CHAPTER VI
SUMMARY, IMPLICATIONS, ISSUES AND CONCLUSIONS

The purpose of this study was to examine the process and impact of government laboratory technology transfer, based upon a qualitative comparative analysis of successful cases before and after passage of related legislation. The two key laws, passed in the mid- and late-1980s, were intended to encourage cooperative research for commercialization purposes.

This last chapter discusses certain of the study's findings presented in the previous chapter. It summarizes the positive findings, and provides implications and issues related to both positive and negative findings. Some of the findings are combined for purposes of discussion and drawing conclusions. The second section of the chapter discusses the lessons learned from this study about technology transfer measurement and evaluation.

No doubt some of the broad societal factors noted in the background section of the literature review chapter (defense conversion, increased attention to global competitiveness, etc.) influenced the outcomes documented through this study. It is impossible to know with total accuracy whether the legislation -- as opposed to other factors -- produced the study's findings. In order to control for other factors, a control group would need to be built into the research design up front. However, this project involved retrospective research.

ASSESSING THE EFFECT OF THE LEGISLATION

<u>Roles of the Laboratory Researchers and Other Personnel</u>

The findings showed that the laboratory researchers' roles continued to involve research, publishing, speaking at technical conferences, producing prototypes and samples, and serving as champions. However, aspects of these roles changed from the pre-legislation period to the post-legislation period.

The findings showed that the laboratory researchers produced more laboratory prototypes and samples. This indicated more proactive technology transfer, but also raised a potential longer-term structural issue related to funding. A higher level of prototyping activities may cause pressure to identify potential sources of funding unless royalty revenues (or other income) support these activities. A dramatic trend toward increased prototyping by many laboratories could signal a move away from basic research towards applied research and even later phases of development.

Although the researchers continued to serve as technology champions in both time frames, closer analysis showed that the champion role changed. In the pre-legislation cases, the champion role took the form of demonstrations, not only for proof-of-concept, but also for technology marketing purposes. In the post-legislation cases, once CRADAs were signed, the researchers roles as champions were funneled towards their close working relationships with their CRADA partners rather than technology marketing.[1]

In addition to this "funneling" effect of CRADAs, the efforts of the technology transfer staff to maintain objectivity in technology transfer may have been downplaying the champion role. The researchers were not involved in deal-making with potential industry partners. This may have been a factor of the complexity of the deals, and the need for the laboratory negotiators to have strategizing skills matching those of their private-sector counterparts. However, a by-product of the researchers being excluded from agreement negotiations is that they may feel that no one is looking out for their individually-vested interests which doesn't help to engender trust.

The implications of a change in the researchers' champion role are that laboratory researchers are doing less marketing and are focusing their energies on their partners, so that the technology transfer staff is losing the marketing assistance of the researchers. Therefore, the technology transfer staff must be prepared to take on more of the role of technology champion and marketing agent.

Neither the pre-legislation nor the post-legislation cases contained many examples of formal market analysis or technology evaluation work with the exception of the Forest Products Laboratory (FPL). In this regard, it is appropriate to view commercialization efforts within the context of laboratory missions. For example, the mission of certain laboratories (like FPL) inherently involves working with industry and other users, so such commercialization initiatives are more "normal" for them than other laboratories (such as the defense laboratories and NASA field centers). As a result, it is difficult to measure degrees of proactivity in this area, but a positive aspect is that the industry-oriented laboratories can serve as models for the others in this area.

It is important to have business-oriented skills in order to assess the validity, value, and marketability of a technology,[2] particularly when technology transfer is demand-centered and market-oriented, as noted. Whose role is it to perform market assessments or to determine the commercial value of the technologies? The unclear responsibilities and lack of attention in this area point to a need for position descriptions and performance expectations that reflect these roles appropriately. If individuals in the laboratories do not have or acquire these skills, another option is to contract out these activities which makes it all the more important to understand the associated time and costs. Some researchers gave the impression of being "intuitively aware" of their technologies' commercial prospects. This type of information could supplement the formal analyses, but it would require good communications between the researchers and technology

[1]For example, the microwave oven scientist was motivated and enlivened by his interactions with the younger scientists at the partnering company whom he mentored. Similarly, in the artificial heart case there was a good deal of interconnectivity and mutual respect between the laboratory researchers and their CRADA partners.

[2]For example, one researcher mentioned that he filled the laboratory's technology transfer position on a part-time basis which is not uncommon in smaller laboratories. In such situations, the individuals are more likely to have scientific skills than market analysis skills.

transfer staff. However, as noted, in the post-legislation cases there was a tendency for the research and technology transfer function to be even less connected as manifested by the effort to "objectivize."

In terms of the researchers' roles, the findings also indicated an undercurrent of caution towards technology transfer in both the pre-legislation and post-legislation cases. A 1985 FLC study[3] determined that less than half of the technology transfer respondents would be willing to visit the site of a potential outside user. If the same survey were administered today to researchers, the results might not be that different. According to the post-legislation cases, the laboratory researchers were still somewhat reluctant to pursue technology transfer which is likely the result of a lack of awareness on legislative intent. The cases in both time frames showed that it took a long time for laboratory researchers to learn about legislative provisions encouraging technology transfer (eg., CRADAs or consulting opportunities related to inventions).[4] The agencies could focus more attention on elevating awareness of the legislation and ensuring that regulations are consistent with the legislation. For example, the cases showed that certain laboratories still have policies or rules prohibiting entrepreneurial leaves of absence (while others are inconsistent in their approaches).[5] Researchers may become entrepreneurial if their laboratories adopt explicit policies and programs in this area. Also, government technology transfer and commercialization training programs may help to address this awareness problem. Most existing training programs are focused on technology transfer personnel. The Navy is one of the few agencies focusing this type of training on scientific and technical personnel; perhaps this is an option to be considered by other agencies. In addition to the laws, the cases suggested certain other topics for "awareness-raising" such as protecting intellectual property while marketing technologies, yet sharing enough information so that the user has a need to license the technology.[6] Another potential training topic suggested by the cases is the repercussions of inadvertently disclosing proprietary and sensitive company information accessible through public-private partnerships.

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[3] *Interagency Study of ORTA Organization and Operation and Lessons Learned Case Studies in Technology Transfer,* Federal Laboratory-Industry Interaction Working Group of the Federal Laboratory Consortium, DOE/METC-85/6019, May 1985.

[4] In the past, for example, even if an agency granted authority to its laboratories to allow laboratory employees to do consulting, the individual laboratories did not necessarily permit it to happen. This was not only a disincentive to the researchers, but also a hindrance to the partnering companies that needed help.

[5] Although it is probably less of a necessity for those policies to be consistent throughout the laboratory system.

[6] The 1980s alginate herbicide/pesticide case shows that laboratory researchers may need time to garner some experience in handling potential partners. The lead scientist in the 1990s microwave oven case addressed the potential disclosure problems involved in serving as marketing agents. Further, increased international activity and use of the internet means that scientists must be careful in the timing of publishing articles because this could mean the loss of both domestic and foreign rights.

Throughout most of the cases in both time frames, a tension was "sensed" between the technology transfer function and the research function, although this was not necessarily explicitly identifiable. Technology transfer inherently brings together different professions (and cultures) who have a responsibility to work together closely. In such an environment, difficulties or points of irritation would naturally become more apparent, whereas they may be hidden in other scenarios. Thus, success presents the challenge of addressing heightened sensitivities and perhaps misunderstandings about technology transfer. The examples cited were oriented toward maintaining some objectivity which indicates that more of an attempt is being made to be specific about roles and responsibilities in response to this highly sensitive working environment.

To encourage more trusting relationships among those who are part of the technology transfer process, perhaps compensation packages can be designed so that a laboratory team (the technology transfer staff along with the research team) is judged on how it works together toward successfully implementing technology transfer mechanisms and agreements. The technology transfer staff, alone, cannot cover all the necessary contacts with the partnering firms (the corporate research team, marketing staff, etc.). And, as noted, the laboratory researchers were discouraged from conducting outreach past a certain point in time. Yet, coordinating as a laboratory team could accomplish this objective. Encouraging teamwork is probably best accomplished through through laboratory compensation packages rewarding teamwork rather than through legislative amendments.

As a closing thought on the topic of roles, one laboratory technology transfer officer recently noted that the truest metric of technology transfer success is the barometer of the laboratory researchers and their research managers; if they don't feel the technology transfer function is supporting them, he said, then there is a problem.[7] So, the question of roles hinges on relationships between the researchers and technology transfer officers. Supporting that relationship and managing the expectations related to it is of paramount importance.

Funding, Financing

The technology transfer legislation did not affect other aspects of laboratory activities, but nevertheless raised policy implications based upon the findings. In terms of government funding, the post-legislation cases showed an increase in small-firm involvement, and several cases involved Small Business Innovation Research (SBIR) recipients, but no recipients of the Small Business Technology Transfer (STTR) program which was established specifically for small firms to partner with government laboratories or universities. This may reflect the fact that the STTR program is relatively new[8] and the fact that the amount of government funding for SBIR is more than that for STTR. On the other hand, the STTR program may need to be promoted to various audiences such as FLC awardees.

[7]Christopher D. McKinney, Oak Ridge National Laboratory, Presentation on Panel Session, "Why Can't We All Get Along?", Association of University Technology Managers 1998 Annual Meeting, February 27, 1998.

[8]Enacted in 1992, initiated fiscal year 1994.

Intellectual Property

The findings also showed that laboratory (and company) patenting increased in the post-legislation cases. The enhanced interest in patenting presumably was the result of the improved incentives for both researchers and laboratories provided by the legislation. However, increased patenting on the part of the laboratories may yield to more selective patenting in the long run due to the cost of patenting and the potential for increased royalty revenues based upon market analyses and technology evaluations. Many high technology firms strategically manage their intellectual property, and the case of the thermoplastic material case provided an example of licensing a technology to "round out" the firm's intellectual property portfolio in a technology area.

Technology Transfer Mechanisms

Findings related to technology transfer mechanisms showed a lack of differences between the pre-legislation and post-legislation cases. In both time frames, the laboratories emphasized CRADAs and licenses to transfer technologies. They used other technology transfer mechanisms to a lesser degree, and the post-legislation cases exhibited slightly less variety in mechanisms than the pre-legislation cases. Neither the pre-legislation nor the post-legislation cases had many examples of mechanisms like scientific user facilities and reimbursable work as they relate to technology transfer, and there were no examples of personnel exchanges.

Is it effective for government laboratories to rely on one or two standard mechanisms such as CRADAs and licensing? In their favor, licensing-related issues for both time frames declined over time. And CRADAs have certain advantages over older mechanisms like procurement contracts or memorandums of understanding (such as allowing joint development work without creating conflicts of interest). Nevertheless, in both time frames, both researchers and private partners expressed some negative views toward CRADAs, indicating the laboratories should not rely exclusively on this mechanism.[9] However, the implications are that both government and industry may need incentives to use other mechanisms. With personnel exchanges, for example, possible incentives could include permitting tax deductions on the part of industry or earmarking funds for government personnel to exchange scientific and technical personnel.

The researchers' comments about license royalty-sharing indicated their strong feelings in this area, and the strong feelings increased in the post-legislation cases. This shows that royalty-

[9]For example, in one case, it was implied that the guarantee of exclusive licenses offered to CRADA partners by the 1995 act hinders the laboratory's negotiating position in terms of agreed-upon royalty rates, which is counter-productive to the royalty incentives for laboratory researchers. The researcher in another case had some negative comments about CRADAs and the technology transfer function, but asked not to have this documented on the record.

sharing as an incentive is working but, as a result, certain implementation issues related to royalty-sharing may need to be examined. As suggested by the cases, for example, the "greed factor" may come into play when multiple inventors are involved. This will necessitate dispute mechanisms such as at the level of individual laboratories, or at the agency level, or government-wide. Also, the scientists may not be getting the level of business support needed from their laboratories in the form of regular statements to track their royalty income (such as through the laboratory finance office). Further, there may be a need for guidelines regarding the disposition of royalties or other income from unpatented technology licensing[10] or commissions from revenues resulting from other technology transfer mechanisms such as user fees. Lastly, references to the lack of uniformity among agency incentives raised the issue as to whether the minimum royalty-sharing provisions of the 1995 Technology Transfer and Advancement Act apply to contractor-operated laboratories. (DOE, with its numerous contractor-operated laboratories, is taking the position that the act applies only to government-owned and -operated laboratories.)

User Groups

In terms of process, technology transfer was practiced more efficiently and effectively in the post-legislation cases than in the pre-legislation cases. The post-legislation cases involved more small firms, indicating that fairness-of-access prevailed for the small-firm partners. They also exhibited more user-initiated contacts, indicating more market pull than technology push. In addition, the users narrowed from broad groups to targeted markets in the post-legislation cases. Further, the post-legislation cases exhibited improved systemic effects of the legislation such as more "institutionalized" university relationships.

Barriers to Commercialization

The barriers to commercialization did not appear to be "in-house" problems such as lack of management support, in either the pre-legislation or post-legislation cases.[11] The laboratories' private partners experienced problems in their commercialization efforts, particularly in the post-legislation cases. The private partners had problems in scaling-up, difficulties in marketing highly-technical products, and partnership problems. However, it is questionable as to whether public solutions are appropriate. How far should government laboratories go in assisting the private sector with commercialization roadblocks? Economic conditions and prevailing politics dictate that typical private sector problems are not amenable to, or appropriate for, public policy solutions and, therefore, don't warrant government involvement.

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[10]Although less common than patent licensing.

[11]As noted earlier, the military and weapons laboratories are often cited in this area, yet the cases did not exemplify this problem. For example, in the post-legislation cases, the following laboratories and researchers aggressively marketed their technologies: (1) the Air Force team funding the speech coder, (2) the Navy light-stick researchers, and (3) the DOE Oak Ridge weapons complex.

In any case, the overall benefits of the technology transfer legislation to the private sector partners were clear. It is hoped that ultimately realizing such benefits on an individual basis would help to ameliorate any difficulties experienced during the commercialization process. The laboratory/company relationships in the cases appeared to be viable, productive and mutually-beneficial relationships, even though the laboratories and companies each had different objectives, with the laboratories being focused on their missions and the companies on profitability.

User Benefits/Economic Impact/Outcomes

The findings and analysis of the series of cases indicated that the technology transfer legislation had positive effects in terms of user benefits, economic impact, and outcomes. The indicators showed that, in comparing the pre- and post-legislation cases, new products (generated as a result of technology transfer) increased from sixteen in the pre-legislation cases to 114 in the post-legislation cases. Similarly, sales revenues increased from "a few thousand dollars" to $7.7 million. New companies increased from zero to six, and new jobs increased from zero to 348 net jobs generated. Also, the post-legislation cases exhibited fewer technology transfer and commercialization failures (inactive licenses, etc.) than the pre-legislation cases.

In addition, the cases showed that technology transfer contributions to dual use and similar types of government gains increased in the post-legislation time frame. The Pentagon has enhanced its dual use initiatives in the 1990s, but the findings in the cases resulted from efforts to transfer technologies rather than from those programs, indicating government technology transfer is helping to diversify the military-industrial base.

Furthermore, in addition to greater economic impact and government gains, the findings showed that government laboratories and their partnering firms became faster in getting products to market. Perhaps as a result of their close working relationships with private-sector partners, the laboratories are becoming more sensitive to the issue of timing in moving a technology from the laboratory into the commercial sector.

International Activity

In both the pre-legislation and post-legislation cases, government laboratory technology transfer was the domain of domestic companies, but these firms were doing quite a bit of international commercial activity. Government policy circles have worried for years about whether the laboratories should give preference to domestically-owned firms in carrying out their technology transfer activities. The cases indicated this is not necessary now, but it may be worth monitoring in the future.

The second implication in the international area relates to the international commercial activity becoming more prominent in the post-legislation period. Certain companies in the cases sought patents overseas, yet the U.S. laboratories did not file for foreign patent rights. This is surprising with the increased emphasis on global technology sectors and recent changes in NAFTA, GATT, and U.S. Department of Commerce regulations. The lack of interest in foreign patenting probably comes from a combination of the lack of good market data plus the large costs in foreign patenting, but this cannot be determined strictly from the cases. The agencies may need criteria for determining the need for foreign filing so that their technologies are protected, marketed and used overseas if appropriate.

Economic Development, Technical Assistance

In both the pre-legislation and post-legislation cases, the findings indicated a lack of interaction between the government laboratories and state and local governments as users. In both time frames, they also indicated a lack of interaction between high-technology companies and state and local governments as service providers.

The small amount of work being undertaken by the laboratories for state or local government users was surprising. One of the two cases that involved state and local government work was the Navy penetrometer case at Stennis Space Center, which was not a surprise since the government entities located at Stennis are traditionally known for their outreach to local communities.[12] Why aren't other laboratories making more of an effort to reach out to neighboring jurisdictions and assist their school systems, public works departments, economic development groups, etc.? Given that the incentives for companies to be involved in technology transfer are rooted in commercial returns, perhaps the commercial incentives provided by the legislation are similarly causing the laboratories to focus on the more lucrative commercial aspects and to ignore state and local government needs for technical assistance.[13]

The total lack of use of state- and locally-provided economic development and management/ technical assistance services by the partnering companies was surprising. Either those services are doing an inadequate job of outreach to potentially needy high-tech firms, or the services aren't needed, or the services may be targeted toward a different audience than the partners in the cases in this study. In any event, the interview question addressing this topic did not directly relate to the overall research question regarding whether recent technology transfer legislation has made a difference. Rather, it was asked as a matter of peripherally-related interest. Perhaps the interview question should have addressed the use of public (or private) technology venture funds rather than economic development broadly.

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[12]The other case involving state and local government work included one of the lightstick companies working with local high schools.

[13]Not to be confused with the state and local government "market" that purchases high-tech equipment such as computers and police cars, albeit a disaggregated one with widely varying requirements.

LESSONS LEARNED - TECHNOLOGY TRANSFER EVALUATION

The literature review chapter of this dissertation attempted to show that the measurement and evaluation of technology transfer is a major issue in the technology transfer community for a variety of cited reasons. There is a relative lack of experience in technology transfer evaluation, as well as a lack of measurement models. There are a handful of individuals who are successfully making progress in this area as it relates to government laboratories, including Chapman, Bozeman, Roessner, Link, Papadakis, and others. This list expands to include Tornatzky, Feller, and even others from the closely-related state and university communities. Each of these researchers has attempted to explain some of the contradictions and complexities in "metrics" for the technology transfer field (and how it differs from traditional evaluation), and their observations were highlighted in that chapter and/or referenced in footnotes. Based upon the early findings of this study's literature review, the methodology for this study was carefully designed to try to overcome the expected problems and pitfalls. In the tradition of the experts noted, the lessons learned about technology transfer metrics through this study are shared below.

In this study, in both the pre-legislation and post-legislation cases, the researchers and partners described their successes many ways. Therefore, documenting technology transfer results in a consistent fashion for comparison or benchmarking[14] purposes was problematic in both time frames. The findings from this study suggest that the agencies could consider some approaches to addressing this and other problems if they are not already doing so. Various recommendations are discussed in more detail below. In short, some minimum requirements for technology transfer metrics are: acceptance of a wide variety of indicators; complex intangible measures; particularly long measurement periods; mandatory feedback (with no enforcement capabilities!); ironclad data protection efforts; interagency coordination to eliminate double counting; and documentation of failures (with no incentives to do so!).

Experiment With a Greater Variety of Indicators

The interviewees in this study were not required to answer the question about economic impact or outcomes in any particular way. As a result, the findings both validated the typically-used indicators for measuring technology transfer and revealed a variety of additional indicators such as the: amount of commercial space occupied, percentage of market share, level of teamwork, new market opening, taxes paid by the private partners, gain of a unique patent position, and speed-to-market advantage. With a little experimentation on the part of the agencies, some of these indicators could become used consistently enough to be comparable. Many agencies already track or document other indicators used in the cases (license royalty revenues, number of publications and literature citations, and number of awards), and they may want to think about using these statistics more publicly if they are interested in furthering technology transfer. The variety of indicators shows that technology transfer involves several

[14] Benchmarking can be referred to as the gathering of standardized measures across programs. It helps to identify best practices and program improvement opportunities.

sets or types of measures: those related to commercial activity, those related to scientific milestones, and those related to laboratory missions. The overall recommendation here is for the agencies to continue concentrating on the most important and most useful impact indicators, but also be flexible in adding others to the repertoire which may, with repeated use over time, yield unexpected results and useful patterns.

Legitimize Intangible Measures for Less-Common Mechanisms

From the cases, it appears that some of the less common technology transfer mechanisms cannot be associated with typical indicators. Several cases, particularly in the pre-legislation time frame, did not involve commercial successes although the technologies contributed to public objectives:

- The not-fully-commercialized penetrometer was used to help neighboring state and local jurisdictions, providing productivity gains in that arena.

- The commercially-unsuccessful laser-based method was used in cancer research in hospitals and other settings; also, it contributed to improving the laboratory's image.

- The commercially irrelevant radiation therapy quality assurance program provided medical benefits, contributing to improved quality of life.

- The tracer technology was used for testing purposes, making indirect contributions to commercial success (such as when a builder improves air circulation in its structures).

Rather than CRADAs and licenses, these cases involved technology transfer mechanisms such as standards-setting, scientific user facilities, technical assistance, and consulting. With these mechanisms, there appeared to be few accepted means to measure their contribution because of the distinctively intangible nature of the resulting successes. As long as the laboratories continue to use these albeit lesser-used mechanisms, the agencies need to acknowledge their inherently less-tangible measurement approaches as legitimate. Otherwise, the means for categorizing the successes is lost. Thus, the agencies could consider providing incentives for using (and systematically documenting) the lesser-used mechanisms, particularly technical assistance to state and local governments.

Accept Longer Measurement Periods

Although the findings showed that the time to market has decreased, they also confirmed the long-term nature of technology transfer relative to political administrations. This verifies that longer time frames are necessary to properly assess legislative impact in this area. This also has significant implications for the political tendency to change direction with each new administration.

Team With Partners to Measure, and Document in Agreements

As technology transfer is increasingly practiced with partners, its measurement and evaluation also needs to be a teaming effort. Laboratories and agencies cannot determine ultimate economic or societal impacts without input from their private partners. For example, bartering products for services or intellectual property, as was the situation in a couple of the cases, makes economic impact measurement difficult and complicated, and only the private partner can help to sort out the value of such trades. To assist this measurement process, the partnering agreement (eg., CRADA) could specify the precise type of information (ie., which measures will require quantification) to be disclosed by the partner, the time period, and how the information would be protected and reported (in the aggregate, individually, anonymously, etc.).

Take Care with Confidential Company Information

The study also suggests the laboratories should take care with confidential company financial and business information. A systematic series of cases is useful for research purposes such as this study, but the experience of implementing this study suggests that a retrospective case study approach would be an expensive means for the agencies to collect basic economic impact statistics in the aggregate.[15] In addition to the expense, another problem inherent to an individual case study format is that privately-held companies in extremely competitive markets are not willing to divulge sales revenues, certain financial data[16] and other proprietary information.[17] The point is that, with more CRADAs and similar public-private partnering, senstitive company information is often available to the in-house laboratory personnel working with the company. Laboratory personnel must be careful when handling this type of information, because if improperly revealed to one of the company's competitors, it could undermine the company's competitive position or result in the loss of intellectual property rights.

Avoid Double-Counting

The cases exhibited examples of both incremental and revolutionary applications of

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[15]Individual cases can also be useful for other purposes such as communication with politicians, technology marketing, or public relations, but for those uses the cases would not necessarily need common elements or formats.

[16]For example, the capital investments and other leveraged outside investments that were discussed under the topic of funding could be used as additional indicators of success; however, the firms were not willing to share enough detail for this indicator to be useful.

[17]Information on industrial activities, such as launching new products or agreements, is also sensitive company information. In two cases, the laboratory researchers said major business deals were "in the works" but couldn't be discussed until after official announcements. In both cases (the Oatrim case and one of the herbicide/pesticide cases), the details were soon revealed in newsletter articles.

technology. Revolutionary applications are easier to track than incremental ones because they can be directly attributed to a particular source.[18] However, since incremental applications do occur, in tabulating government-wide technology transfer metrics, it is important to avoid the double counting that may result when agencies tally up the technology transfer results of their entire laboratory system. This points out the importance of an interagency coordination effort.

Document Failures

The fact that several of the spinoff businesses failed but were replaced by successful ones shows that it is important for the agencies and laboratories to document both successes and failures, thereby revealing the net result or reason for failure.[19] For example, the original spinoff company the gravity meter case employed twenty persons before going out of business; however, the two "replacement" spinoff companies employed ten people altogether. As another example, among the failed products and inactive technology licenses in the pre-legislation cases were those of the thermoplastic material case. The inventor thought one or two of the licenses had been rescinded (perhaps under march-in rights), but was not certain (and neither the technology transfer office nor the company knew). Since the government has rarely exercised march-in rights, this is another example of a failure from which we could learn, if the information were only available. Naturally, agencies will be reluctant to document failures because this may reveal program weaknesses. However, it is important to keep in mind that metrics are not just for program justification, but also for program improvement.

Ultimately, the call for standards in measuring technology transfer will become louder and may lead to the creation of a forum to sort out and build consensus upon the measurement and evaluation methods. This will allow comparisons among common programs and/or laboratories, contributing to a more rational budgeting process and improved communication. Over time, this would promote more efficient allocation of scarce budget dollars.

[18]For example, the alginate-based herbicide/ pesticide case shows that, as incremental applications and variations on the base technology gradually unfold in other geographical areas and institutions, the original inventor begins to lose credit. This is unfortunate, and it is obvious why the inventor would be interested in tracking these variations and may have difficulties doing so.

[19]Currently, there is a debate within the small business policy community about the accuracy of small firm statistics because it is charged that they only count firms starting up or in existence during a given year and do not include firms that cease to exist.