboratory's income and expenditures were as follows:

- A. Income in 2003 Swiss francs
\$2.6 million—Total (U.S. \$2.0 million)
- B. Source of Income (2003) (Swiss francs):
Government—58% (1.5 million)
Services provided—15% (0.4 million)
Third-party sources*—27% (0.7 million)
*Special, nonrecurring income from industry and government.
- C. Expenditures in 2003 Swiss francs
Personnel—92% (2.4 million)
Operating expenses and infrastructure—8% (0.2 million)
- D. Focus of expenditures in 2003 Swiss francs
Basic wood sciences—19% (0.5 million)
Wood protection—31% (0.8 million)
Wood technology—31% (0.8 million)
Timber engineering—19% (0.5 million)

Scientists and Supporting Staff: In 2003, the Swiss ETH Domain engaged 18,694 students, 2,780 staff with diplomas, and 11,765 personnel classified as professors, non-professional academic, or administrative-technical staff. EMPA total staff in 2003 was 824 persons or 719 full-time equivalent positions. These 824 staff were as follows: five professors, 367 research personnel, 462 administrative and technical personnel. EMPA was also responsible for 67 doctoral candidates, 50 diploma students, 657 trainees, and 33 apprentices. Twenty-one staff were assigned to EMPA's Wood Laboratory, distributed as follows: wood basic science—4 staff, wood technology—6 staff, wood protection-microbiology—6 staff, and timber engineering—4 staff.

Measures of Performance: The EMPA will measure its performance through a general description of research results (reported in EMPA annual report and in EMPA annual report of activities). For 2003, the following were cited as accomplishments: 425 publications, 21 patents granted or applied for, six licensing agreements, and two spinoffs or start-ups. In addition, the EMPA Academy sponsored 199 events (seminars, courses, lectures) that involved 6,000 persons. For the Swiss ETH Domain in general, the following performance goals are to guide the domain's two institutes and four independent research organizations (including EMPA): excellent and attractive teaching and research by international standards, pole position in international research, attractive working conditions and equal opportunities for women and men, creation of innovative teaching programs, increased cooperation with the other Swiss universities of applied sciences, and technological and economical implementation of new knowledge and techniques.

Taiwan (Republic of China)

Taiwan Forestry Research Institute (TFRI)

Date Established: Established in 1945, although origin can be traced to the late 1890s.

Public-Private Sector: Public government organization

Mission: To conduct research focused on forests, forestry and forest uses

Primary Research Focus: Forestry and forest products

Governance and Organization: The institute's director is supported by a deputy and a secretary general reporting to the Council on Agriculture. The Institute is organized into three administrative support offices (accounting, personnel, ethics), six regional centers, and 10 divisions (27 laboratories). The divisions are forest biology, silviculture, forestry economics, forest management, watershed management, forest protection, forest utilization, forestry chemistry, wood cellulose, and forestry extension. The Institute is headquartered in Taipei, Taiwan.

Strategic Program Directions: The Institute's programs are aligned with its divisional structure:

- Forest biology (laboratories on forest resources conservation, forest ecology, forest plant systemic)
- Silviculture (laboratories on tree genetics, silviculture, forest soil)
- Forestry Economics (laboratory on forest economics)
- Forest Management (laboratory on forest planning, recreation, stand management)
- Watershed management (laboratories on forest hydrology, water chemistry, erosion and sediment control)
- Forest protection (laboratories on forest pathology, forest fire, entomology, wildlife)
- Forest utilization (laboratories on wood material, wood processing, wood composites, timber engineering)
- Forest chemistry (laboratories on chemistry, polymeric resins, wood preservation)
- Wood cellulose (laboratories on papermaking, pollution abatement, pulping and bleaching)
- Forestry Extension (extension of research findings, information management, experimental forests)

The major research activities of the divisions engaged in forest and wood products research are as follows:

- Division of Forest Utilization

Wood Material Laboratory—investigation of anatomic, physical, and mechanical properties of wood, bamboo, and rattan; evaluation of material strength by nondestructive tests; wood identification and material properties analysis services

Wood Processing Laboratory—development of kiln schedules for drying wood and bamboo; improvement and development of machining technology; manufacture of lam-boo and press-lam products; utilization of small-diameter logs

Wood Composite Laboratory—manufacture and processing of particleboard, fiberboard, and oriented strandboard; identification and reduction of volatile organic compound emission during adhesion; evaluation of adhesives and adhesion technology

Timber Engineering Laboratory—evaluation of static and dynamic strength of wooden structure; investigation of fatigue strength of furniture; examination of the structure performance in wood construction, furniture, and interior decoration

- Division of Forest Chemistry

Forest By-products Laboratory—extraction, analysis, processing and utilization of essential oils; analysis and chemical processing of forest by-products; media development for mushroom cultivation and their chemical analyses

Polymeric Resin Laboratory—synthesis and analysis of coatings and adhesives; durability evaluation and property improvement of coating and adhesives

Wood Material Preservation Laboratory—chemical modification and flame-resistance improvement of wood material; development of low-polluting preservatives; natural durability and utilization study of plantation wood

▪ Division of Wood Cellulose

Pulping Laboratory—wood fiber morphology and chemical analysis; raw material and pulping studies; pulping technology

Papermaking Laboratory—papermaking technology; paper characterization and evaluation; handmade and specialty papers; paper converting

The six regional centers place emphasis on subjects that benefit from a center's particular geographic location, for example watershed management, urban forestry, silviculture, biological diversity, and natural forests.

The institute also engages in extension activities (through the Division of Forestry Extension) that include distribution of forestry research results, training and education programs, conference sponsorship and organization, management of information data bases, and preparation and distribution of publications.

Client Groups: The institute serves public and private clients.

Services Provided: The institute provides information, research (direct delivery of products), consultation (advice), and training (workshops).

Budget and Funding Sources: Not available

Scientists and Supporting Staff: In 2003, staff totaled an estimated 168, of which 137 were considered scientists or technical staff. The institute also employs an additional 201 support staff (technicians, helpers, drivers) that are assigned to various units of the institute (headquarters, division, branch centers). Excluding the 201 support staff, the Institute's administrative and scientist staff was distributed as follows:

Office of Director and Administration—31 (18%)
 Division of Forest biology—12 (7%)
 Division of Silviculture—16 (10%)
 Division of Forest Management—21 (12%)
 Division of Forest Economics—6 (4%)
 Division of Forest Protection—8 (5%)
 Division of Forest Utilization—12 (7%)
 Division of Forest Chemistry—8 (5%)
 Division of Wood Cellulose—7 (4%)
 Division of Forestry Extension—7 (4%)
 Research Centers (five)—40 (24%)

Measures of Performance: The institute measures performance by listing publications and a general description of the results of research carried out by each division in the Institute.

United Kingdom

Timber Research and Development Association (TRADA) *

Date Established: Established as TRADA in 1962, its origin can be traced to 1934 as the Timber Development Association.

Public-Private Sector: The TRADA is a private independent organization. In 1994, TRADA's two TRADA subsidiaries (TRADA Quality Assurance Services and TRADA Technology) became TRADA Technology Limited and a member of the TTL Chiltern Group of Companies. Through a unique relationship, the services of TRADA Technology Limited are provided through a sole appointed service provider, TRADA Technology (Timber Research and Development Association).

In addition to TRADA Technology, the Chiltern Group of companies also provides specialized services through BM TRADA Certification (a multi-sector certification body accredited by United Kingdom Accreditation Service), Chiltern International Fire (fire resistance testing, fire safety engineering), Chiltern Dynamics (testing of building materials for security, strength and durability), FIRA International (testing, research and consultancy for furniture and allied industries), and Chiltern Clarkebond (consultancy in prefabrication and modular design).

The TRADA has a very diverse membership encompassing companies and individuals from around the world and across the entire wood supply chain, from producers, merchants, and manufacturers to architects, engineers, and end users. Membership categories are corporate members (companies that produce, trade, or manufacture wood products), professional members (organizations and individuals that design, specify, or use timber), and student members (persons enrolled in recognized educational body).

Mission: To provide members with the highest quality information on timber and wood products to enable them to maximize the benefits that timber can provide. The TRADA's mission is to be accomplished through active and ongoing programs of information and research. Information is made available through web sites, extensive collection of printed materials, and education and training courses, whereas research programs are driven by the desire to update and improve information so that it continues to meet members' needs in the future.

Primary Research Focus: The TRADA researches forest products, directed entirely at building markets and specifications for timber and other wood-based products. Complementing the organizations major program areas, the

organization is administratively divided into four major units: timber frame housing construction program, timber construction program, engineered timber and components program, and timber supply chain program.

Governance and Organization: The TRADA is governed by a board of directors of 11 elected persons and a chief executive officer.

The TRADA does extensive partnering in the sponsorship of its research program. For example, a project involving the calibration, testing, and evaluation of plywood glue-bond performance is jointly sponsored by 12 organizations: European Commission; TRADA Technology, Ltd.; Danish Technological Institute; Wilhelm-Klauditz-Institut (Germany); VTT (Finland); Centre Technique du Bois et de l'Ameublement (CTBA, France); Stichting Hout Research (SHR, Netherlands); Statens Provningsanstalt (SP, Sweden); Building Research Establishment (United Kingdom); Centro de Investigacin Tecnolgica, Spain; Blomberger Holzindustrie (Germany); and Toro-Compensati Toro (Italy).

Strategic Program Directions: TRADA research falls within four broad categories:

- Timber frame housing and construction (three projects 2004)
- Engineered timber and components (structural use of timber) (nine projects 2004)
- Timber in construction (nonstructural use of timber) (three projects 2004)
- Timber supply chain (non-constructional uses, statistics, e-commerce) (nine projects 2004)

The TRADA research program is delivered exclusively under contract by TRADA Technology, an independent company. Most research projects are carried out in partnership with leading industry companies and most are partially funded with government support, both from the United Kingdom and the European Union.

Client Groups: The TRADA serves public and private clients and has an owner-member emphasis.

Services Provided: Information (especially <http://www.trada.co.uk/>); research (direct delivery of products, joint research activities); consultation (advice); and training (workshops). The commercial service activities of TRADA and TTL Children are extensive, falling primarily into the following areas: building surveys (on-site inspections), certification (chain of custody certification, ISO 9001 quality management certification), engineering (construction support), business solutions (performance and management), testing (material and construction), and fire safety (engineering and testing).

Budget and Funding Sources:

- A. Income in 2003 British pounds
628,000—Total (U.S. \$1.1 million)

- B. Source of income in 2003 British pounds
Member fees—68% (424,000)
Investment Income—6% (35,000)
Other Income—26% (169,000)

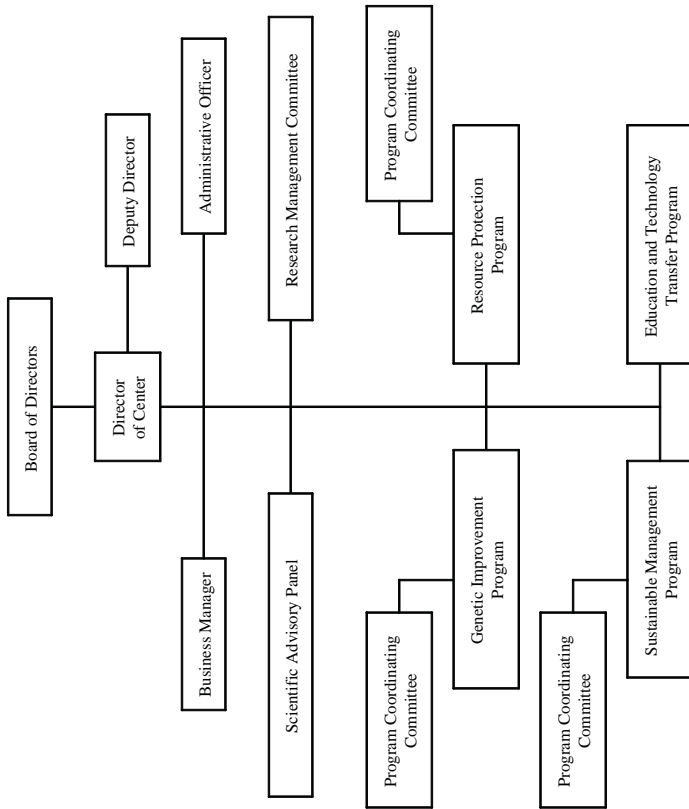
- C. Expenditures in 2003 British pounds
Operations—75% (727,000 GBP)
askTRADA (website) expenditure—25% (248,000)

Program focus of expenditures is not available.

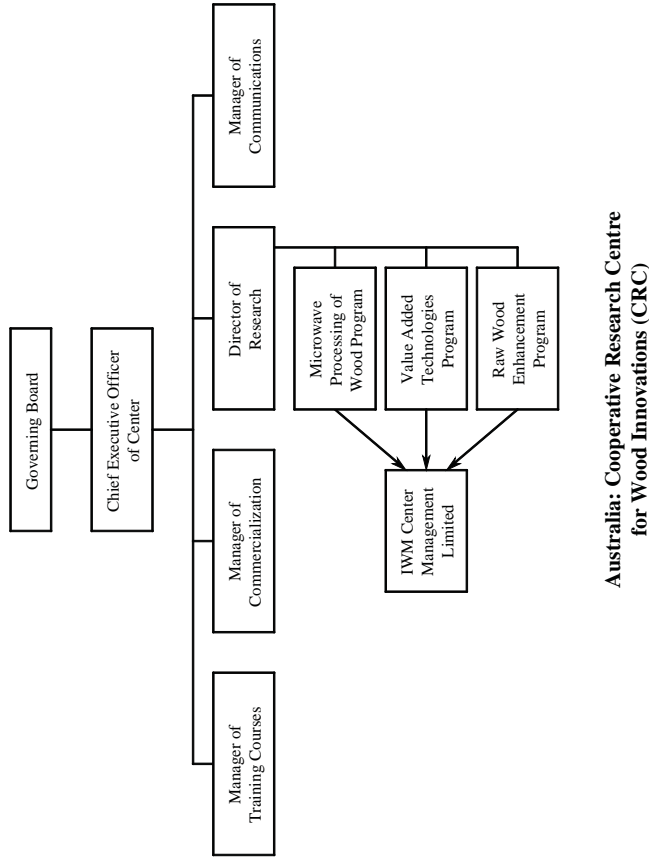
Scientists and Supporting Staff: TRADA Technology employs an estimated 50 people.

Measures of Performance: The TRADA measures its performance by income and expenditure statements and statements of assets and liabilities.

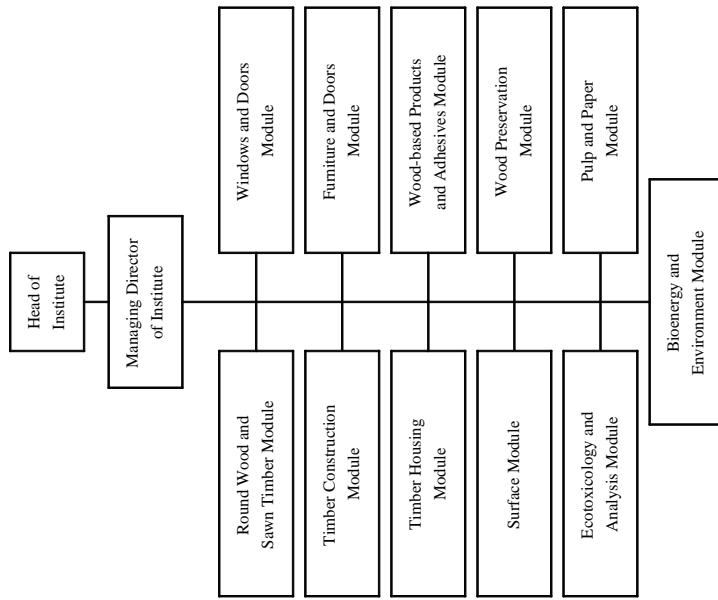
Appendix B—Organizational Charts of Case-Example Forest Products and Related Research and Development Organizations



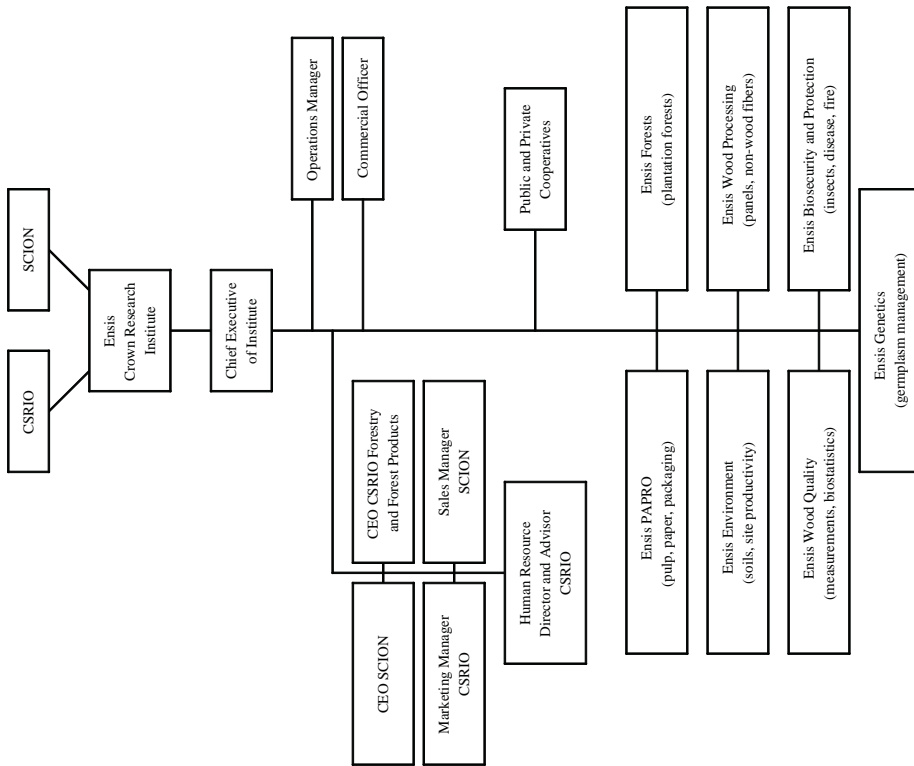
Australia: Cooperative Research Centre for Sustainable Production Forestry (CRC)



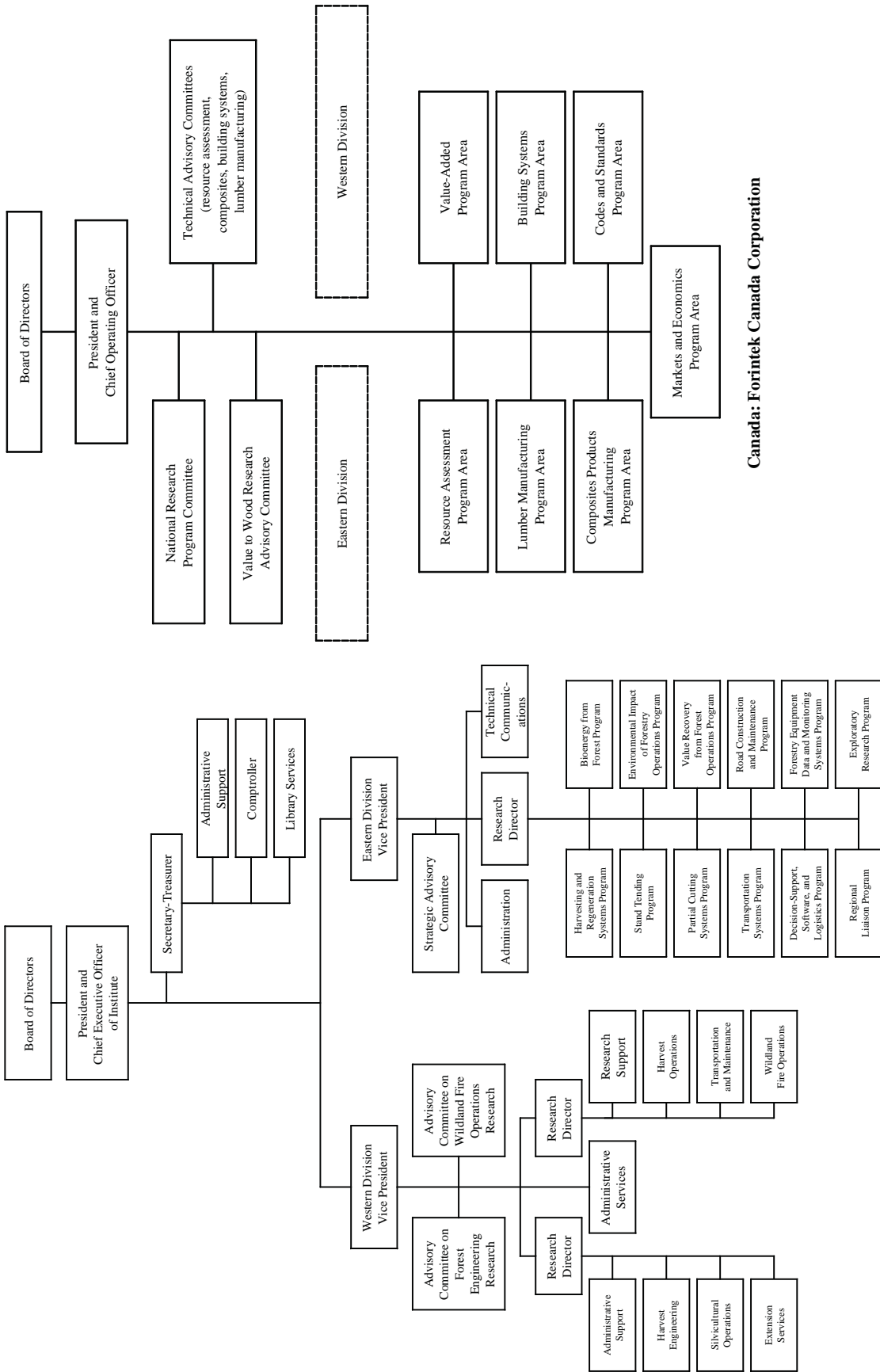
Australia: Cooperative Research Centre for Wood Innovations (CRC)

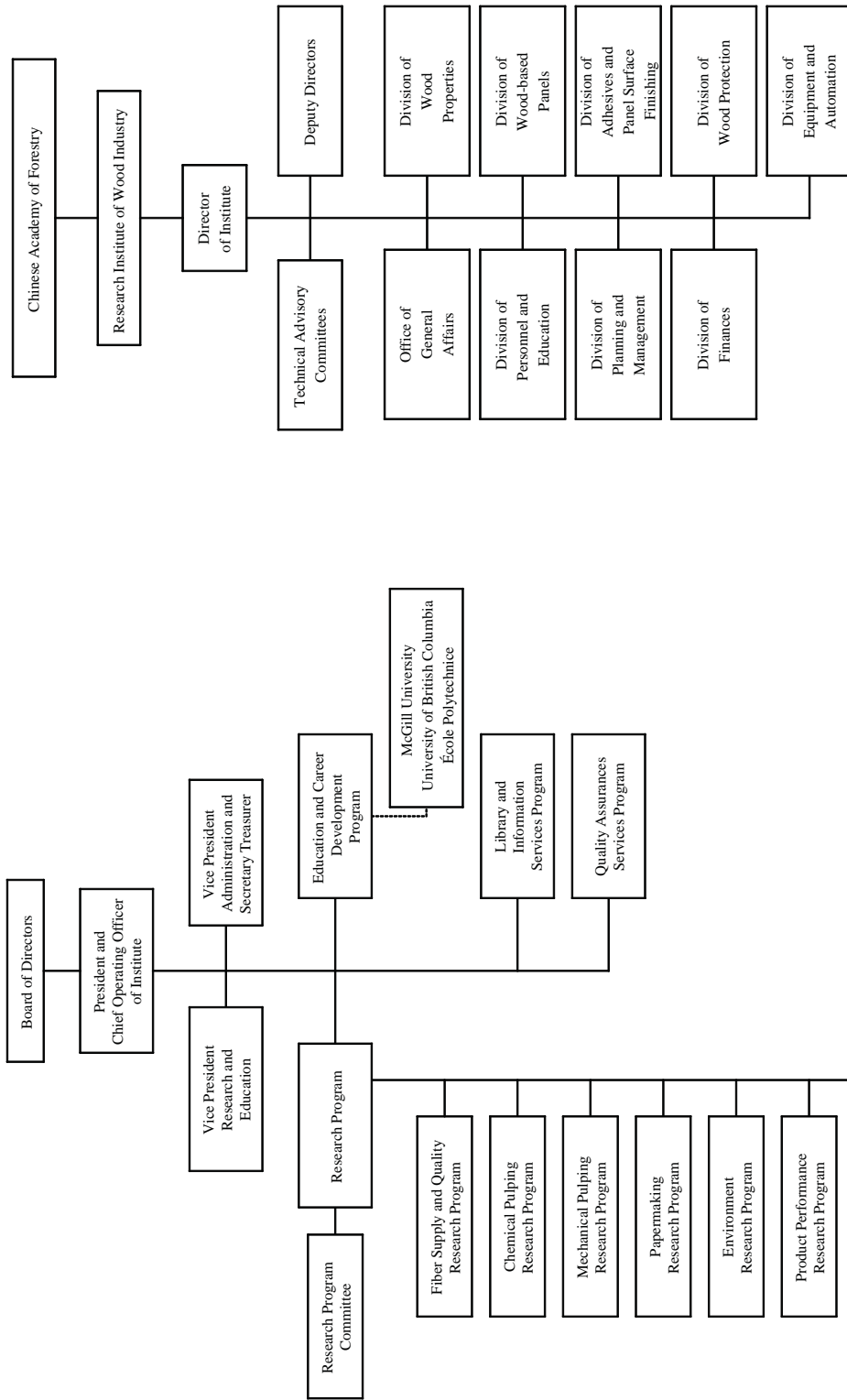


Austria: Holzforschung Austria (HFA)

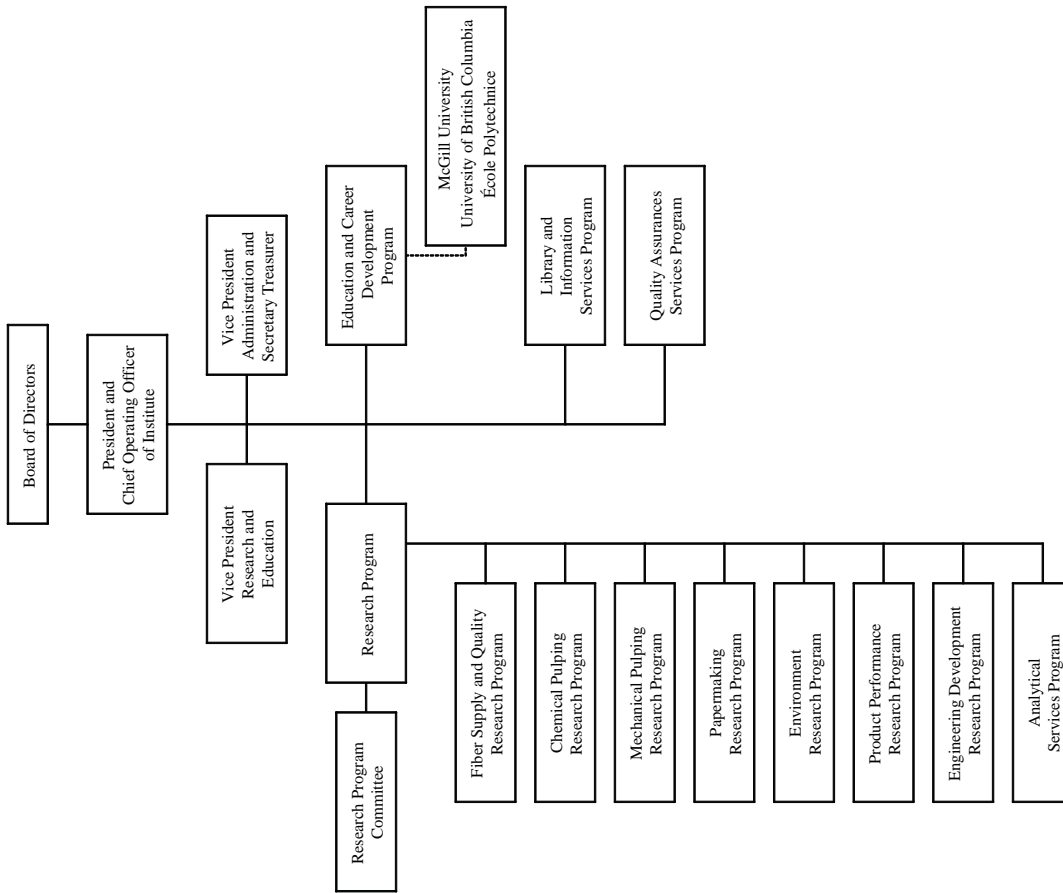


Australia: Ensis

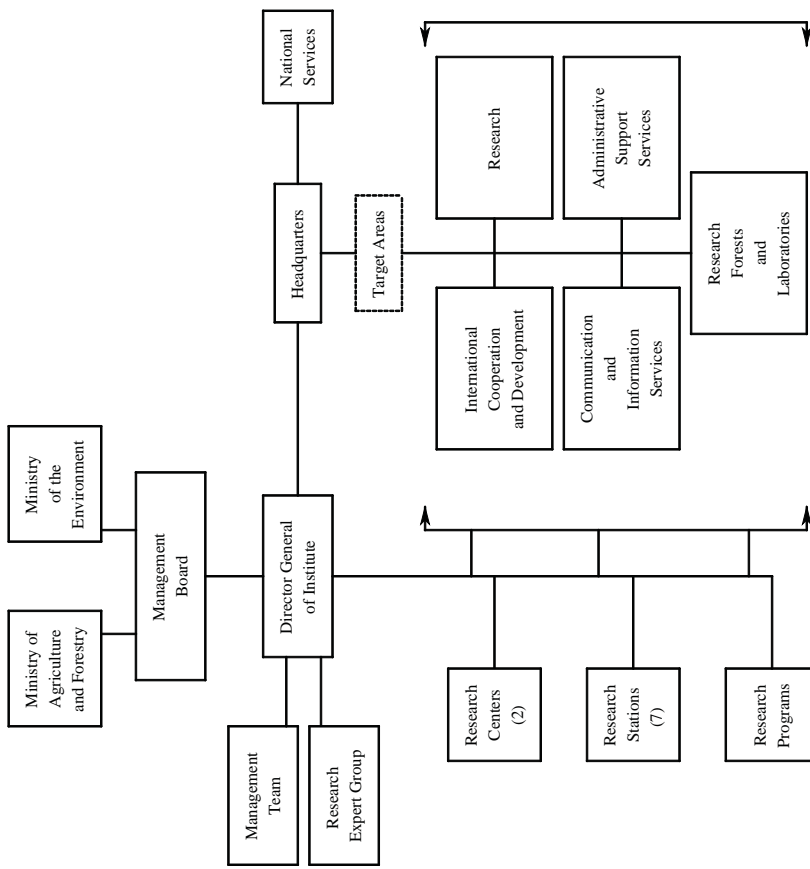




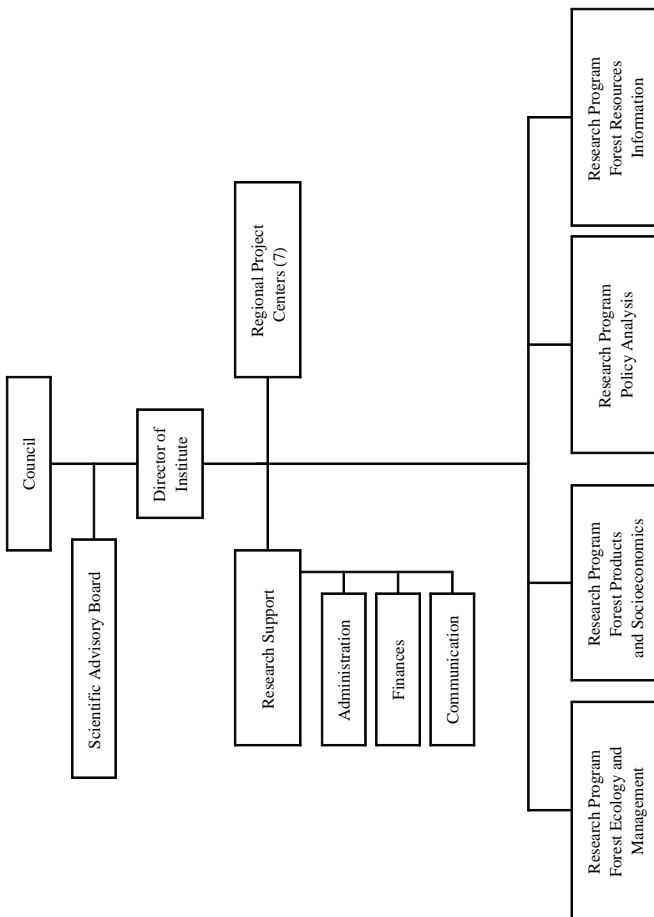
China: Research Institute of Wood Industry (CRIWI)



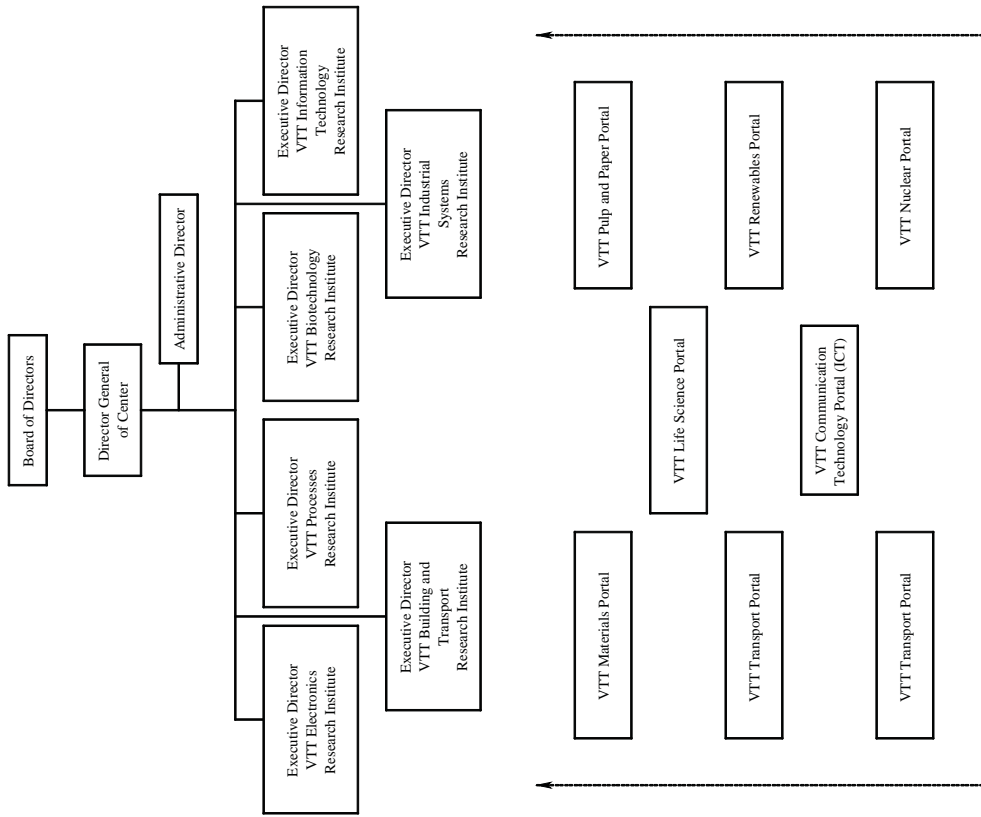
Canada: Pulp and Paper Research Institute of Canada (Paprican)



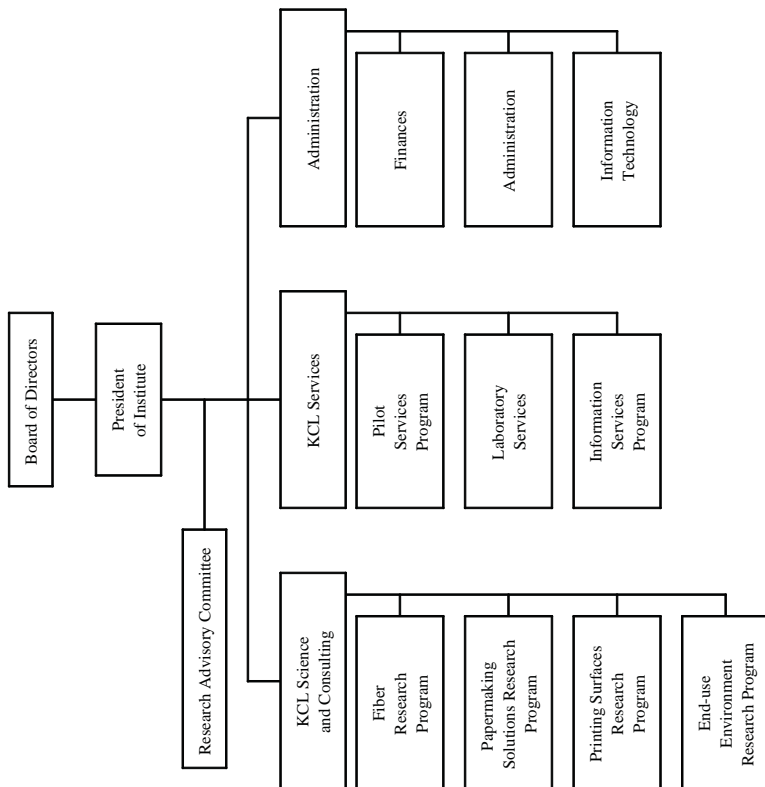
Finland: Forestry Research Institute (Metsä)



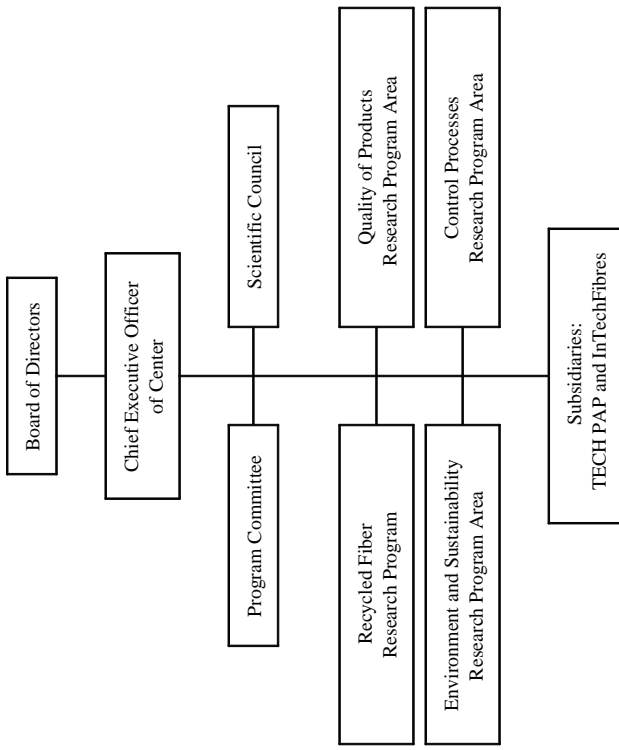
Finland: European Forest Institute (EFI)



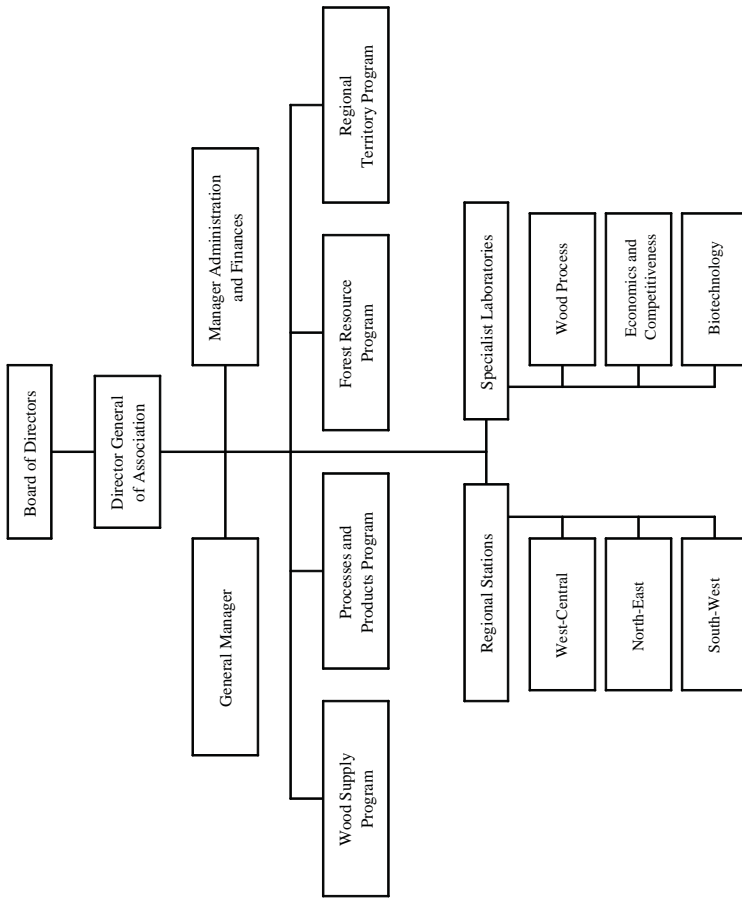
Finland: Technical Research Centre of Finland (VTT)



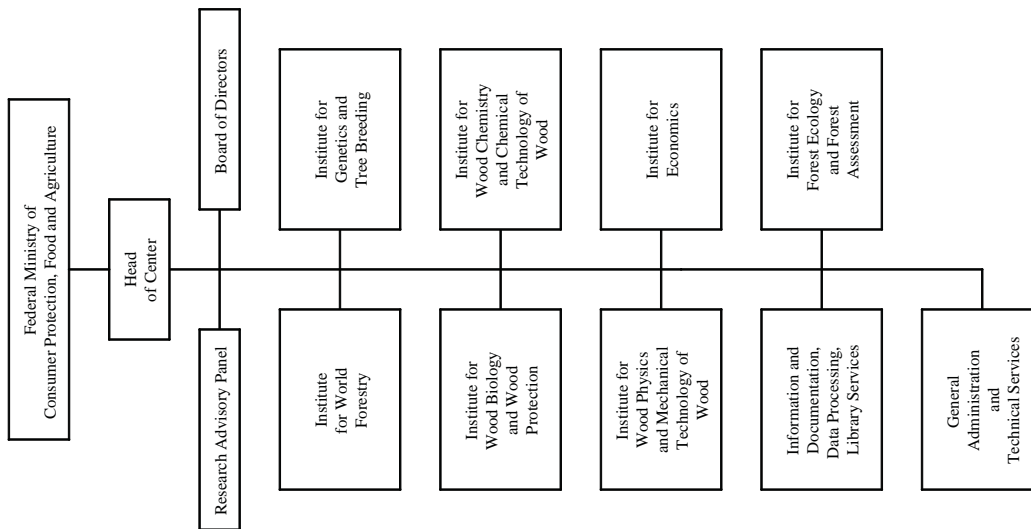
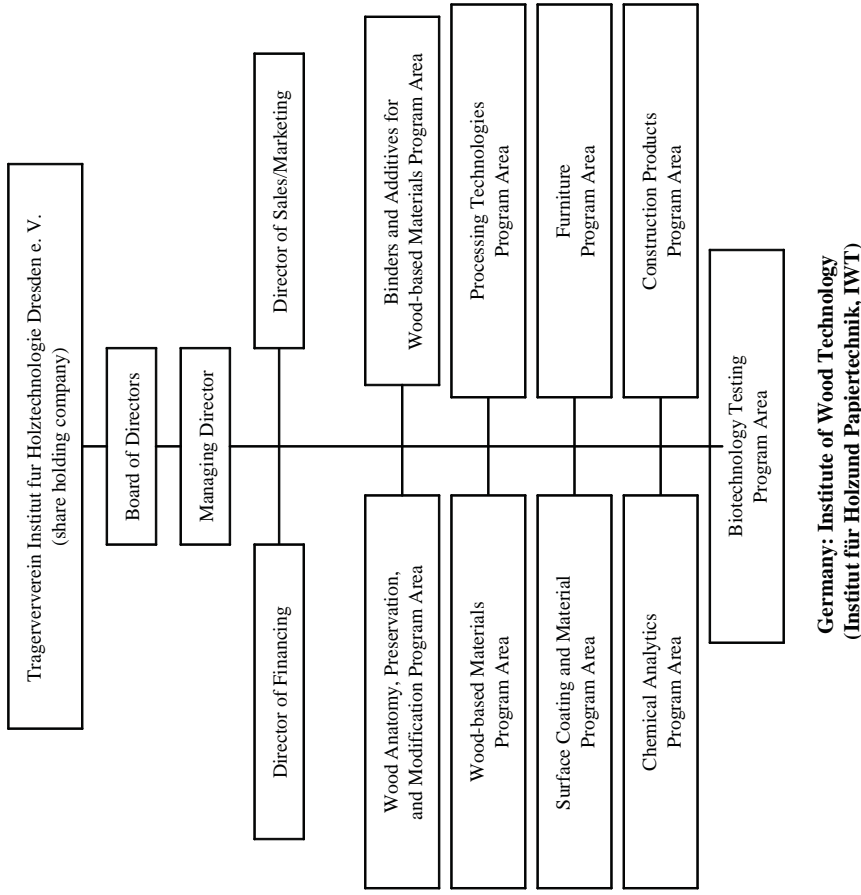
Finland: KCL (Oy Keskuslaboratorium-Centralaboratorium Ab)

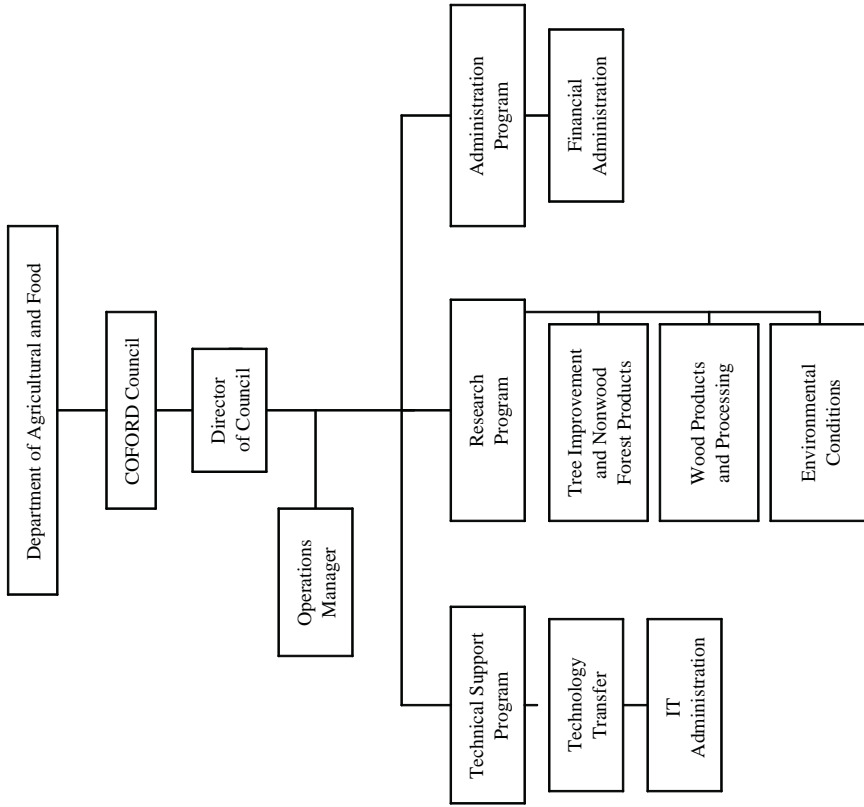


France: French Pulp and Paper Research and Technical Centre (Centre Technique du Papier, CTP)

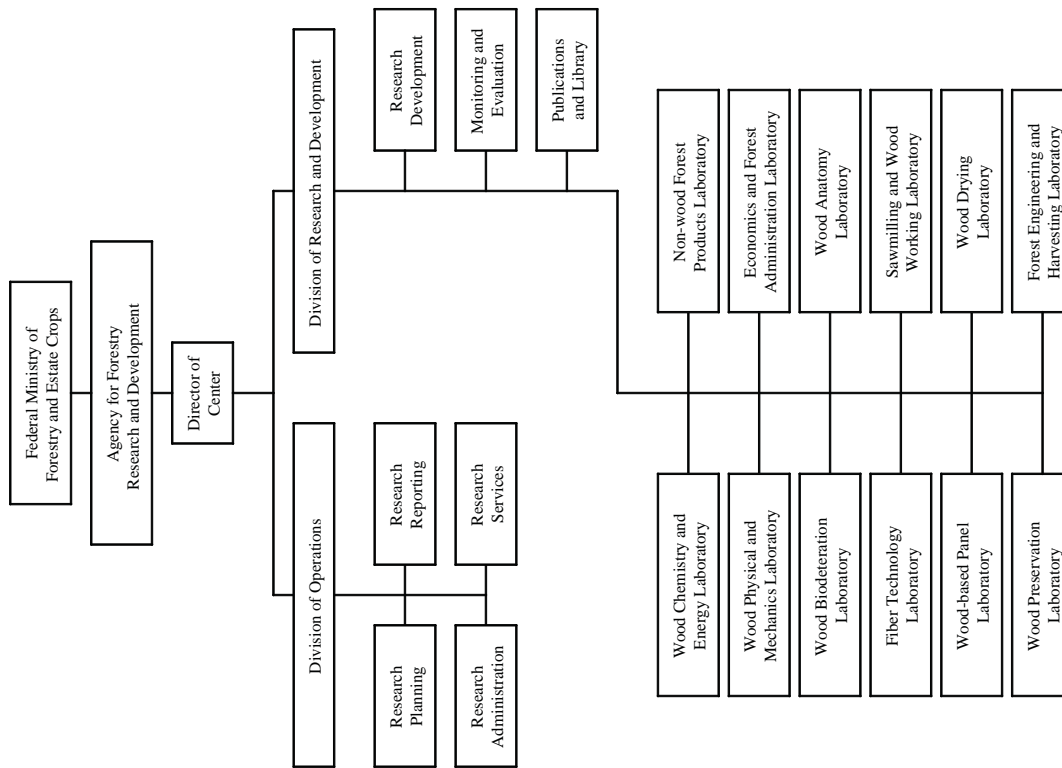


France: Association Forest Cellulose (AFOCEL)

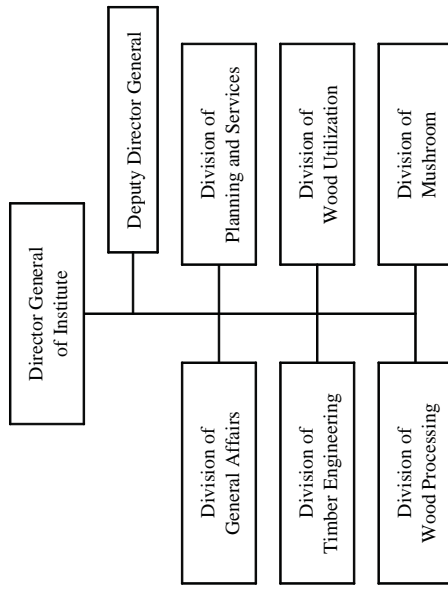




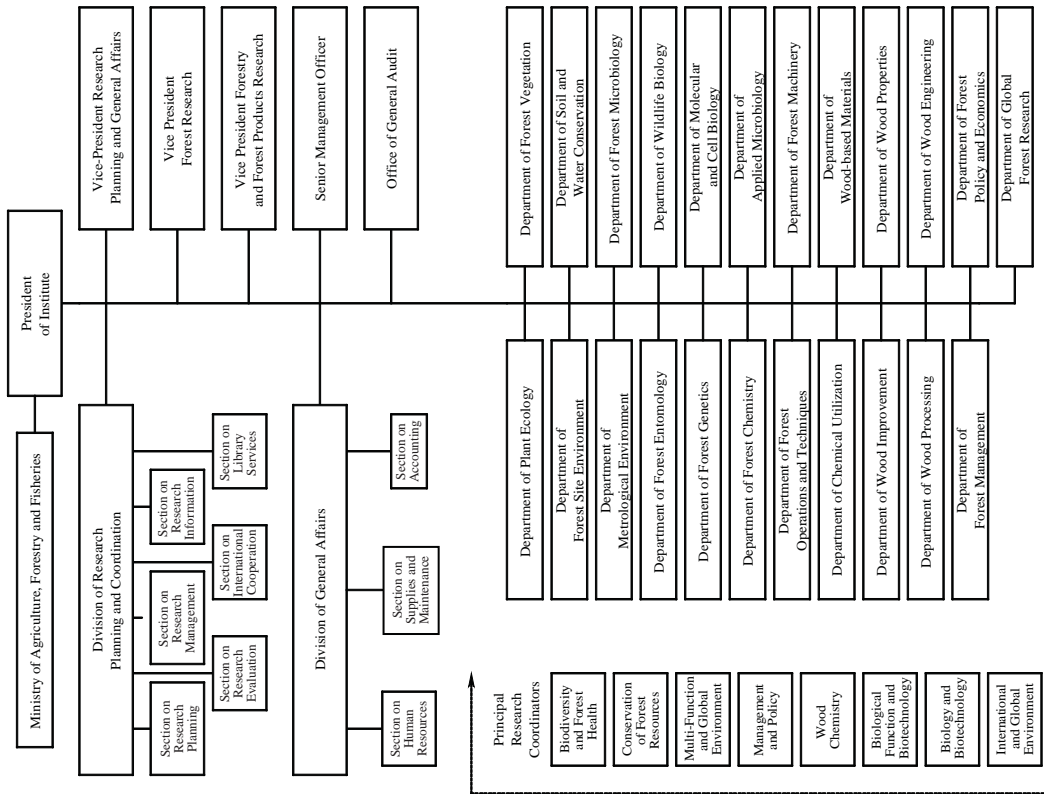
Ireland: National Council for Forest Research and Development (COFORD)



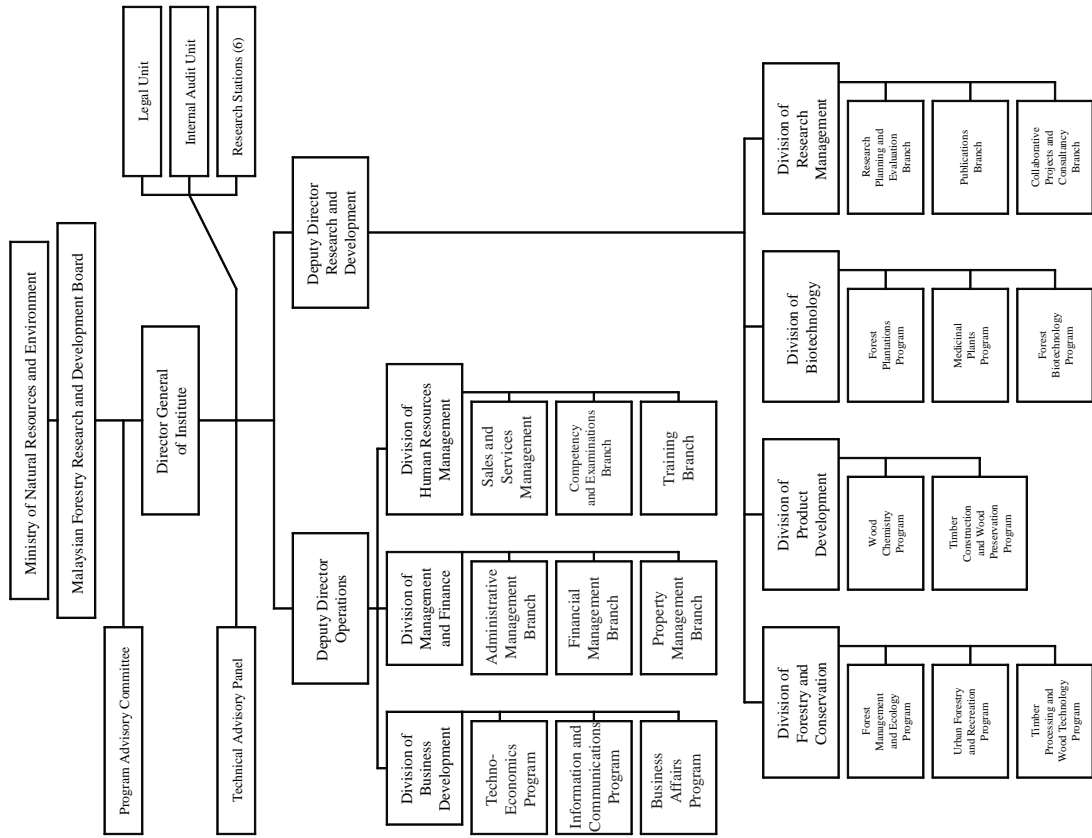
Indonesia: Forest Products and Forestry Socio-Economic Research and Development Center



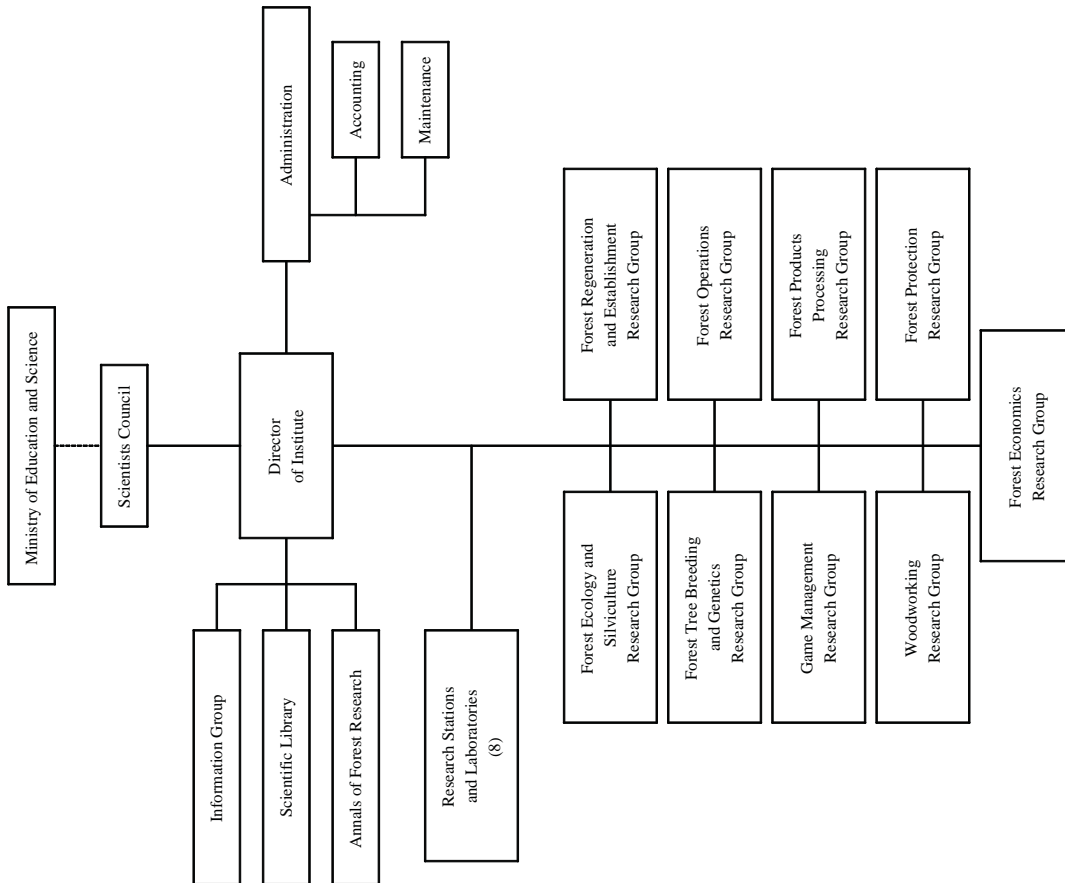
Japan: Hokkaido Forest Products Research Institute



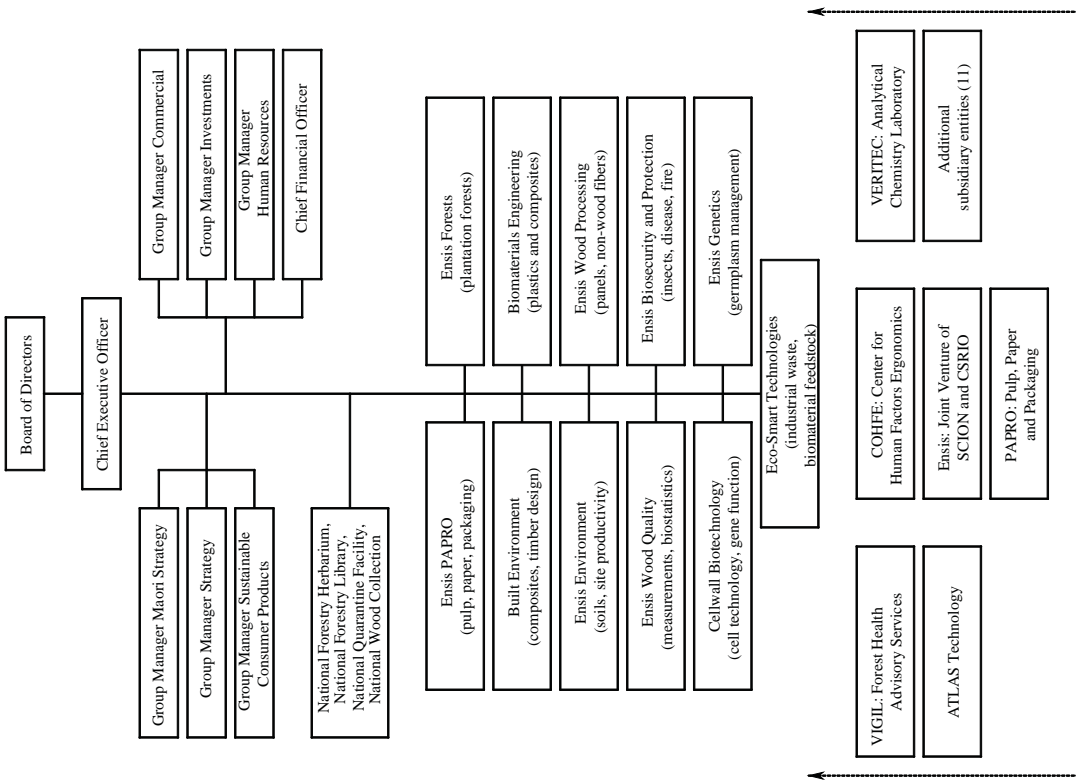
Japan: Forest and Forest Products Research Institute (FFPRI)



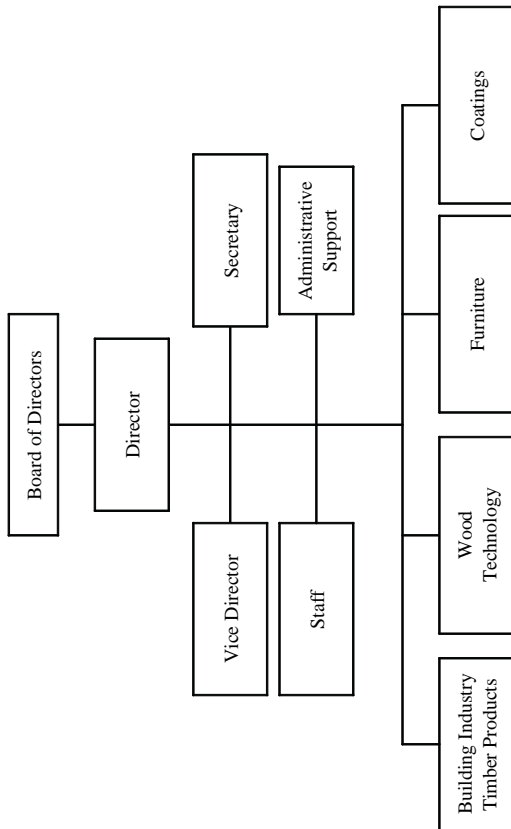
Malaysia: Forest Research Institute (FRIM)



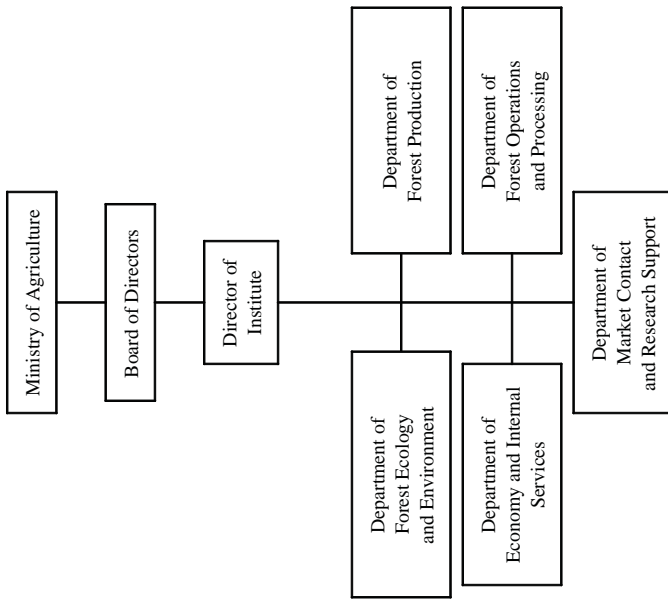
Latvia: State Forestry Research Institute (Silava)



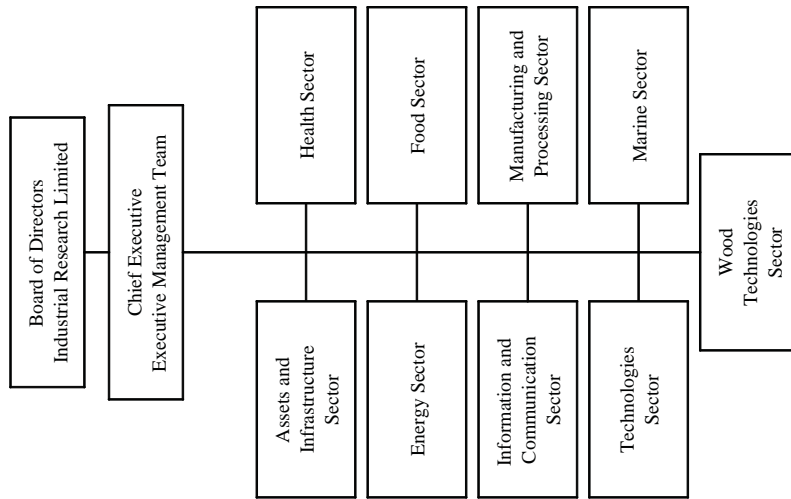
New Zealand: Forest Research, Ltd. (Scion)



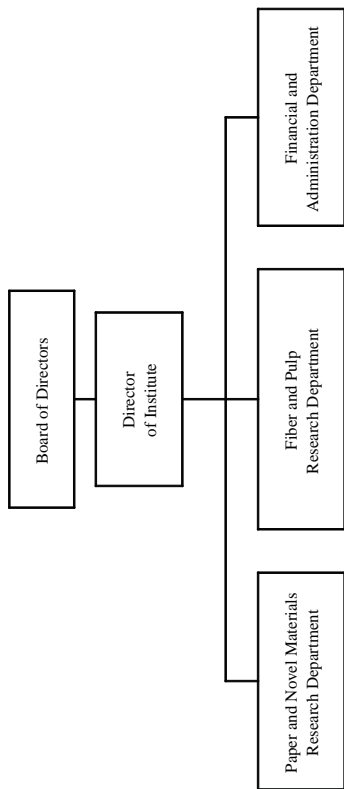
Netherlands: Stichting Hout Research (SHR) Timber Research



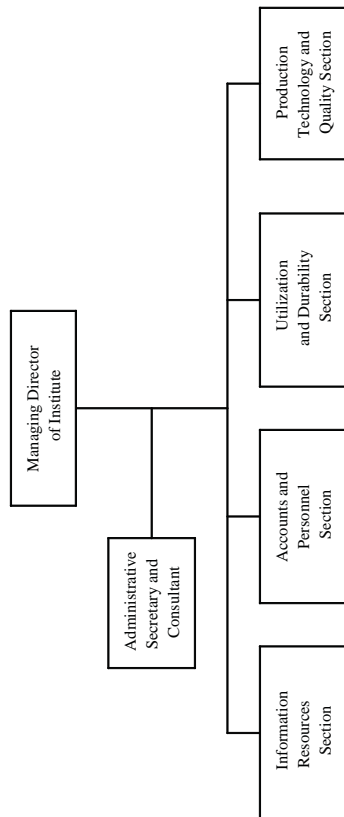
Norway: Norwegian Forest Research Institute (Skogforsk)



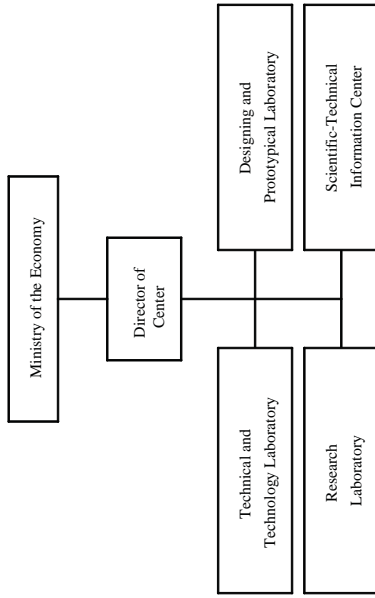
New Zealand: Wood Technologies Research Sector, Industrial Research Limited (IRL)



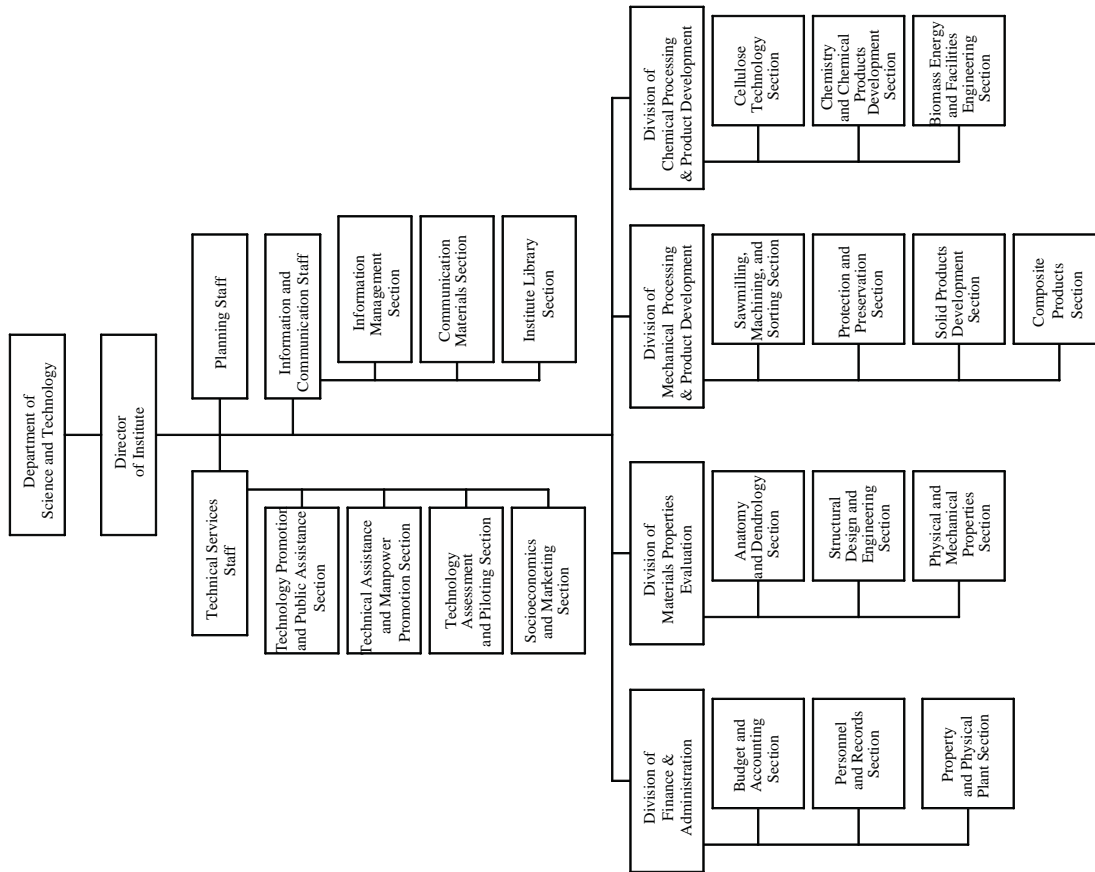
Norway: Paper and Fiber Research Institute (PFI)



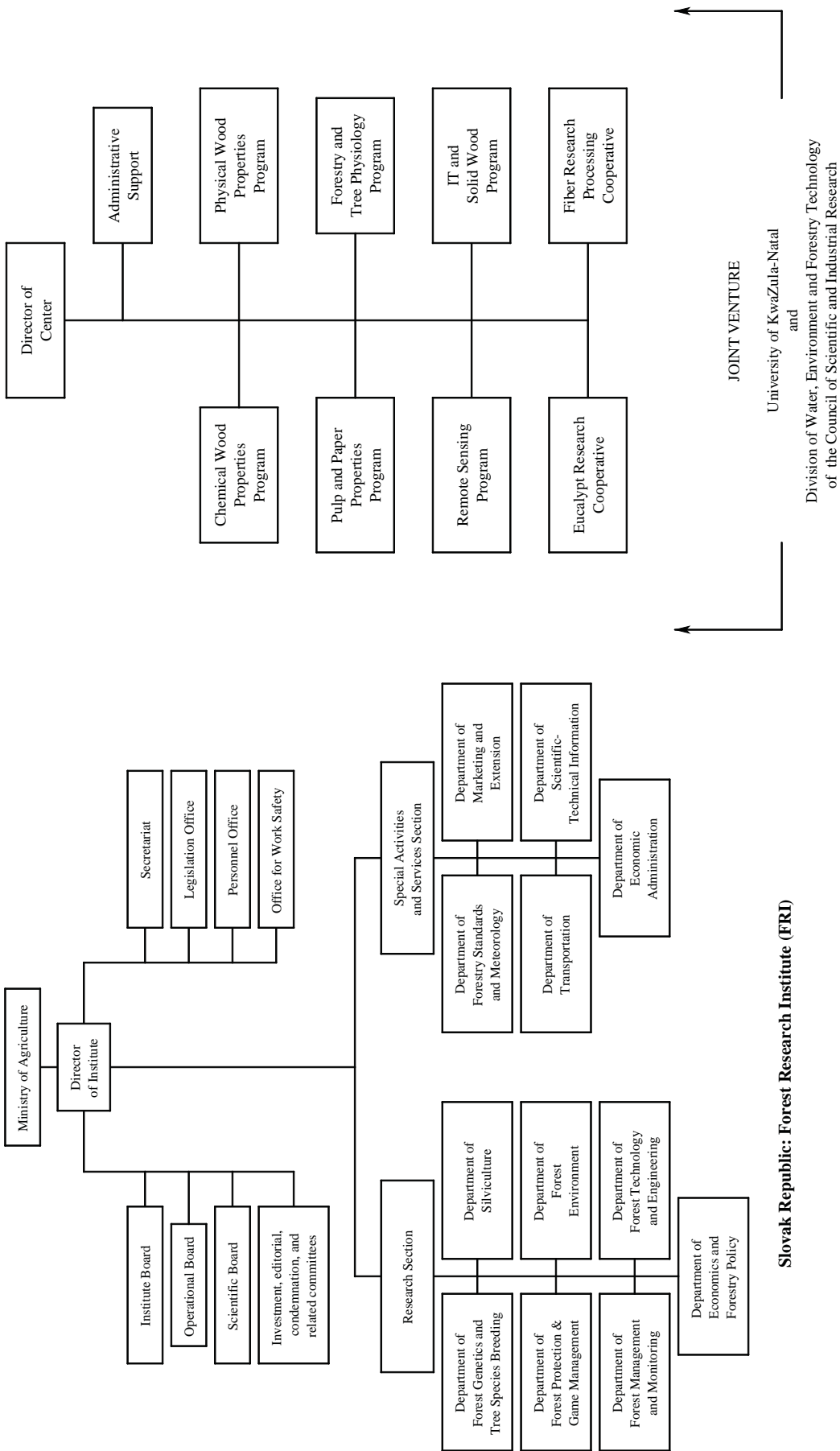
Norway: Norwegian Institute of Wood Technology (NTI)



Poland: Research and Development Centre for Wood-Based Panels

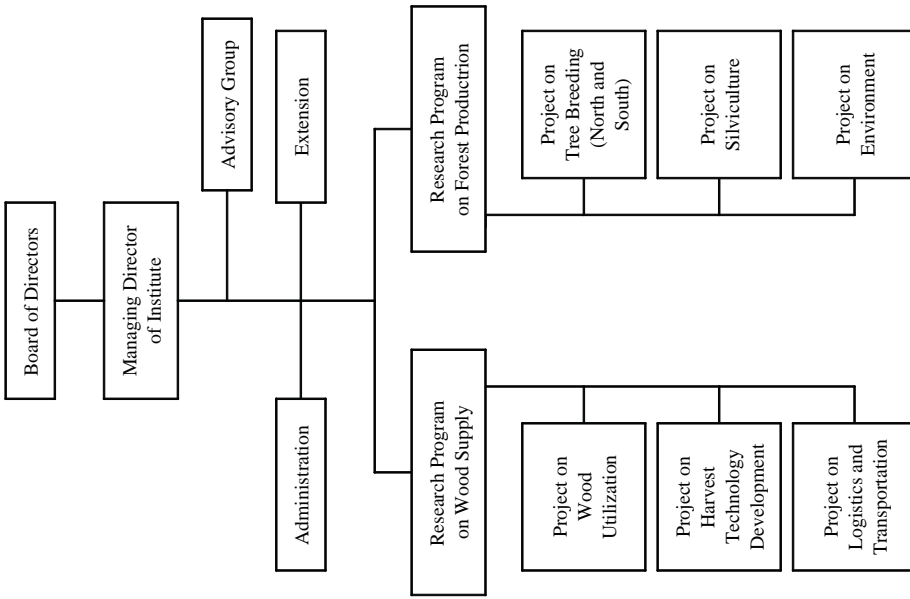


Philippines: Forest Products Research and Development Institute (FPRDI)

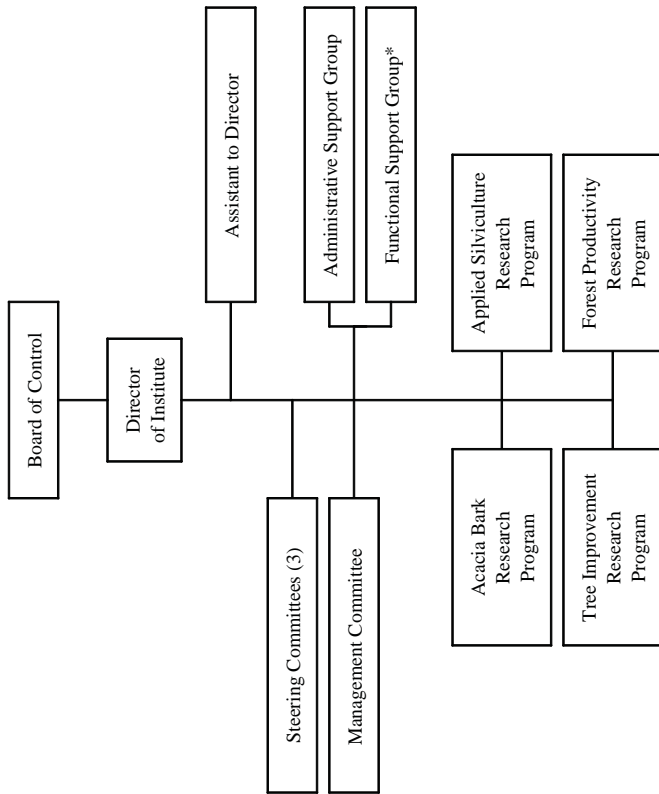


South Africa: Forestry and Forest Products Research Centre (FFP)

Slovak Republic: Forest Research Institute (FRI)

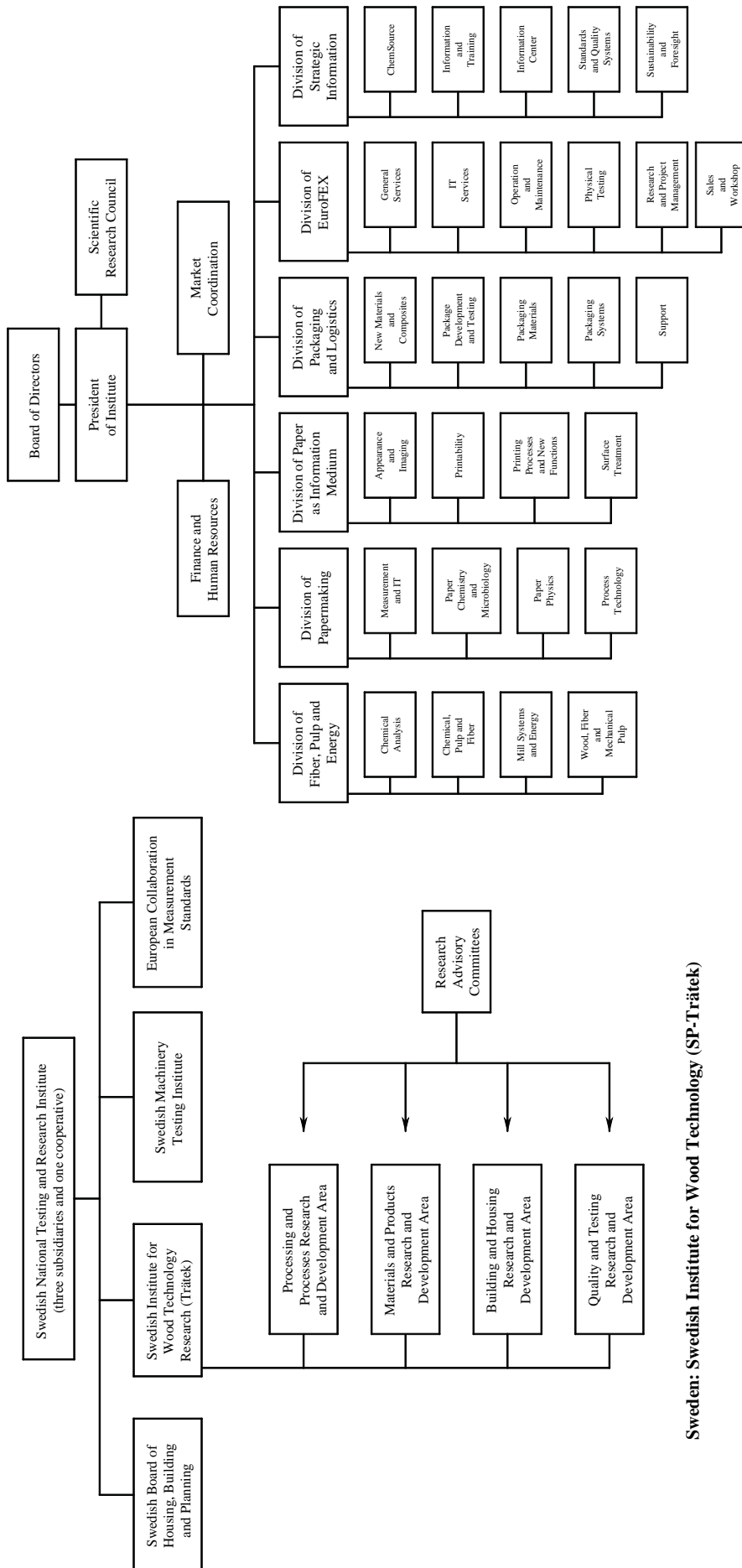


Sweden: Forestry Research Institute (Skogforsk)



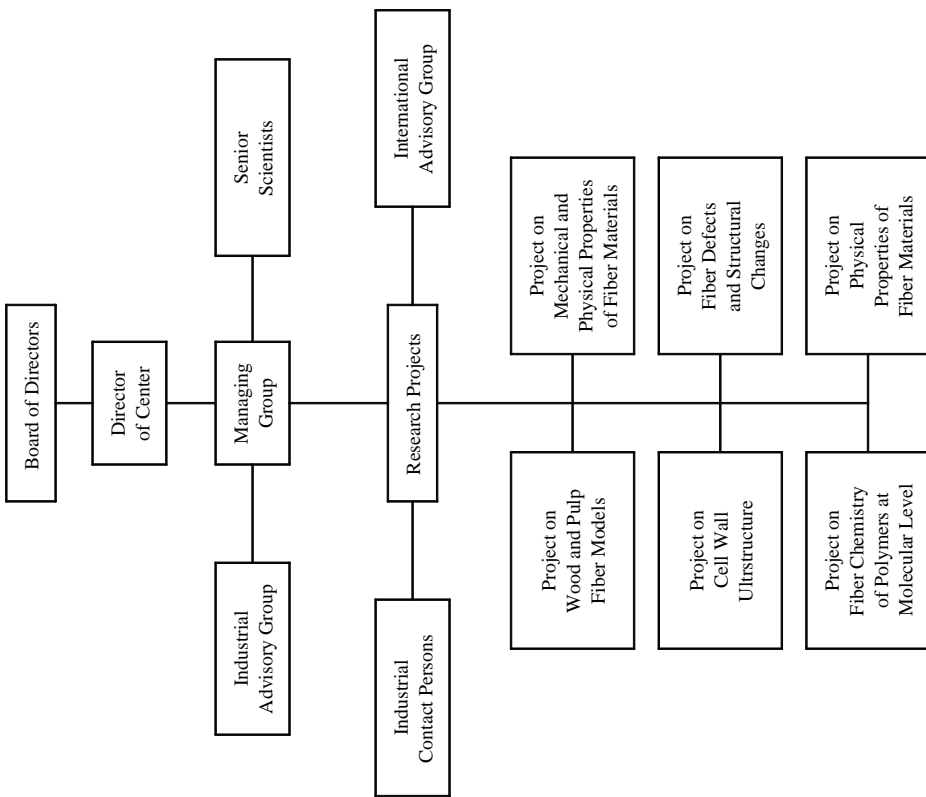
* Library, Laboratories, Editorial Publications, Information Management, Computer Network

South Africa: Institute for Commercial Forestry Research

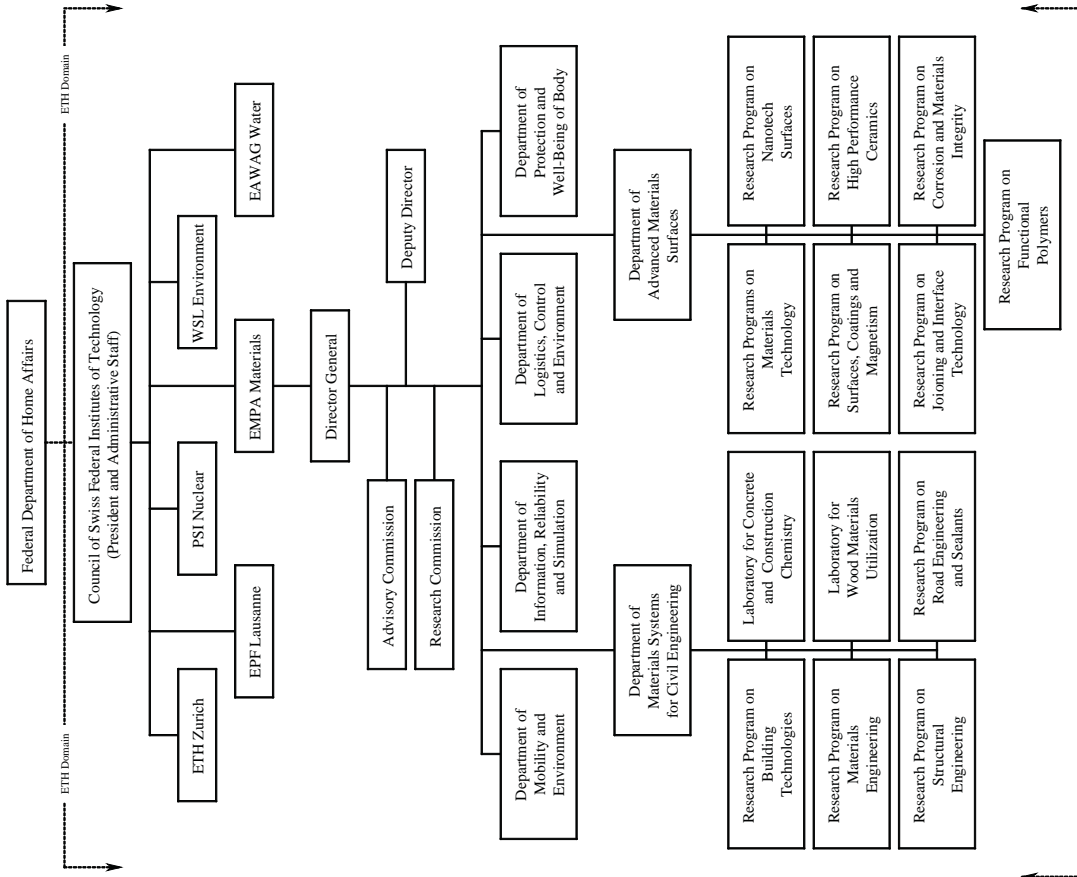


Sweden: Swedish Pulp and Paper Research Institute/
Institute for Packaging and Logistics (STFI-Packforsk)

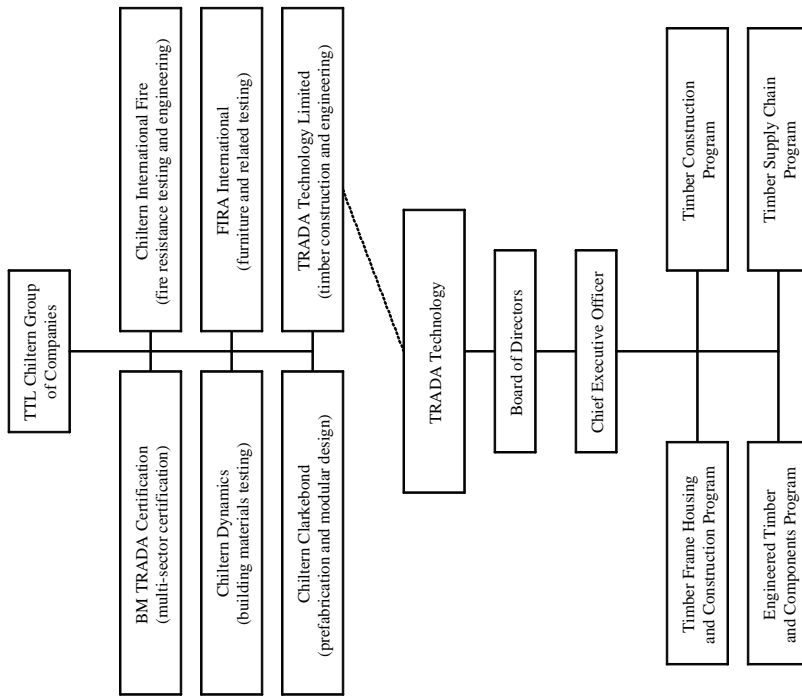
Sweden: Swedish Institute for Wood Technology (SP-Träteknik)



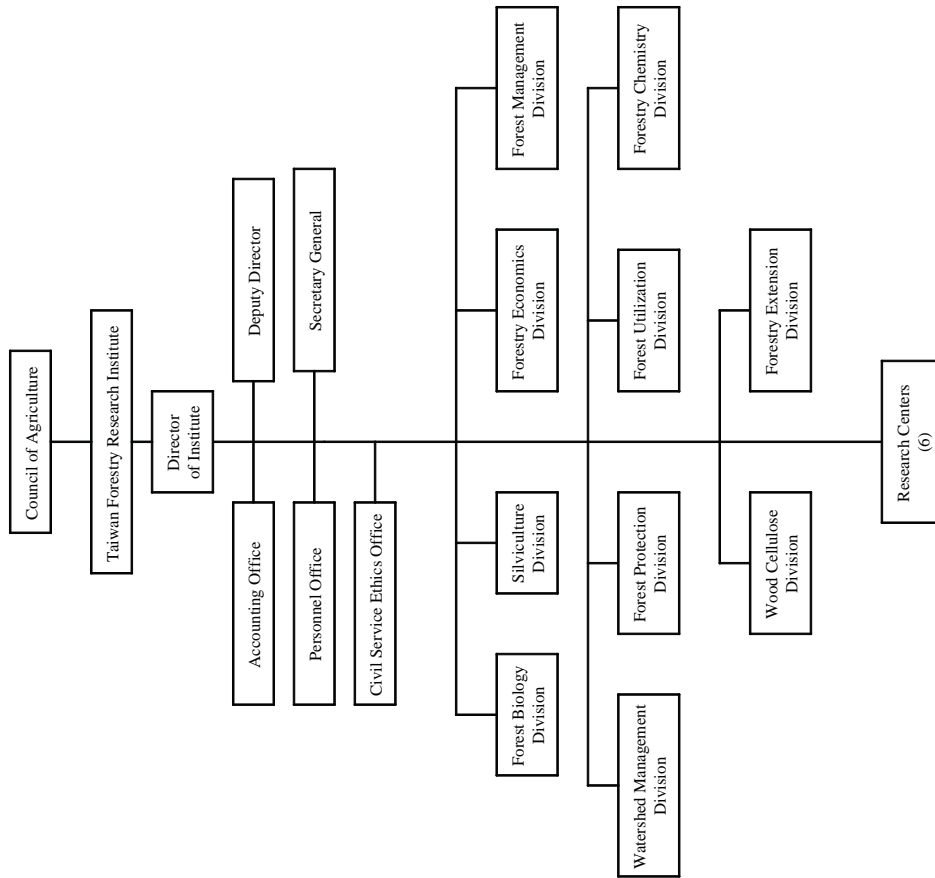
Sweden: Wood Ultrastructure Research Centre (WURC)



Switzerland: Swiss Federal Laboratories for Material Science and Testing (EMPA)



United Kingdom: Timber Research and Development Association (TRADA)



Taiwan: Forestry Research Institute (TFRI)

Appendix C—Design Standards for the Structure and Administration of Organizations

Organizations Generally

In general, the organizations we surveyed possessed the following attributes:

- Mission and goals are socially meaningful, deserving of praise, and are viewed as especially worthy of pursuit. Employees are motivated by mission and goals and are engendered with a sense of personal self-worth because of them (Carnevale 2003).
- The structure is simple and straightforward, enabling employees and outsiders alike to understand who performs what functions, who has the authority to take actions, and why such functions and authorities exist (Gibson and others 1994, Ranson and others 1980).
- Responsibility and accountability are clearly assigned, ensuring that no major decision or action goes without review and possible modification. Integrated ongoing systems exist for evaluating performance, and the organization has a welcoming attitude toward the need for adjustment in direction and emphasis (Eliadis and others 2005).
- The organization has flexibility in structure and managerial capacity, allowing for redirection of operations and the assumption of new responsibilities, new methods and procedures, and new persons with different specialties. The organization is also able to creatively respond to external threats to its assigned mission and responsibilities (Gibson and others 1994, Hughes 2003).
- The organization provides deliberate communication of accurate and timely information, both within the organization and to client groups served by the organization. Communication is an integrated part of efforts to consistently work to provide client groups with sought-after services and products (Johnson 1992, Rosenbloom and Goldman 1986).
- The organization displays a confident and forceful interest in securing the sustainable flow of human and financial resources necessary to accomplish assigned goals and objectives. The organization is able to act on opportunities worthy of investment and bases such investment opportunities on good science and sound financial and economic analyses (Gibson and others 1994, Gordon 1992).
- The organization has the capacity to resolve ongoing internal disagreement over priority in mission and in goals and objectives. It is capable of preserving order and consistency in procedures (Gordon 1992).

Research Organizations

Successful research organizations share the following tactics:

- They have a clear understanding of the organization’s research “niche” (for example, applied versus basic research, training versus testing) and a secure view (strategic direction) of the technological needs and opportunities in the chosen niche. Continuous monitoring of the research organization’s strategic and operational plans, giving ample opportunity to adapt to changing technological and business environments (Arnold and others 1998, Rush and others 1996).
- The organization shows a special sensitivity to the research needs of client groups and the relationship of such needs to the expertise available within the research organization. The organization has a particular concern with creating awareness of the organization’s capabilities, maintaining very close (on-site) contact with clients within an industry (or government), and giving special attention to key client groups that are major contributors to the economy or to society (Bremser and Barsky 2004, Grier 1996).
- They are part of a unified organization with an overriding mission to serve clients, rather than a collection of loosely-connected technological fiefdoms each going separate ways. The organizations provide a range of services to clients that incorporate many opportunities for interaction between clients and technical staffs. These organizations assertively search for “feedback” from clients that use new technologies developed by the research organization (Arnold and others 1998, Goldman and others 1997).
- Leadership and managerial staff set a tone that emphasizes technical excellence and a service orientation. Leadership with a background in industry and in technical fields is helpful to organizational performance, but not a necessity. It is more important to internalize client and researcher linkages (Goldman and others 1997, Thamhain 2003, von Zedtwitz 2003).
- Successful research organization have quality, hard-working research staff with a high level of expertise and communicate and interact regularly with industry. The organizations make incentives available that promote staff advancements and encourage staff to work for the goals of the organization, both as an individual and as part of teams (Gassmann and von Zedtwitz 1998, Grier 1996, von Zedtwitz 2003).
- Researchers show sensitivity to industrial operating priorities and pressures and a willingness to often compromise technical perfection to meet market and production needs. These organizations show a special concern for the

relationship of new technologies and the cost to industry of their adoption (Arnold and others 1998).

- They separate governance responsibilities, especially formal separation of guidance and oversight on strategic matters (responsibility of governing board of directors) from guidance on technical matters (responsibility of technical advisory body). The overall composition of governance boards and advisory groups are strongly weighted in favor of industry (Arnold and others 1998, Ingham and Mothe 1998)
- They have extensive linkages (formal or informal) with research-supporting organizations, both public and private and within and outside the research organization's chosen niche (for example, universities, foundations, industry, government agencies, special interest groups). They also need a willingness to enter into partnership with other research organizations (especially partnerships based on trusting relationships, complementary assets, and mutual research experiences) (Ingham and Mothe 1998, Carayannis and Laget 2004).
- These organizations competitively offered funding sources that encouraged business-oriented structures and management schemes. They avoid total or entire organization funding by government, especially when mechanisms do not exist for ensuring that services are being provided to well-defined client groups. Public funds focused on basic research activities, while applied research (near-market) funded by individual firms or commodity groups (industry levies or check-offs) (Alston and others 1997, Arnold and others 1998, Billings and others 2004, Goldman and others 1997).
- They continuously scan broader technological environments and seek to identify, and as appropriate, acquire and master new advanced technologies. They avoid pushing the technological frontier far beyond the technologies that clients are able to use (Coccia 2004, Goldman and others 1997).
- They aggressively diffuse new technological capabilities across the economy generally or to especially relevant sectors of the economy (Coccia 2004, Goldman and others 1997).
- They prominently place performance measures in a management scheme, especially performance viewed from a financial perspective (return on investments), client perspective (retention rate), business perspective (time to adoption), and growth perspective (budget and revenue) (Alex 1998, Bremser and Barsky 2004, Thamhain 2003).

Forest Products and Forestry Research Organizations

Successful forest products and forestry research organizations share the same tactics:

- They establish clear national and regional priorities for investment in high-quality relevant research programs that have a client focus at both the domestic and the international levels. They operate with a long-term strategic view of science as an investment (Aldwell 1998, Fryk and Nordansjo 1998, Lundgren and others 1994, Spilsbury and others 1999).
- They create a high standard of awareness of the organization's research programs and encourage periodic critical review and assessment of research priorities, including subsequent strengthening of institutional research capacity that is required to address such priorities (International Task Force on Forestry Research 1988).
- They are capable of effectively accommodating major changes in the environment for research, including competition for financial resources and professional talent, attention to performance and accountability (planning, prioritizing, evaluation), justifying reasoning for public research programs, emphasis on collaboration and cooperation, and increased attention to the direction and management of research programs (Blyth and others 1998, Ellefson and Ek 1996).
- They focus on clients served by research programs and not unduly on institutional infrastructures. They relate measures of performance to knowledge generated and used by clients, not simply on measures of program inputs: for example, the number of staff employed, trends in budgets, and number of research publications (Spilsbury and others 1999).
- They are organizationally structured along issues or problems (for example, risk management, product commercialization, manufacturing systems) rather than along disciplines or products (for example, chemistry, composites, pulp and paper) (Aldwell 1998).
- They promote extensive research networking by scientists and program managers, doing so with a strong leadership commitment to networking, ample rewards for long-term engagement in networking activities, emphatic interest in communication and the sharing of materials and experiences, resources sufficient to participate in networking activities (for example, computers, travel), and well-defined issues toward which networking is focused (Bengston and Gregersen 1988, Burley 1989, Hytonen 2001, Lundgren and others 1994, Parker and McFadden 1990).

- They foster and participate in formally structured co-operative research activities (for example, alliances, cooperatives, joint ventures), especially where research interests and goals are similar, multi-disciplinary specialized research skills are required, high-cost equipment and facilities are beyond the means of a single organization, and the scale of research programs and research organizations are inadequate (Blyth and others 1998, Ellefson and Ek 1996).
- They embrace progressive research management processes and skills, especially processes that promote efficiency and effectiveness in the interest of improving performance and that lead to a suitable balance between the short-term needs of clients and the funding required to support the organization's long-term relevance (Blyth and others 1998).
- They promote employee competence and pride in accomplishing organizational goals and objectives. Remuneration and career development are competitive with equivalent fields. Special consideration is given to employees with exceptional talents and those that are party to fields considered to be highly competitive in the marketplace (Blyth and others 1998, Lundgren and others 1994).
- They focus on direct and identifiable beneficiaries of the research activities and seek payment for the value of the services provided. They make fee-for-service funding an important (but not exclusive) part of the organization's overall funding strategy, recognizing that by doing so the value of research becomes increasingly clear and more appreciated, responsiveness to clients becomes more focused and timely, research becomes more relevant to commercial interests, and attention to financial and project management increases (Aldwell 1998).
- They seek to maintain an appropriate blend of public and private funding of research programs. For research involving a high rate of return, low risk of uncertain results, and a single or a small group of clients, private funding is considered proper. Public funding sought for research where markets are imprecise (dispersed) for the products of research, assignment of intellectual property rights is unclear (for example, uncertain patent conditions), gains by an individual firm or small group of firms are insufficient to cover the costs of research, sustained funding of long-term research is uncertain, and there exists broad public interest in focusing on research that will benefit certain social and economic segments of society (for example, rural economic development) (Hellstrom and others 1998, Hyde and others 1992).
- They recognize the virtues of research funded by private sources but acknowledge that the long-term consequences of an inordinate emphasis on such sources can be chancy. Long-term consequences may be limited support for research infrastructures, reduced freedom to explore

high-risk but large payoff research opportunities, possible compromising research objectivity and neutrality, and a diversion of attention away from important long-term research projects (Aldwell 1998, Hellstrom and others 1998).