PART 3

Dissemination of Knowledge

If knowledge from the projects is disseminated—either through products and processes commercialized by the innovators or through publications, patents, and other modes of knowledge transfer—it may benefit other producers in the economy and, subsequently, consumers. The resulting national benefits may go far beyond the returns to the innovating firms and the benefits to their customers.

Multiple Ways of Disseminating Knowledge

New knowledge developed in a project can be diffused in a variety of ways. This section discusses two principal means: through patents filed and granted by the U.S. Patent and Trademark Office (USPTO) and cited by others, and through preparation of technical papers that are published or are presented at conferences. Collaborative activity among research and commercial partners, treated in Part 1, is another way by which knowledge is disseminated. Another way is through the observation and reverse engineering of the new goods or services produced directly by the innovators and their partners, discussed in Part 4. Among the other important ways—not explicitly covered here—in which knowledge developed in a project can be diffused are informal interactions among researchers, suppliers, customers, and others; movement of project staff to other organizations; distribution of nonproprietary project descriptions by government funding agencies; and project-related workshops and meetings.

Pathways of knowledge dissemination allow others to obtain the benefits of R&D without having to pay its full cost. When the technology is particularly enabling—in the sense of providing radically new ways of doing things, improving the technical bases for entire industry sectors, or being useful in many diverse areas of application—the spillover benefits to others are likely to be particularly large.[2]

[2] The generation of spillover benefits, or positive externalities, from technological advancement is an important argument for public support of enabling technologies.

Balancing Intellectual Property Protection and Knowledge Dissemination

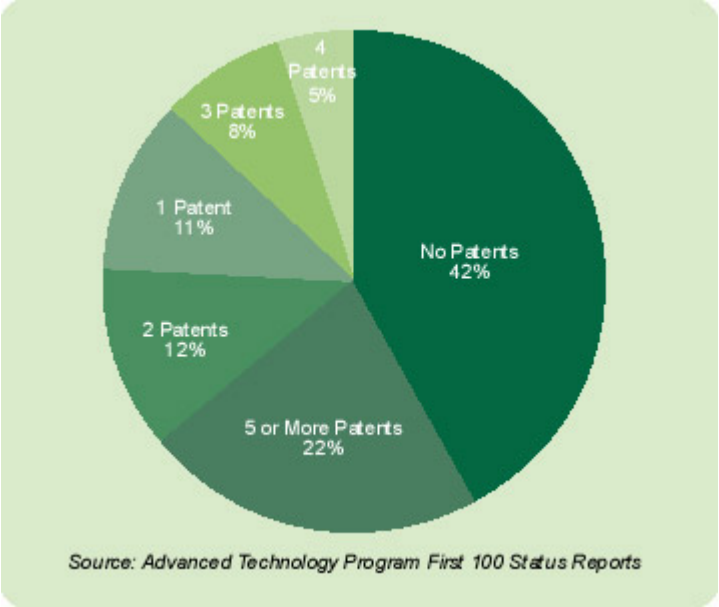
ATP encourages broad dissemination of knowledge produced in ATP-funded projects because it increases the number of potential users of the knowledge and, therefore, may increase national benefits. At the same time, ATP does not force innovating companies to compromise their ability and willingness to pursue early commercial applications of the technology by giving away all of their intellectual property. After all, these companies, which contribute a substantial share of the costs, have agreed to tackle difficult research barriers and to take the technology to the marketplace as rapidly as possible.

Thus, it is not surprising that the amount of knowledge dissemination varies among the projects. Most of the projects pursue some forms of deliberate knowledge dissemination, such as publishing scientific papers, giving presentations, and forming collaborative relationships. Most projects also engage in considerable unintended knowledge dissemination; for example, as a company's scientists move and work among other companies and universities; as myriad formal and informal discussions occur; as others reverse-engineer their products; and through mergers and acquisitions of the innovating companies.

Public Disclosure of Patent Filing Information

When applying for a patent to protect intellectual property, an inventor must explicitly describe the invention. Because patent law requires that the invention is both novel and useful, the inventor must demonstrate that the invention is essentially different from any other invention and must describe how it can be used. When the USPTO grants a patent, the full application text

Figure 3.1 Distribution of Projects by Number of Patents Filed



Source: Advanced Technology Program First 100 Status Reports

describing how the invention may be used and how it is related to other technologies is put into the public record and becomes a medium through which knowledge is transferred to others. Hence, patents serve to disseminate knowledge.

At the same time, patent data are not perfect signals of knowledge creation and dissemination. Despite the limitations, patent statistics serve as useful indicators of knowledge creation and dissemination, and they are widely used by researchers. The decision to seek patent protection for intellectual property is influenced by many factors, including the ease with which others can copy the property's intellectual content and the difficulty of defending the patent position from infringement. Some companies may decide that patent protection is not worth its expense or that a strategy of trade secrets and speed-to-market is more effective. Conversely, patents may be filed as the basic ideas are forming, and trade secrets used in later stages. Furthermore, the importance of patents as a strategy varies among technology areas; for example, patents figure more strongly in electronics and manufacturing than in computer software. The absence of a patent does not mean that intellectual property was not created. But the presence of a patent is a signal that it was created.

Of the 100 completed projects, 58 had filed 326 patents at the time the study data were collected.[3] Fifty-one of the projects had among them a total of 202 patents granted, or 60 percent of the total filed. Twenty-two of the projects had filed a total of 124 patents for which a final decision on granting was still pending.

Figure 3.1 displays the distribution of the 100 projects by the number of patents filed, whether granted or not yet granted. More than half the projects have filed one or more patents. Participants in 11 percent of projects had filed a single patent, 25 percent had filed 2 to 4 patents each, and 22 percent had filed 5 or more patents. Forty-two percent of the projects had yet to file a patent.

Knowledge Disseminated by Patents as Revealed by Patent Trees

Each published patent contains a list of previous patents and scholarly papers that establish the prior art as it relates to the invention. The citations provide a way to track the spread of technical knowledge through patents granted to ATP-funded projects. By following the trail of the patent referenced, it is possible to construct what looks much like a horizontal genealogy tree.

Once the pool of ATP-related patents was identified, computerized tools made available by the USPTO were used to track subsequent patents that refer to each of the ATP-related patents as prior art and the links recorded.[4] The process is then repeated in turn for each of these patents, until the chain of references is complete. Next, the information is converted into a graphic format that illustrates the diffusion of knowledge along the path from ATP project patents in the tree.

With the passage of additional time, new branches may emerge as outgrowths of earlier patents. To the extent that later patents are dependent on the earlier ones, the patents in the tree represent developments in knowledge that would not have occurred, or at least not in the same timeframe, had ATP not stimulated the creation and dissemination of that platform knowledge.

Patent Tree Illustrating International Knowledge Dissemination

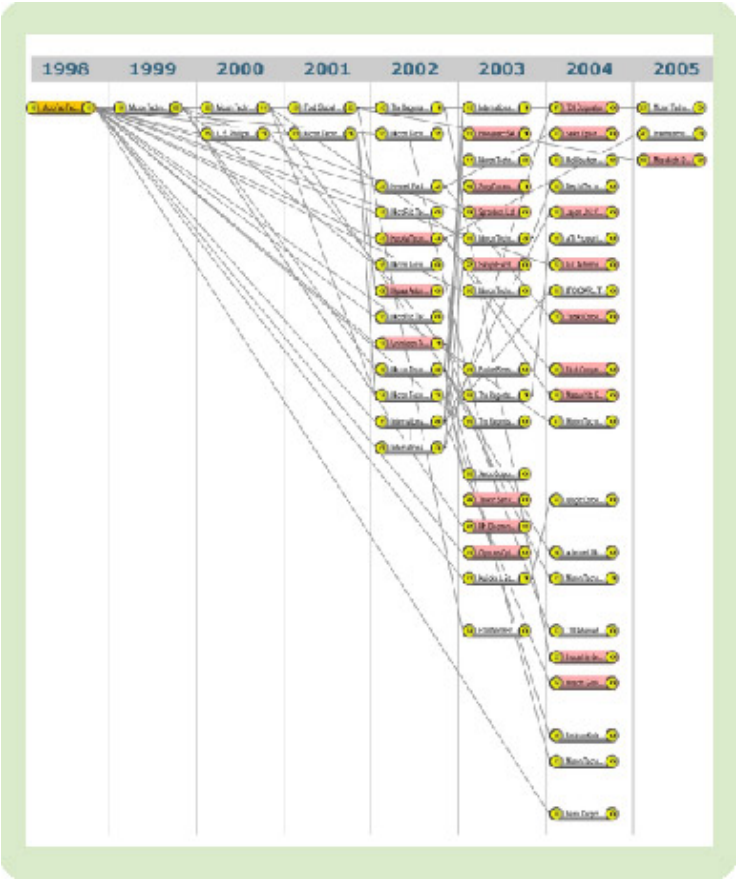
Figure 3.2[5] is a patent tree for 1 of the 100 completed projects, a project to develop liquid solder-jetting carried out by MicroFab Technologies, Inc., a small company based in Plano, Texas.

[3] Patents filed and not yet granted are included here, in addition to those filed and granted, despite the fact that there is no public disclosure until patents are actually granted. The reason for including patents filed and not yet granted is to help offset the problem that there are substantial differences across industries in the lag time between patent filing and granting.

[4] The references to prior patents contained in a published patent are based on information supplied by the applicant and on research by USPTO researchers. There is no way to distinguish between the two sources and no indication that one tends to dominate the other. (USPTO telephone interview with ATP staff, February 11, 2000.)

[5] Patents highlighted in pink are assigned to foreign companies.

Figure 3.2 Patent Tree for MicroFab Technologies, Inc. – Patent 5,772,106
Project Impact through Knowledge Dissemination



The company received five patents for technologies resulting from its ATP-funded project. Patent number 5,772,106, granted in 1998 and entitled “Printhead for liquid metals and method of use,” involved a printhead assembly used for depositing molten solder droplets, without the need for fluxes and without conducting the operation in a confined chamber, into a semiconductor substrate. In the following 6 years, 19 patents that directly cited the MicroFab patent were granted to 13 companies. Some of the companies that benefited from the knowledge were Hewlett Packard Company, Micron Technology, Inc., and Ferro Corporation from the United States, as well as Unimicron Technology Corporation, Ltd. from Taiwan, Kuroda Techno Corporation and Olympus Optical Company Ltd. from Japan, and Luk. Automobiltechnik GmbH & Company from Germany. At the end of 2004, a total of 56 patents, which directly or indirectly cite the MicroFab patent, were granted to companies from 8 countries, including France, Sweden, Korea, and the Netherlands.

As explained in the project status report for MicroFab Technologies, Inc., the ATP award was instrumental in allowing the company to collaborate with and attract additional funding from a consortium of five major electronics manufacturers (Motorola, Delco, Texas Instruments, Kodak, and AMP) to further develop its technology. These relationships also had the potential to improve the ultimate diffusion of the technology.

The patent tree in Figure 3.3 shows citations of a patent that came out of an ATP-funded project led by TopicalNet, Inc. (formerly Continuum Software) during which they developed MultiPly™, a technology allowing business programmers to develop scalable business applications without having to learn parallel programming. Though TopicalNet achieved technical success, at the time the project was completed, venture capital was not available because the computer industry was focused on Y2K compliance. This situation made it difficult for the small start-up company to market its innovative software application. For this and other reasons, TopicalNet did not market MultiPly™.

The patent tree illustrates how an ATP-funded project whose direct path appears to have slowed or has come to a standstill nevertheless has the potential to remain influential along an indirect path of knowledge utilized and cited in subsequent patents. As the patent tree illustrates, a number of other companies are referencing the TopicalNet patent, and the potential for beneficial impact from the research continues. (See http://statusreports-atp.nist.gov/reports/94-06-0034.htm.)

Figure 3.4 shows citations by other companies of a patent resulting from a project led by Ingersoll Milling Company. Though the company went bankrupt, the patent tree illustrates how knowledge can outlive its creator and continue to be disseminated. An observer who equates business success of the innovator, one-to-one, with ATP project success may be mistaken, because the indirect path may nevertheless produce important benefits.

Figure 3.3 Patent Tree for TopicalNet (formerly Continuum Software) – Patent 5,999,729
Project Impact After Innovator Reduced Activity

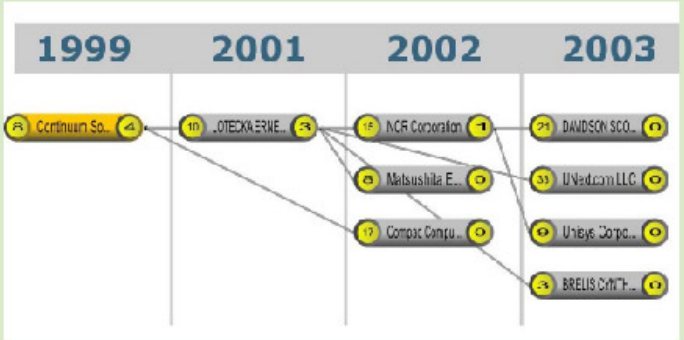


Figure 3.4 Patent Tree for Ingersoll Milling Company – Patent 5,392,663
Project Impact Where Innovator Went Bankrupt

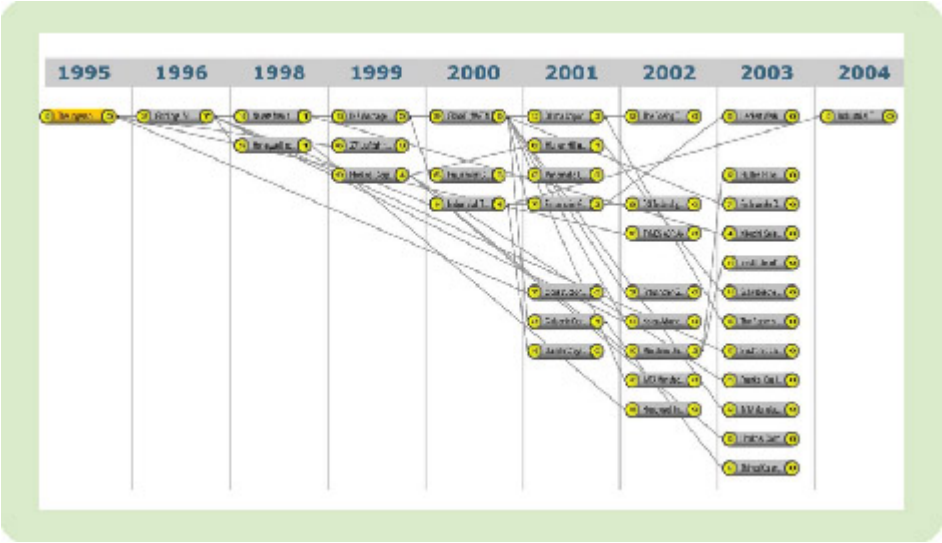
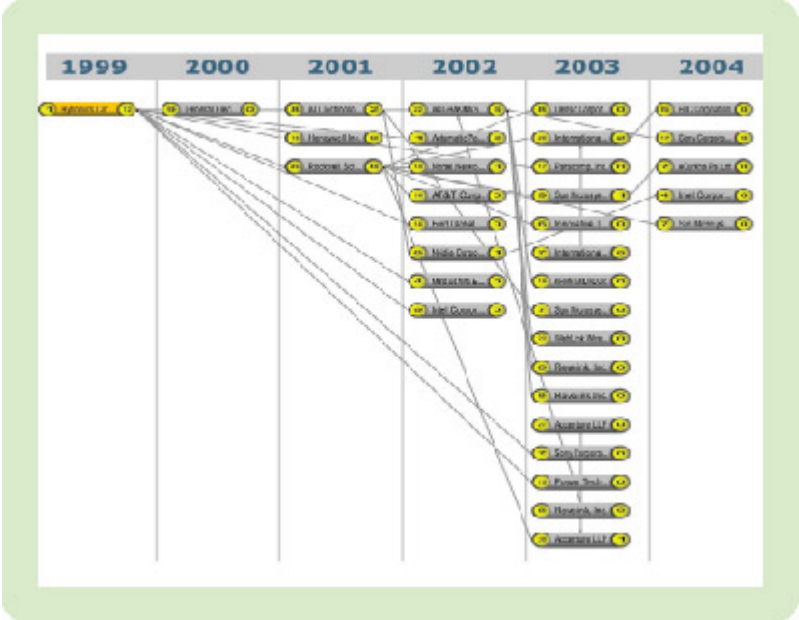


Figure 3.5 Patent Tree for Hynomics (formerly Sagent Corporation) – Patent 5,963,447
Example of Extensive Knowledge Flows



Patent Tree Illustrating Extensive Knowledge Flows

Figure 3.5 illustrates just how complex knowledge dissemination through patent citations can become. The path shown is for a patent resulting from an ATP-funded project led by Hynomics (formerly Sagent Corporation). The project developed a workforce optimizer and people scheduler using hybrid systems, automata, and control theory. Hynomics has entered into a number of partnerships involved with commercializing their technology. As shown in the patent tree, the work has generated substantial interest as demonstrated by the number of citations of their patent.

For projects that have received a patent or patents, access to patent trees is available through the individual status reports on the NIST ATP website (http://statusreports-atp.nist.gov/basic_form.asp). All patent trees for the first 100 status reports were updated as of June 2004. Although representing only one aspect

of knowledge dissemination, the patent trees extend awareness of the influence of the new knowledge.

Knowledge Dissemination through Publications and Presentations

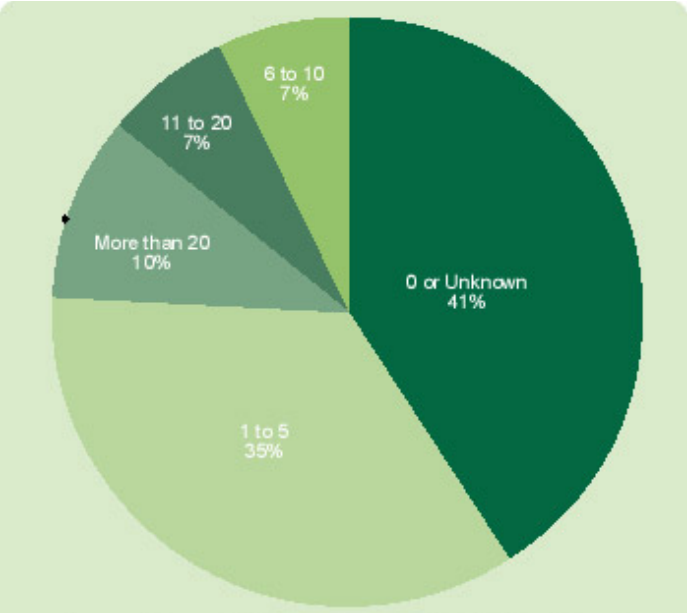
Participants in almost 60 percent of the 100 projects had published or had presented papers in technical and professional journals or in public forums. Participants in about half of all projects had published, and the number of publications totaled at least 393 papers. Participants in nearly 40 percent of the projects had given project-related presentations, and the number of presentations totaled at least 443. Overall, publications and presentations for these 100 projects equaled or exceeded 836.

Figure 3.6 gives the distribution of projects by their numbers of publications and presentations. Thirty-five percent of the projects each had between one and five papers published or presented. Seven percent had between 6 and 10 papers published or presented, and another 7 percent had between 11 and 20. At the high end, 10 percent of projects each had more than 20 papers published or presented. Forty-one percent had no known presentations or publications.

Knowledge Dissemination through Other Means

Aside from publishing, presenting, and patenting, ATP-funded projects have a high rate of collaborative activities. Eighty-two percent of the projects showed some type of collaboration (see Table 1.1). With so many partners, collaborators, and subcontractors involved, it would be difficult to secure the information. The involvement of so many participants in the projects provides rich avenues of further interaction, and those interactions in turn may increase knowledge flows through personal and professional contacts.

Figure 3.6 Distribution of Projects by Number of Publications and Presentations



When the government enters into an agreement with an organization, certain information about the agreement is generally made public. Such is the case with ATP and company cost-sharing partnerships. Nonproprietary information has been disclosed to the public for each of the 768 projects funded by ATP in 44 competitions held from 1990 through September 2004 (project information is available on the ATP website[6]). Further, new nonproprietary project descriptions are added to the site as new awards are made. Evaluation reports, such as this one, are also available at ATP's website and provide information to the public.

ATP organizes and sponsors public workshops, where companies present non-confidential aspects of their ATP-funded research and engage in open discussions. These workshops facilitate information flow among ATP award recipients and from the recipients to other companies, ATP project managers, other government program managers, the press, potential investors, and universities. Public meetings, presentations by ATP staff, and other events are posted at ATP's website.

When a product or service incorporating new technology reaches the marketplace, a buyer can learn a great deal about the technology. The mere functioning of a new product reveals some information. Intentional investigation, including reverse engineering, reveals even more. More than 60 percent of the 100 projects reviewed for this study had some commercial products or processes based on ATP-funded technology already on the market. Therefore, product use and examination are providing others with information about the new technologies.

[6] http://jazz.nist.gov/atpcf/prjbriefs/listmaker.cfm or http://atp.nist.gov (go to Funded Projects Database).