*The Impact of Immersion Training
on Complementing Organizational Goals
and Accelerating Culture Change*

A Field Study

RECEIVED

APR 09 1996

OSTI

Los Alamos
NATIONAL LABORATORY

MASTER

Los Alamos National Laboratory is operated by the University of California
for the United States Department of Energy under contract W-7405-ENG-36.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This thesis was accepted by the Department of Management of Technology, National Technological University, Fort Collins, Colorado, in partial fulfillment of the requirements for the degree of Masters of Science. The text and illustrations are the independent work of the author and only the front matter has been edited by the CIC-1 staff to conform with Department of Energy and Los Alamos National Laboratory publication policies.

An Affirmative Action/Equal Opportunity Employer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither The Regents of the University of California, the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by The Regents of the University of California, the United States Government, or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of The Regents of the University of California, the United States Government, or any agency thereof. The Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; therefore, the Laboratory as an institution does not endorse the viewpoint of a publication or guarantee its technical correctness.

*The Impact of Immersion Training
on Complementing Organizational Goals
and Accelerating Culture Change*

A Field Study

Sarah M. Hayes

Table of Contents

Table of Contents.....	v
Acknowledgments.....	vii
Preface.....	viii-x
Abstract.....	xi-xii
Part I. Introduction	1-9
Part II. Literature Review	10-15
Part III. Research Structure	16-18
Part IV Research Methodology	19-22
Part V. Research Results	23-37
Part VI. Interpretation of Results and Conclusions	38-43
Part VII. Perspectives for Further Research	44-45
Bibliography	46-54
Appendix A The Innovation Process	
Appendix B Post-Workshop Evaluation Form	
Appendix C Research Survey Results	
Appendix D Return-On-Investment Report	
Appendix E Interview Questions	
Appendix F Large Volume Flow -Through Detector Commercialization Time-Line	

Acknowledgments

I thank the management of Los Alamos National Laboratory for the encouragement and support in allowing me to become a transformational leader and to conduct an administrative field experiment in affecting culture change through piloting commercialization training at Los Alamos National Laboratory. One of the key management issues I address on the job, and an issue I chose to research in conducting this field research project, involves the question, "How does an institution with limited budgets *maximize* the impact of training?"

Special thanks goes to Jim Shipley, my "company mentor," who constantly and consistently urged me to plow new ground. Marcia Rorke, President of Mohawk Research, was a key collaborator in introducing commercialization training to Los Alamos principal investigators. Donna Berg, Los Alamos librarian, contributed excellent research assistance. Melissa Miller deserves recognition for leading the pilot commercialization training through implementation stages while at the same time researching her own Field Research Project. Dr. David Lux, my academic advisor, should be commended for helping this action oriented administrator consider and understand the pedagogical aspects of research. Special thanks to Dr. Pat Unkefer, CPW™ #1 alumnus, for hours of thought provoking discussion and helping me analyze the survey results from a scientist's perspective.

And to the professionals (Pete Lyons, Director of the Los Alamos Industrial Partnership Office, Deborah Wince-Smith, Council on Competitiveness, and Jim Shipley, Industrial Fellow of Los Alamos National Laboratory) who read and critiqued this Field Research Project, your insight and comments are invaluable to me. Last but not least, all the CPW™ alumni should be commended for the quality of their action plans and their sustained efforts in embracing the new order of things.

Preface

"There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success than to take the lead in the introduction of a new order of things."

Niccolo Machiavelli

At Los Alamos National Laboratory, a national defense laboratory with a history of working in seclusion and secrecy, scientists and engineers have received an important new mission to partner with industry. The scientists and engineers need to expand their skill base beyond science and understand the business of innovation to be successful in this new environment. An administrative field experiment of conducting intensive, immersion training about the commercialization process was piloted at Los Alamos in September, 1992. This Field Research Project addresses the following research question: **"Does "immersion" commercialization training complement organizational goals and does the method accelerate cultural change?"**

In recent testimony to Congress, Los Alamos Director Sig Hecker said, "Industrial interactions continue to be a key contributor to the scientific vitality of Los Alamos National Laboratory. I view working with industry not as an option but as a business necessity."¹ In addition, an organizational goal that is now included with the Laboratory's mission statement is to become a *learning organization*.

In September of 1992, I was faced with a major challenge as Manager of Technology Integration for the Environmental Management Program at Los Alamos National Laboratory. The challenge was to increase substantially the

¹Hecker, Siegfried S., *Testimony before the Subcommittee on Military Procurement, Committee on National Security, United States House of Representatives*, March 29, 1995

number of commercialized environmental technologies developed at the Laboratory. Partnering with industry was a necessity and the individual principal investigator's skills at industry partnering was key in realizing any success. I developed a plan (an experiment) to pilot and introduce immersion commercialization training for the individual scientists.

In preparing to undertake this Field Research Project, I came to the realization that I had used my position as a manager to conduct an administrative field experiment. The field experiment first began as a pilot Commercialization Workshop conducted for twelve scientists in September, 1992. The objective of the pilot was to create commercialization action plans for promising environmental technologies. At the same time the pilot afforded me the opportunity to evaluate and determine if the immersion style of commercialization training yielded substantive results. Results were defined as significant attitude change (willingness to partner with industry) and well-developed commercialization implementation action plans.

The immersion method was also compared to the indoctrination method of training. The indoctrination training was a one-day lecture style session conducted for one hundred and fifty scientists in July, 1993. The impact of the training was measured by perceived attitude change and the number of subsequent industrial partnerships that followed the training.

The key management question I addressed on the job was, "With a limited budget, how do we maximize the impact of training and achieve the best results?" The pilot immersion workshops and the indoctrination session were conducted well before this field research project began. In the course of doing my job I collected evaluation data from the pilot workshop and from the indoctrination session which serve as retrospective analysis in this field research project. In addition to retrospective data, the new work for this project includes a survey instrument, structured interviews, and a case study.

This Field Research Project will describe the background, methodology, and results obtained from implementing the immersion training approach in the context of accelerating culture change and complementing organizational

goals. In addition to presenting findings I will offer areas that require additional research and attention.

The Impact of Immersion Training on Complementing Organizational Goals and Accelerating Culture Change

A Field Study

**by
Sarah M. Hayes**

ABSTRACT

At Los Alamos National Laboratory, a national defense laboratory with a history of working in seclusion and secrecy, scientists and engineers have received an important new mission to partner with industry. The scientists and engineers need to expand their skill base beyond science and understand the business of innovation to be successful in this new environment. An administrative field experiment of conducting intensive, immersion training about the commercialization process was piloted at Los Alamos in September, 1992. This Field Research Project addresses the following research question: **"Does "immersion" commercialization training complement organizational goals and does the method accelerate cultural change?"**

In preparing to undertake this Field Research Project, I came to the realization that I had used my position as a manager to conduct an administrative field experiment. The field experiment first began as a pilot Commercialization Workshop conducted for twelve scientists in September, 1992. The objective of the pilot was to create commercialization action plans for promising environmental technologies. At the same time the pilot afforded me the opportunity to evaluate and determine if the immersion style of commercialization training yielded substantive results. Results were defined as significant attitude change (willingness to partner with industry) and well-developed commercialization implementation action plans.

The immersion method was compared to the indoctrination method of training also. The indoctrination training was a one-day lecture style session conducted for one hundred and fifty scientists in July, 1993. The impact of the training was measured by perceived attitude change and the amount of subsequent industrial partnerships that followed the training.

The key management question I addressed on the job was, "With a limited budget, how do we maximize the impact of training and achieve the best results?" The pilot immersion workshops and the indoctrination session were conducted well before this field research project began. As a course of doing my job I collected evaluation data from the pilot workshop and from the indoctrination session which serve as retrospective analysis in this field research project. In addition to retrospective data, the new work for this project includes a survey instrument, unstructured interviews, and a case study.

###

Part I. Introduction

Los Alamos National Laboratory

J. Robert Oppenheimer said of the scientists who gathered to develop the atomic bomb, "It was a remarkable community inspired by a high sense of mission, of duty and of destiny...coherent...dedicated...remarkably unselfish...devoted to a common purpose."² This is the root of the "culture" of Los Alamos, a remarkable community with a devotion to a common purpose. However, with the end of the Cold War, there is no longer a single, driving purpose, but instead a new mandate to reduce the nuclear danger and at the same time apply science and technology solutions to civilian challenges such as health, environment, and infrastructure concerns. The Laboratory's Tactical Goal #6 emphasizes developing industrial partnerships. The objective of the tactical goal is to partner with industry to transfer technology that will increase the nation's competitiveness in a global marketplace.³

Organizational Goals-Partnering with Industry

In 1989, DOE defense laboratories were mandated by law to partner with industry. Los Alamos National Laboratory, along with Lawrence Livermore and Sandia, are the Department of Energy's defense laboratories. In total, there are over 700 DOE research laboratories and the Department of Energy annually spends \$6 billion on R&D.⁴ Los Alamos' FY 95 budget was \$1.08 billion. Six years ago, Congress passed the 1989 National Competitiveness and Technology Transfer Act (NCTTA), which amended the Stevenson-Wydler Technology Innovation Act of 1980 to establish technology transfer as

²Bennis, Warren, *On Becoming a Leader*, Addison-Wesley Publishing Company, 1989

³*Tactical Goals for Alamos National Laboratory FY95*, January 20, 1994

⁴U.S. Department of Energy, "The Basis for U.S. Department of Energy Technology Transfer in the 1990's," Sink, Claire H. and Easley, Kevin, *a research paper*, 1993

a DOE agency mission and provided the defense laboratories with Cooperative Research and Development Agreement (CRADA) implementation provisions. Los Alamos recently signed its 150th CRADA with industry. The cumulative value in CRADAs at Los Alamos has passed \$350 million.⁵

Last year the Director's Office sent a memo to all management that began, "Working with industry is a major thrust of the Los Alamos National Laboratory." ⁶ The memo continued on to direct all managers to explore the extent to which every employee could contribute to partnering with industry and to advise supervisors to take into positive account employee partnering with industry in performance appraisals. In addition, the memo stated that positive contributions to working with industry should also be taken into account in determining employees' compensation. Clearly, partnering with industry is an organizational goal.

The Learning Organization

Another organizational goal (and vision) that is now included with the Laboratory's mission statement is to become a learning organization. The vision reads, "We will exemplify a creative, learning organization that forms strategic partnerships with government, academia and industry, and values integrity, excellence and public service."⁷ A learning organization is defined as an organization that values and thinks competitive advantage derives from continued learning, both individual and collective.⁸ One of the characteristics of effective organizations is that "the organization operates in a *learning* mode. It sees itself as always "in process," continually assessing the current state of things and consciously planning improvements."⁹

⁵Hecker, Siegfried S., *Testimony before the Subcommittee on Military Procurement, Committee on National Security, United States House of Representatives*, March 29, 1995

⁶Hecker, Siegfried S., Director, Los Alamos National Laboratory, "Performance Appraisals and Industrial Interactions, *Internal Memo*, June 7, 1994

⁷The Newsbulletin, *Employee Newsletter*, December 16, 1994

⁸Dumaine, Brian, "Mr. Learning Organization", *Fortune*, October 17, 1994

⁹Beckhard, Richard and Harris, Reuben T. , *Organizational Transitions-Managing Complex Change*, Addison-Wesley Publishing Company, second edition, 1987

Training and the Learning Organization

Traditionally government organizations introduce new training and organizational initiatives by indoctrination rather than by continuous learning. This indoctrination approach is focused on reaching the largest number of people. It is most often shallow in content and always broad in scope. Instead of selecting key influencers in the organizations to train deeply (which is exemplified in the immersion approach), and then rely upon the influencers to affect change, the indoctrination approach reaches as broad an audience as possible. Prime examples of the government's indoctrination approach are the recent Department of Energy "stand-down" (where all operations cease) on quality practices and the Navy's "stand-down" to implement sexual harassment awareness training. Every employee is required to spend one day being "indoctrinated" learning new concepts.

In contrast, the immersion approach trains selected individuals intensely in content. The audience of influencers is select and narrow. The immersion approach reinforces key messages, themes, and codes of behavior. Often, this focused and deep training is complemented by follow-on training and continuous learning.

A learning organization must invest in effective methods that support learning and accelerate change. The question is whether indoctrination or immersion training is most effective. As a member of the management team of a learning organization, Los Alamos National Laboratory, I was committed to conduct training that would support learning and accelerate change. Training hours and numbers of people trained were not important metrics to me. Instead, the degree of change and the amount of return to the organization is what mattered.

This field research project is a result of Los Alamos' commitment to become a learning organization. This project will evaluate the effectiveness of implementing training to complement the organizational goal of partnering with industry. It will also evaluate the impact of immersion-style training on accelerating culture change.

The word "culture," is distinct from organizational *climate*, which is a measure of the morale or happiness of a staff at any particular time. *Culture* is a set of artifacts, beliefs, values, norms, and ground rules that define and significantly influence how the organization operates.¹⁰ The ground rules are changing at Los Alamos and the culture is in transition.

The new Congressional mandates since 1989 to partner with industry, and the vision of Sig Hecker, the Laboratory Director, to do the same is a big change from the previous *modus operandi*. In the current new-hire orientation video, Sig Hecker is quoted saying, "People's roles are going to change."

Table 1 presents key cultural changes in values and norms that are required to move from the Cold-War era to today:

KEY CULTURE AND OPERATIONAL CHANGES REQUIRED FOR SUCCESS	
The Past	Today
•Success may require sharing know-how.	•Success may be based on proprietary technological advantage.
•Secure and secret.	•Encouraged to talk and communicate.
•Publications and prestige important.	•Publications may be embargoed by industry partner for competitive advantage.
•Success possible from individual achievement.	•Success requires partnering and teamwork.
•Intellectual property in the public domain.	•Companies may protect intellectual property for five years.

Table 1

¹⁰Beckhard, Richard and Harris, Reuben T. , *Organizational Transitions-Managing Complex Change*, Addison-Wesley Publishing Company, second edition, 1987

As an institution, Los Alamos has acknowledged the need to change. One of the important things to do along this line is to determine the institutional readiness and capability for change. Assessment of the readiness involves an analysis of the attitude toward change. Readiness for change has to do with willingness, motives, and aims. Capability to change involves power, influence, authority to allocate resources, and the possession of information and skills required to carry out the necessary tasks.¹¹ In *Organizational Transitions-Managing Complex Change*, Richard Beckhard makes four very relevant comments about the change process:

1. If tradition, norms, and ways of work are firmly entrenched, some "unfreezing intervention" will be needed to break people away from their deeply held attitudes or behaviors and ready them to try something new.
2. Some temporary systems and projects may need to be set up if present structures are unable to institute change.
3. Some educational activities may be called for if new information, technical knowledge, or skills are required to achieve change conditions.
4. In a complex change process there is a critical mass of individuals or groups whose active commitment is necessary to provide the energy for the change to occur.

Beckhard's first point is particularly important. In 1992, faced with the organizational challenge to significantly increase the level of technology commercialization in the Environmental Management program, I realized that training and an "unfreezing intervention" were called for. Also, to reach success, a critical mass of individuals would have to benefit from the unfreezing intervention and enjoy subsequent success for the intervention to have impact. In April, 1992 the methodology for intervention was chosen. It was immersion-style training. As an intervention methodology, and as a practical way to develop commercialization action plans, the immersion style

¹¹Beckhard, Richard and Harris, Reuben T. , *Organizational Transitions-Managing Complex Change*, Addison-Wesley Publishing Company, second edition, 1987

Commercialization Planning Workshops™ (CPW™) were first offered to scientists at the laboratory in September, 1992.

The Management Question

The big question facing management was, "What is the most effective training scheme to encourage behavior change and achieve results? Is it the "broad and shallow" or the "narrow and deep" approach? Clearly the cost per person decreases significantly if you compare \$50,000 per 12 students (\$4166 per student) vs. \$50,000 per 150 students (\$333 per student). But what is the ultimate return on the \$50,000 investment in training?

If the "broad and shallow" indoctrination (1-day lecture approach), does not reach the student, deliver tools, or affect behavior change you essentially have wasted \$333 per student at a net loss on the investment of \$50,000. If however, the "narrow and deep" immersion-style 4-day approach reaches the student, delivers tools, and affects behavior change, the \$4166 per student investment is worthwhile when the student brings in new partnerships and funding to the laboratory. This recently happened with a CPW™ alumnus leading an Advanced Technology Program call for proposal effort which won a \$15M award. Appendix D shows data that for 65 students, the projected return on investment for FY 95 was \$12,400,000 which averages to a \$190,769.23 return on investment per student. The "narrow and deep" immersion style training yielded a strong return.

Commercialization Planning Workshops™

The Commercialization Planning Workshops™ were introduced to the scientists in September, 1992. These four-day, immersion-style workshops included: basics of the innovation process, individual faculty consultations, and the development of twelve-month commercialization action plans based upon the participant's own work. Understanding the concept that the innovation process includes *concurrent* technical, business, and marketing development is the fundamental learning objective of the workshop. This is referred to in the workshop as the Innovation Process. A chart of the innovation process is attached in Appendix A. The Commercialization Planning Workshops™, were developed for Los Alamos by Mohawk

Research Corporation based upon similar innovation workshops developed by Mohawk Research for other government agencies and the private sector.

The first group of twelve scientists was selected for workshop participation by the Environmental Management-Office of Technology Development of the Department of Energy and environmental managers at Los Alamos National Laboratory. The pilot workshop was sponsored by the Environmental Program of the DOE. The Assistant Secretary of DOE at the time, Leo Duffy, said "If all we do is clean up the DOE complex, it is not good enough. We have to partner with industry to commercialize environmental technologies and create jobs." This direction was the impetus for introducing CPWTMs to environmental scientists at Los Alamos. Then, word of mouth about the value of the workshops spread throughout the laboratory.

Subsequently, the weapons program, the Chemical Science and Technology Division, the Industrial Partnership Office, and the Non-Proliferation and International Security Technology Division sponsored workshops and selected all participants. Many scientists requested to attend the workshops and didn't wait to be selected by management. There is still a waiting list to attend today.

The immersion-style training proved very effective in accomplishing learning objectives. Several attributes create the "immersion experience": conducting the four-day workshop off-site (away from the office), mandatory overnight accommodations, mandatory nightly homework related to developing an action plan, assigned seating at meals to encourage dialogue between scientists and industry experts, and consistent reinforcement of key commercialization concepts.

As a result of the success and impact of the first three workshops conducted in 1992 and 1993, the Division Director of the Chemistry Science and Technology Division wanted to expose more scientists in his division to the concepts taught in the workshop. In July, 1993 we conducted a one day Commercialization seminar with many of the same lecturers and faculty members for 150 people from the Chemical Science and Technology Division.

This indoctrination session did not produce individual action plans, nor did it yield significant return in subsequent industry partnering.

The immersion style method of commercialization training was introduced to the workplace in 1992. The indoctrination style of commercialization training was in July, 1993. The comparison of post workshop surveys was examined in July, 1993. Evaluation forms distributed after the indoctrination session clearly indicated that the one day session was not as effective as the four day immersion format workshop.

The Indoctrination Commercialization Training Format

The training was conducted for 150 students. The format was a one-day, lecture-style information session. A panel of four faculty experts delivered six hours of lecture covering topics such as commercialization, market research, and intellectual property protection. The faculty of experts was composed of an entrepreneur, a patent attorney, a business professor, and a commercialization expert.

The Immersion Commercialization Training Format

The format of the four-day workshop included nine and one-half hours of lecture, five hours of individual consultation, and more than twenty-two hours of consultant evaluation of individual commercialization action plans. The commercialization action plans were presented orally by the students to the faculty for review. The faculty of ten experts was composed of business and marketing professors, entrepreneurs, a licensing executive, and a patent attorney. The faculty met each evening to evaluate action plan progress and discuss the "fatal flaws" and "next steps" required for each project. These four to five hour evening discussions were ruled by consensus and were highly effective in guiding the students' work and progress the following day. Each immersion day ran for (both students and faculty) from 7:00am to midnight or well after.

In addition to learning about the innovation process, the training also created an opportunity to evaluate the value of the industry partnerships in relation to the core competencies and strategic direction of Los Alamos National

Laboratory. It is important to the institution that industrial partnerships bolster the core competency base and contribute strategically. Here is a figure that graphically shows the importance of the CPW™ plan filter and depicts the relationship to institutional goals:

Figure 1

Part II. Literature Review

"As I see it, the moment one expresses in any very general manner the various potentialities of behavior as dependent upon the simultaneous status of one or more variables, he has the substance of what is currently called field theory." Hilgard ER. and Marquis DG Conditioning and Learning, Appleton Century Co . 1940

The literature review has proven especially important in this field research project. In fact, the literature review allowed me to develop the ideas, frameworks, and approaches needed to complete a retrospective experiment with an "unfreezing intervention." The work of Beckhard proved particularly important in this regard, but many other works have helped shape the direction of this project. These works appear in a variety of disciplinary contexts, but all directly concern the issues addressed in this thesis:

technology transfer, organizational change and field experiments, and training, productivity and culture change in organizations.

Technology Transfer

Recently, there have been a number of empirical studies conducted on the value and methods of technology transfer from the Federal Laboratories (Roessner and Bean, 1993; Mowery, 1995; Bozeman, 1995; Markusen, 1995). These studies report that using the national laboratories effectively can contribute to national productivity. Markusen's study acknowledges that the defense laboratories are a strong national asset and great repository of talent. Specifically, the study found that Los Alamos has a strong and diversified portfolio of technological strength most of which capitalizes on the strong multi-disciplinary tradition of scientific work. The Roessner and Bean studies show that indeed industry does benefit from lab-industry partnerships but these benefits are not necessarily measured in terms of new jobs.

Mowery's study also addresses measuring value and the difficulty of measuring near-term economic benefit in terms of jobs resulting from lab-industry partnering.

In the non-empirical popular press the debate is still on regarding the role of government-funded facilities and the intent of our nation's technology policy. Here are some representative questions relevant to the ongoing debate: Is all technology developed with tax-payer dollars considered public domain technology? What is the intent of this nation's technology policy? Does this nation have a formal technology policy? And, is the culture clash too great between federal labs and industry to engender productive collaborations? (Barnett, 1994; Berkowitz, 1994; Cohen, 1994; Mitchell, 1995).

Many studies and reports have been completed in the past three years regarding the proper role of the labs, the nation's technology policy, and the best recommended configurations for the nation's research and development infrastructure (Fisher, 1994; NSTC, 1994; Bozeman, 1995; Galvin, 1995; Johnston, 1994; OSTP, 1995; DOE, 1994; DOC, 1994; Markusen, 1995). Many reports such as the *"National Benefits from National Labs...Final report of the Center for Strategic and International Studies"* (Senator J. Bennett Johnston, Chair) and the *Galvin Report* suggest organizational realignment.

The reports cite several organizational factors that could be improved to enhance technology commercialization. The recommendations include changing intellectual property policies, streamlining management procedures, and building in better metrics and incentives for partnering that would improve the current system. It is striking to note that none of the official studies and reports give any attention or credence to the role of the individual (the scientist) who is so integral to the commercialization process. The emphasis is on the organization, the human being is summarily ignored.

However, some excellent psychological studies have been done probing the attitudes of weapons designers (Broad, 1985; Cohn, 1987; Lux, 1994). The conclusion is that weapons designers are proud of their skills and want to

serve society. However, they tend to work in quite isolated situations, psychologically as well as physically.

Organizational Change and Field Experimentation

One of the seminal books in organizational development entitled *Scientific Management* by Frederic W. Taylor published in 1910 focused on measuring work. The book described the classic study of documenting and programming the labors of pig-iron handlers at Bethlehem Steel. Scientific organizational management took a position outside of the task, not of it. In this approach to organizational change Taylor created a new technological skill called industrial engineering and a new class of specialized practitioners.

The Hawthorne studies conducted in the 1930's involved observing small groups in their natural setting in the work place, a method borrowed directly from social anthropology. However, the results indicated that the people being observed made changes in their behavior due to the intervening variable of *being observed* rather than because of the specific effect of X. This is a classic example of an evaluation study which demonstrated the importance of including intervening variables in the formulation of the evaluative hypothesis. This effect has become known as the "Hawthorne Effect". This led to the phenomenon of "field experiments" and quasi-experimental design which started in the literature in the 1950's. W. Richard Scott from Stanford University wrote a comprehensive chapter entitled "Field Methods in the Study of Organizations" where he defines field work as "observation of people *in situ*; finding them where they are."

In the important article "Reforms as Experiments" (1969) Donald T. Campbell defends field experiments and quasi-experimental designs but describes nine possible threats to internal validity when leaving the lab and going to the field. Much of the literature about field experiments refers to the administrator as key and in a unique position to set up various experiments (Thompson, 1974; Campbell, 1970; French, 1953; Shaver, 1971). Much of the interest in evaluative research and field studies in the 1970's was stimulated by "Great Society" legislation and a concern for domestic social reform.

As late as 1969 the field of "organizational development" was still emerging. Douglas McGregor, social scientist, wrote the classic *The Human Side of the Enterprise* in 1960. The "people" approach to organizational change acknowledges that changing the organizational world is achieved by changing the behavior of the actors in the organization. The popular articles and books written about this approach have stressed the importance of realizing human potential as opposed to only realizing maximum product output as an end. (Bennis, 1985; Bennis, 1993; Perry, 1995; Tichy, 1993). Some of the popular books of this genre include *Theory Z* by Ouchi and *In Search of Excellence* by Peters and Waterman.

Training, Productivity, and Culture Change

There is little empirical evidence on the impact of training on labor productivity. A report prepared by the congressional Office of Technology Assessment in 1990 concluded that American workers need more training if the United States is to remain internationally competitive. The basic premise of the OTA report was that training enhances labor productivity. Since the data on labor productivity is very limited, studies by labor economists have attempted to demonstrate empirically the relationship between training and labor productivity utilizing data on individual workers. The studies rely on the observed relationship between training and wages as evidence of a relationship between training and productivity.

The study "*Productivity Gains from the Implementation of Employee Training Programs*"¹² by Ann Bartel attempts to fill the gap by measuring individual wage performance to business unit and organizational productivity. The major finding is that businesses that were operating below their expected labor productivity levels in 1983 implemented new employee training programs after 1983 that resulted in significantly larger increases in labor productivity growth between 1983 and 1986.

The popular press is full of case studies about increased productivity and culture change as a result of implementing training programs (Wiley, 1993;

¹²Bartel, Ann P., "Productivity Gains from the Implementation of Employee Training Programs", *Industrial Relations*, vol. 33, No. 4, October, 1994

Lang, 1991; Cook, 1990; Tichy, 1993). The articles reveal that many companies that invested heavily in workplace training recaptured significant market share from their competitors. After training and retraining over 110,000 employees worldwide in 1983, Xerox regained market share in its industry. The trend is that in the 1990s, training will continue to focus on contributing to the bottom line. This positions training as "a means to an end rather than an end itself".¹³

Excellent case study information is found in reading the literature about the organizational and cultural changes at General Electric (GE). The changes at GE can be attributed to CEO, Jack Welch's vision in recognizing the potential and impact of training in complementing organizational goals. Welch hired Noel Tichy, an organizational development expert, to turn GE's management development institute (located in Crotonville, NY) into an instrument of change. The change sought was to increase workforce productivity. Starting in the early 1980's the focus at Crotonville was on workshops that wrestled with real organizational and people problems. Training left the theoretical realm to favor practical applications.

This practical approach of using training to change corporate culture and increase productivity is also written about in several case studies about the transformation at Corning (Lang, 1991; Henkoff, 1993; Wiley, 1993). James Houghton, CEO, took over in 1983 and immediately began talking about the Corning he envisioned in 1995. He foresaw a company that would be world-class in quality, growth, performance, innovation, valuing diversity and integrity. As a way of moving toward these goals he announced that by 1991 all employees should spend 5% of their working time in meaningful training and education. His goal was to move Corning into the top quartile of Fortune 500 companies for return on equity. Implicit in the new training requirement was the mandate that employee education should focus on moving the company toward its goals.

¹³Wiley, Carolyn, "Training for the 90's: How Leading Companies Focus on Quality Improvement, Technological Change and Customer Service" *Employment Relations Today*, Spring 1993

The Corning trainers met with Noel Tichy whose work at GE was based on an educational model that stressed training as a means to achieve fundamental corporate change. As a result, all new courses developed by Corning's training department fall on the high-impact end of the continuum; they seek to drive fundamental change.¹⁴ In fact, individual skills training in reading and math was farmed out to an educational institution- allowing the training department to focus on high-impact courses. Corning's approach to training points out the close link between education, training, and work reforms.

Motorola, whose sales were a record \$13.3 billion in 1992, spent \$120 million (\$60M on training and \$60M on lost work time) on education. That's equivalent to 3.6% of payroll, more than double the 1.5% goal President Clinton advocated during his campaign. Motorola calculates that every \$1 it spends on training delivers \$30 in productivity gains within three years. Since 1987 the company has cut costs by \$3.3 billion. This cost savings was achieved not by the normal expedient of firing workers, but by training them to simplify processes and reduce waste. Sales per employee have doubled in the past five years, and profits have increased 47%.¹⁵

The research studies and the popular literature articles definitely show a trend in training away from individual skill training toward group and organizational practical training where the results are focused on the bottom line and organizational goals. This Field Study will evaluate similar training, The Commercialization Planning Workshops™, at Los Alamos National Laboratory where the results are focused on increasing strategic partnerships with industry.

¹⁴Lang, Sarah, "Corning's Blueprint for Training in the 90's", *Training*, July, 1991

¹⁵Henkoff, Ronald, "Companies that Train Best", *Fortune*, March 22, 1993

Part III. Research Structure

"When you run into something interesting, drop everything else and study it!" BF Skinner

The research problem addressed in this thesis involves the difficulty of retrospective analysis of an "unfreezing intervention." The Los Alamos CPW™ was well underway when preparing for this field research project alerted me to the fact that these workshops offered a rare opportunity to explore questions involving culture change, learning organizations, and training. In effect, a critical administrative experiment was already unfolding; the research problem was to ensure the validity of the retrospective analysis.

In total, ten CPW™ workshops were conducted for Los Alamos scientists and engineers from September, 1992, to January, 1995. Workshops averaged ten principal investigators. The April, 1994 CPW™ was held jointly with Savannah River Site and accommodated seven Los Alamos scientists. A total of 101 Los Alamos scientists have completed the training to date, and the same number of commercialization action plans have been completed. Post workshop evaluations were conducted after each workshop.

What I found interesting in the post workshop evaluations was the nearly unanimous response that this training was relevant and worthwhile from the scientist's perspective. The content, subject matter and format hit the mark. I subsequently heard, in conducting individual interviews with CPW™ alumni, a fascinating rationale for the high marks about the immersion training method. It was explained to me that Ph.D. level scientists considered themselves experts in everything they were involved in. Suddenly being told to work with industry was a very disconcerting change for many of these scientists who had little experience with commercialization and working with industry partners. The opportunity to learn about

commercialization and partnering with industry in an intense and focused fashion represented a real opportunity for these "experts" to become expert in a new arena.

The literature review, initial post-workshop evaluation information, and the anecdotal comments shaped my research question: **"Does "immersion" commercialization training contribute to achieving organizational goals and does the method accelerate cultural change?"** The purpose of this study is to explore the impact of immersion-style commercialization training on achieving the Los Alamos National Laboratory organizational tactical goal #6, strategic partnering with industry.

The research structure reflects a mix of retrospective analysis and new work. There are five elements used for analysis:

1. Evaluation surveys, post CPW™ Workshop	Retrospective
2. Email survey to CPW™ alumnus mid-year progress report	Retrospective
3. Structured Interviews and Discussions with CPW™ Alumni & Lab management	New Work
4. Research Survey, "Commercialization Training and Industrial Partnering at Los Alamos"	New Work
5. Case Study	New Work

This research structure includes three new instruments: the structured interviews, the research survey, and the case study. These new instruments allowed me to use the retrospective analysis data and the new work to "triangulate" findings on attitude change, culture change, immersion training, and achieving organizational goals.

I could not manipulate or control the results of the training because the training experiment was underway when this field research project began. Instead, I developed new instruments to test and analyze the initial findings. The research structure allowed four hypotheses to guidengthen the analysis of earlier evaluation instruments and shape the new research undertaken in this field project:

Hypotheses

Hypothesis 1: If immersion-style training is focused and effective, it can lead to significant attitude change.

Hypothesis 2: The Commercialization Training Workshops will foster greater productivity by increasing a knowledge base.

Hypothesis 3: Training is an effective tool to use in accelerating culture change.

Hypothesis 4: Training is an effective tool to use in achieving organizational goals.

Part IV. Research Methodology

It's not what you don't know that hurts you, it's what you know that just ain't so. Satchel Paige

This study uses a matrix of information and data to evaluate and validate the four hypotheses. Post-workshop surveys and a July 1994 e-mail survey were conducted as a matter of course in doing my management job at Los Alamos. After I considered the research structure and methodology for this field research project, the structured interviews, the research survey, and the case study were administered. Scientists, marketing personnel, and lab management contributed qualitative data both in terms of structured interviews and evaluation surveys. The matrices of information and data consisted of:

1. Evaluation surveys, post CPW™ Workshop	Retrospective
2. Email survey to CPW™ alumnus mid-year progress report	Retrospective
3. Structured Interviews and Discussions with CPW™ Alumni & Lab management	New Work
4. Research Survey, "Commercialization Training and Industrial Partnering at Los Alamos"	New Work
5. Case Study	New Work

The research methodology was also structured to probe further the results obtained from the report "Unreported Technology Transfer at Los Alamos National Laboratory"¹⁶ based upon CPW™ research conducted in 1993. A series of structured interviews were conducted by Mohawk Research personnel. The preliminary research protocol simply called for measures before and after the workshop experience to determine the participant's experience with responding to market needs; in turn suggesting a willingness to engage in systematic commercialization planning. For workshops 2

¹⁶Lux, David and Rorke, Marcia, "Unreported Technology Transfer at Los Alamos National Laboratory", a commissioned report, January 1994

through 6 the pre-workshop forms each participant was asked to complete prior to attendance contained a baseline question asking: "Have you ever planned your research agenda with commercial needs in mind?" That question then offered the basis for expanded interview probes during each participant's intake interview at the workshop.

Such probing was intended to check participant's self-perception and to build a nuanced understanding of principal investigator's attitudes toward technology transfer and commercialization. Finally at the exit presentations on workshop Day 4, each participant was asked if, in the future, he or she would be willing to consider commercial market opportunities as they plan research.

In completing their pre-workshop intake forms, just over half the group reported an earlier willingness to plan their research agenda around private sector needs. Initial interviews yielded 76% positive responses. Overwhelmingly, those who have been asked at the end of the CPW™ about future willingness to plan for commercialization responded positively (93%).

Here is a description of the various qualitative data techniques used to probe these initial findings. This field research project employed the following data techniques:

1. Evaluation surveys, post CPW™ Workshop

Retrospective

Post-workshop evaluations were administered to attendees at the conclusion of the four day commercialization training workshop. The surveys were distributed after all ten of the workshops conducted between September, 1992 and April 15, 1994. The return rate was 98%. Following are the dates the evaluations were administered:

1. September 25, 1992	6. November 5, 1993
2. April 2, 1993	7. April 15, 1994
3. April 30, 1993	8. July 29, 1994
4. July 16, 1993	9. September 20, 1994
5. September 17, 1993	10. January 27, 1995

A sample Post-Workshop evaluation form is attached as Appendix B.

2. E-mail survey to CPW™ alumnus mid-year progress report **Retrospective**

An e-mail was sent in June, 1994 to the then current sixty-five CPW™ alumni. The survey requested input to the value of their CPW™ training. It was explained in the e-mail that information was being solicited for a presentation I planned to give entitled "Culture Change and Training Underlie Successful Industry Partnerships at Los Alamos National Laboratory" July 18, 1994 to the Los Alamos senior management group, the Lab Leadership Council.

3. Structured Interviews and Discussions with CPW™ Alumni and Lab management

During the months of February, March, April, and June, 1995 I conducted eight structured interviews with CPW™ alumni, marketing personnel that work closely with the CPW™ alumni scientists, and lab management, to get a feeling of their lasting impressions and/or benefits obtained from having participated in the CPW™ training. See Appendix E for the interview questions used.

4. Research Survey, "Commercialization Training and Industrial Partnering at Los Alamos "

A pre-survey was sent to a small group and the questions were refined. The survey probed for data about the demographics of the CPW™ participants, the extent of industrial interactions, the views and attitudes of the CPW™ participants, the ways to maximize the impact of training, and viewpoints about cultural change and partnering with industry.

The April 7, 1995 survey was mailed to 101 CPW™ alumni which represents the entire sample size of principal investigator CPW™ alumni at Los Alamos National Laboratory. A sample research survey form that includes the summary of responses is attached in Appendix C. Thirty-two principal investigators responded to the survey, which is a 32% return rate. Seventy-eight percent of the respondees received their Doctorate in science. Twenty-five of the thirty-two respondees were trained in science, six in engineering, and one in business. This included twenty-five PhDs, three Masters level, and four Bachelors level.

Over half of the respondees *strongly agreed* with the statement, "I am an entrepreneurial individual at heart". When the rating of 3 (mid-point

between *strongly agree* and *strongly disagree*) is included with the rating of 4 and 5 ascending scale of *strongly agree*, 88% of the respondees considered themselves entrepreneurial. Ninety-one percent of the respondees consider themselves leaders and 94% consider themselves risk-takers.

These consistent and strong personal demographics in terms of leadership, entrepreneurship, and risk-taking beg the question of how the attendees to CPW™s were selected. One could surmise that highly motivated individuals chose to attend this training. In fact, the attendees were selected and recommended for the workshop by their managers and peers in the beginning. After the first workshop and when word of mouth positive comments spread throughout the lab, many of the attendees indeed did "self-select" themselves and managed to get on the roster. Many motivated individuals perceived this training as offering information and skills training in a new arena (industrial partnering) which would be a growth area for the laboratory.

5. Illustrative Case Study

This is a case study that tracks a scientist's progress and attitude over thirty months. The scientist was a participant in the March, 1993 CPW™. The case study is illustrative of many similar cases where the commercialization action plan is implemented. It is a case about the real world and the real challenges involved in technology transfer.

Part V. Research Results

"Everything is possible and almost nothing is certain." Vaclav Hamel

1. Evaluation surveys, post CPW™ Workshop

The pilot CPW™ was conducted September 22-25, 1992. The post workshop evaluation was outstanding. One hundred percent of the attendees rated the investment of time in the workshop as *excellent*. Ninety percent of the attendees rated the quality and relevance of the information presented as *excellent*, with ten percent rating it as *good*. One hundred percent of the participants would recommend the workshop to a fellow principal investigator, one hundred percent would recommend the workshop to management. There were no negative comments.

These results were significant because 80% of the attendees were Ph.D. level scientists, a group which tends to be extremely analytical and critical. In addition, at least six of the twelve participants were participating under duress and were extremely confused at first about what relevance commercialization had to their work. Commercialization was a new mission for many. I personally cajoled, enticed, and conspired to get several key influencers and "early adopters" to attend.

The second workshop held March 30-April 2, 1993 had similar post workshop evaluation results. Once again, a full one hundred percent of the participants would recommend the workshop to a fellow principal investigator and to management.

The third workshop held April 27-30, 1993 which was comprised of scientists specifically from the weapons program followed suit. An evaluation memo sent May 6, 1993 said, "A perfect 10!" The quality and relevance of the

information presented was unanimously rated as *excellent*. Across the board every scientist recommended his or her management attend.

Here is a sample (covering the ten CPW™s) of some of the scientist's comments attached to the post workshop surveys:

POST-WORKSHOP SURVEY COMMENTS

- "Though at first I was in shock, I am now convinced that this approach is very effective and I highly recommend this for anyone interested in technology transfer."
- "I need a resource within or outside the Laboratory to help with some details of the commercialization plan, e.g., cost/benefit analysis, and obtain critique/help with a marketing plan."
- "Excellent chance to succeed but I need to learn more about markets."
- "Four days were essential to me to take in and integrate the information. Don't change the length."
- "I have a feeling that demand for this course is going to explode!" (July 93)
- "We need some very high level management people in this class ASAP!"

Table 2

2. E-Mail survey to CPW™ alumnus mid-year progress report

In June, 1994 an e-mail survey was sent to 65 CPW™ alumnus requesting information on the status of their commercialization plans and asking them to evaluate the value of their training. In terms of dollars, the return on investment from commercialization training was significant. Participants projected a \$12 million return in FY 95 as a result of implementing their action plans. Also, various comments and replies indicated cultural shifts and increased productivity. The Return on Investment Report with specific detail is attached in Appendix D.

The survey indicated that several partnering mechanisms were used in developing and implementing action plans. The mechanisms ranged from Cooperative Research and Development Agreements (CRADAs) to increased DOE programmatic funding. The use of CRADAs, including small business

CRADAs, was a chosen partnership mechanism 51% of the time. Collaborating with industry partners on a dual-use applications for technology was another preferred area for partnering. This table shows the percentage of various industrial partnership mechanisms used for industrial partnerships:

Table 3

The various comments received from the e-mail survey can be categorized into areas according to the four hypotheses of this field research project: attitude change, productivity, culture change and organizational goals.

Attitude Change

- The CPW™ training was very helpful in giving me the perspective of the real world in approaching commercialization. My approach has become *less grandiose and more pragmatic*, which I now believe is important. The training is useful and important in orienting us to the correct approach for our industrial partnership and dual use efforts. We can now identify characteristics of industrial partners which are critical to a good collaboration.

- We need to walk the fine line between what we know we can and need to do (eventually) and what businesses can deal with now. The

business planning process and concepts are one way of scaling back our expectations.

Productivity

- I have used these principles both in pursuing a promising commercialization project in a careful and conservative way as well as in deciding to not pursue several unsuitable collaborations.

- Sorry to report that so far I have not successfully received a CRADA, Funds in or user facility agreement, or anything else. However, I did *discovered that a market does not exist* for our Computed Tomography system. Thus, I have saved lots of time by not working on a worthless project.

- The interactions with CPW™ and CPW™ alumnus has been valuable, especially contact and work with the EM program office. Possibly the most important has been *my internal contacts within the Laboratory*. As a result of the CPW™ alum group I have *teamed* with Steve Booth and Russ Gritzo on instrumentation, with money changing hands.

- We have applied for two patents as a result of the course.

Culture Change

- I learned the marketing evaluation skills at the CPW™. The CPW™ has been very worthwhile for me. Besides saving time and resources by not working anymore on the Tomography marketing plan, the course has *taught me how to deal with business folks*.

- Before all this "new" emphasis on tech transfer, several of us were interacting with a group from a multinational company that then set up their own small business. That group took one of our general concepts (published) and defined a specific application which I believe they patented and formed a joint venture around. This is the example I used the other day where *knowing how to speak CPW™ can protect us*.

- CPW™ provided me with a *stronger basis from which to interact with companies*. Most often, this involves being more of an ambassador from the Laboratory than a technologist with transfer capabilities. I spend a lot of time at meetings explaining what the Laboratory is, how it interacts with business, and trying to direct these contacts to several appropriate points of entry (particularly appropriate technologists).

Results...Organizational Goal

- Because of CPW™, I found two National Machine Tool Partnerships in the last year. And I am still working on a user facility agreement.

- The NO2 sensor now has a CRADA with Medical Manufacturing and Distribution Inc. of Fort Lauderdale, FL. The arrangement has resulting in a \$50 k amount supporting the engineering prototype development of the sensor.

- Actual dollars as a direct result of CPW™—TTI with TSA-6 has evolved into a \$200 k DOE investment for process control, funding of one post doc, and we are looking at 4 key areas for private firms.

- Since attendance in the CPW™, the LRAD program has grown from ~\$1 M/year to its current level of ~\$2 M/year. Much of this growth has been encouraged by our relationships (including a CRADA and licenses) with Eberline, TMA, and other companies. These relationship (and our approach to them) have been strengthened and enhanced by the interactions started at the CPW™.

- My CPW™ training and action plan development involved Highly Filled Polymer Technology and resulted in a CRADA funded by the Small Business Initiative for \$50K. The industrial partner is Fantastic Tool from Livingston, NJ.

3. Structured Interviews and Discussions with CPW™ Alumni and Lab management

Several interesting themes were repeated by nearly every person interviewed. The themes about the value of commercialization training included having increased understanding and empathy, increased comfort level in dealing with industry, enhanced skills in commercialization, and the importance of an ongoing informal support network at the lab. Despite some angst and confusion about the recent Galvin Report relegating industrial partnering to a "back-seat role" (derivative mission) of being appropriate only if it complements the weapons research and energy research missions of the lab there still remained an exceedingly high level of enthusiasm for industrial partnering.

Several managers and marketing professionals commented on the quality of the commercialization action plans and the enhanced communication skills of scientists as they worked with potential industry partners. Also, several observers commented on the "change" in attitude as participants completed the training. It appeared as though the mystery of how to accomplish successful industrial partnering had been de-mystified. This led to higher enthusiasm for venturing into the new area.

Several attendees commented in the structured interviews that one of the greatest contributions of the training was to provide a level of knowledge about the commercialization process which in turn enabled scientists to move forward more confidently and enthusiastically in pursuing industrial partnerships.

4. Research Survey, "Commercialization Training and Industrial Partnering at Los Alamos"

Seventy-eight percent of the respondees received their Doctorate in science. Twenty-five of the thirty-two respondees were trained in science, six in engineering, and one in business. This included twenty-five PhDs, three Masters level, and four Bachelors level.

Over half of the respondees *strongly agreed* with the statement, "I am an entrepreneurial individual at heart". When the rating of 3 (mid-point between *strongly agree* and *strongly disagree*) is included with the rating of 4 and 5 ascending the scale to *strongly agree*, 88% of the respondees considered themselves entrepreneurial. Ninety-one percent of the respondees consider themselves leaders and 94% consider themselves risk-takers. When the ratings 3,4,5 are included, 91% agreed with the statement, "I am a scientist at heart".

The research survey probed areas and asked questions relevant to the four hypotheses about attitude change, increased productivity, culture change and getting results. These results consider the ratings of 4,5 in ascending scale to *strongly agree* with 3 being neutral. The ratings 2 and 1 indicate *disagree* and *strongly disagree*. Here is a summary of the findings:

Setting the Context...Beliefs about the Laboratory and Technology Transfer

Eighty-one percent of the sample agrees strongly that the Lab should actively engage in technology transfer. Eighty-four percent *strongly agree* that the lab has valuable technologies to co-develop with industry while five respondees *strongly disagreed* with that statement. A significant eighty-one percent *strongly disagreed* with the statement that the lab is structured well to encourage technology transfer. Only one respondee *strongly agreed* with this statement. Sixty-six percent of the respondees *strongly agreed* with the statement, "Partnering with industry is within the spirit of the lab's mission."

Attitude Change

Fifty percent of the sample *strongly agreed* with the statement the CPW™ training "removed my sense of mystery of a new discipline, commercialization." Sixty-nine percent *strongly agreed* that the training

"gave me a greater comfort level in working with industry." Only one person disagreed with this statement. In responding to the statement, "The CPW™ training definitely changed my attitude about partnering with industry" ten people *strongly agreed*, five were neutral and seven disagreed. Twenty-one respondees, sixty-six percent, *strongly agreed* that "CPW™ training made me excited to work with industry."

Productivity

Ninety-four percent of the respondees *strongly agreed* with the statement, "Attending the CPW™ was a valuable use of my time." There were no neutral responses. Two people disagreed with the statement. Eighty-seven percent of the sample *strongly agreed* with the statement, "The immersion format of the CPW™ had more impact for me than a traditional lecture-style course." Over fifty percent (53%) of the sample *strongly agreed* with the statement that the training "gave me the knowledge and insight about a project that had diminishing returns." Over half the sample (56%) *strongly agreed* that the training workshop "taught me how to recognize and obtain the added resources I need." Sixty-two percent *strongly agreed* that the training workshop "connected me with peers and colleagues doing similar work." Seventy-two percent *strongly agreed* with the statement, "It (CPW™) introduced me to commercialization and marketing support staff in the lab."

Culture Change

Sixty-two percent of the respondees *strongly agreed* with the statement that the Lab's culture has definitely changed in the past five years. When asked if training is a good tool to use in accelerating culture change, eighty-one percent of the sample *strongly agreed*. Thirteen rated this a five (*very strongly agree*). Only one person disagreed with this statement.

Results...Organizational Goal

In response to survey questions, this Table shows the percentage of various industrial partnership mechanisms used in implementing the actions plans and developing industrial partnerships:

Industrial Partnering Mechanisms as A Result of Implementing Action Plans

Table 4

The responses to the question, "To date, additional funds in from an industry partner to continue my science and research has been" ranged from \$10,000 to \$300,000. The total amount documented from all 32 responses was \$490,000. Several respondees commented that it was too early to document the return as several deals were pending.

5. Illustrative Case Study

One of the interviews I conducted provided a rich source of insight into the central issues this field research project addresses. So, I spent more time in interview sessions with the scientist and developed this illustrative case study that highlights technology transfer and commercialization issues.

Case Study of Post CPW™ Training and Implementation of the Commercialization Action Plan-Large Volume Flow Through Detector

I developed this case study with Russ Gritzo, the principal investigator of the Large Volume Flow-Through Detector (LVFTD) technology development project, to determine the value of developing the action plan in the workshop, to benchmark the implementation of the plan, and to document lessons learned. Gritzo's CPW™ training was conducted in March, 1993. The interview was conducted 30 months later in September, 1995.

As Gritzo had developed a very detailed commercialization action plan in the training workshop, he knew what his first action would be upon returning to the lab. Immediately following the CPW™ workshop, Gritzo contacted the patent office at the laboratory to protect his intellectual property. The commercialization timeline developed in the CPW™ workshop covered activities from April, 1993 to September, 1995. At the time of the case study interview, Gritzo was successfully completing his action plan in spite of several changed and slipped milestones. These milestones are noted by *. Here is a synopsis of the timeline (see Appendix F for original document):

Commercialization Timeline	
3.93	Commercialization Planning Workshop Attendance
4.93	Patent started
6.93	Commerce Business Daily Ad placed to solicit interest in attending an industry outreach workshop about the technology.
8.93	Technology considered patentable at the Intellectual Property Review Board meeting.
10.93	FY 94 funding received for continued R&D.
11.93	Industry Outreach meeting conducted. Twelve potential partners attended.
3.94	Patent filed.
4.94	Industry partner selected. CRADA negotiations begin.
10.94	FY 95 funding received for continued R&D. Industry partner acknowledged in funding request.
10.94*	CRADA signed.
11.94*	18 month product development clock starts running.
9.95	Field demo completed.
10.95*	Follow on development with CRADA funds conducted.
* Indicates milestone not met.	

Table 5

Industry Outreach Meeting 11.93

The industry outreach meeting was a key milestone in Gritzo's action plan. Twelve potential industry partners flew to Albuquerque to participate in the informational meeting in November, 1993. The Gritzo team described the features, attributes, and potential markets for the new technology. At the conclusion of the workshop, participants were invited to submit partnership proposals for the technology. Bidders were given a 60 day period to respond.

Proposals were evaluated using a pre-determined set of selection criteria composed by the project team. The selection criteria encompass such factors as marketing plan, financial backing, technical expertise, benefit to the US economy, and agreement desired by the laboratory. The project team included Gritzo (the principal investigator and project leader), technical support staff, a licensing professional, and a marketing professional. The team worked with patent and legal officials, program managers, administrative support, and other specialists throughout the laboratory as required.

One of the important outcomes of Gritzo's industry outreach meeting was the input and feedback from participants about the name of the technology. Many felt that the name was difficult to remember and didn't adequately capture the features of the technology. The name "Large Volume Flow-Through Detector" (LVFTD) was subsequently changed to the "Flow-Through Alpha-Detector" (FTAM). For several months all documentation referenced the "FTAM, formally known as the LVFTD."

**Milestones not completed.*

10.94* CRADA signed. A memorandum of intent was signed by the industry partner and the laboratory in April 1994, but the joint work statement that describes the commitments and deliverables of both the industry partner and the laboratory still has not been signed. The joint work statement is the paperwork that accompanies an official CRADA. Therefore, the intent was indicated but not demonstrated.

Gritzo commented that there "was always one more roadblock." The two biggest roadblocks from Gritzo's perspective were first, the industry partner expected Gritzo to provide him with a customer base. The partner felt that the primary market was DOE sites where mixed waste was a problem. This, in spite of the fact that the industry partner had an excellent distribution channel of companies that had environmental problems due to alpha particles in air streams. The lab scientist thought the industry partner had access to the market, the industry partner thought the lab scientist had access to the market. Gritzo and his colleagues had no intent to become sales representatives for the industry partner. There was a real difference of expectations and assumptions.

Secondly, the industry partners did not want to sign any binding agreements until they had seen the technology field tested. This was another unfortunate misunderstanding because the scientist was looking forward to the expertise and guidance the very experienced industry partner could bring to a field test situation. Instead, the partner chose to reduce risk and wait in the wings to see if the technology worked.

11.94 18 month product development clock starts running.* The industry partner declared that, "at their company, if a new product development cycle spanned more than 18 months, it was considered a failure." In this specific case the product development cycle did not begin because the joint work statement was never signed and there was no CRADA.

10.95 Follow on development with CRADA funds conducted.*

This was not accomplished because the CRADA was never initiated.

Changes in Plan

In October, 1994 Gritzo dropped everything to devote full-time energy to preparing for the scheduled field demo eleven months later. The field demo was actually conducted nine months later in July, 1995 at a commercial testing facility in Idaho Fall, Idaho. The testing facility used a 200-kilowatt plasma hearth system and mixed waste surrogates for R&D purposes.

The demo was successful. The technology performed as expected except that the plates did not perform to manufacturer's claims in the areas of temperature tolerance. As a result of this imperfection, lab scientists are trying to develop a new material for the plates that will perform at high temperatures. Also, Gritzo is working with the plate manufacturer to use the existing plates and enhance performance by developing a new plate design. The new design will better distribute the heat to ensure better performance. Lab engineers are working on this new engineering and design approach. Another field demo with the refined configuration and plate is scheduled in 1996.

The Field Demo...Reality Check

Another key milestone in Gritzo's commercialization action plan was the field demo. The field demo was a new experience and a reality check for the lab scientists. To demonstrate this point here are a few comments from Gritzo:

- "I did not expect someone to run a 200 amp welder right next to my electronics rack."
- "Also, I couldn't believe that people were grinding metal that produced showering sparks right next to my electronics rack. I guess that was reality of an industrial setting. You just never know where your technology will end up!"
- "I'm used to handling my equipment delicately, in a controlled laboratory setting. These guys used a fork-lift!"

Lessons Learned

When asked about lessons learned in the past thirty months since attending the CPW™, Gritzo said his feelings and attitudes had changed. He had learned many lessons from the practical application of what he learned at the workshop. Here is a representative list of his lessons learned:

- "It's really clear to me now that companies will do anything to minimize their risk. In my case on this project the partner essentially managed everything so they have nothing to lose."

- "I was so naive and idealistic when I took the workshop. By really applying the knowledge I have become much smarter and much wiser."
- "I learned that it's not right to stand back and be stereotyped as a national laboratory that cannot do anything "real." This is a myth. In fact we were far more together and proactive than this industry partner. There are too many myths about the lab being unconnected to the real world floating around.
- "It is very easy to underestimate the amount of work it takes to keep on top of the commercialization process. The technical champion has to put a good team together of business and marketing people. Otherwise, failure is guaranteed."

Projected Outcome

The projected outcome is that a license, rather than a CRADA, will be signed. In essence, the laboratory did all the "shared research" itself. Initially, the team intended to turn over as much intellectual property as possible to the industrial partner because they wanted to see the technology used. Now, as a result of real experience, the team has decided to be far more restrictive with the licensing strategy for this technology.

There are many specific cases of CPW™ alumni working with industry. The most recent success can be attributed to learning commercialization skills and to pure and simple persistence. One of the CPW™ alumni, Don Rej, led a proposal effort at the lab to respond to the recent Commerce Department's Advanced Technology Program, a government/private sector partnership program aimed at stimulating economic growth and job creation. Rej and his team worked in partnership with industry to obtain funding for his plasma-based processing of lightweight materials technology. The specific application is for manufacturing motor-vehicle components. The proposal was initially rejected by the Advanced Technology Program reviewers. The plasma source implantation team led by alumni Don Rej persisted and finally received a \$15 million award to further work with industry and university partners to develop this pioneering technology. The award was announced September 1, 1995 by the Commerce Department.

As illustrated in Gritzo's case study, the experience of *doing* technology transfer and working with industry partners is very valuable and enhances our capabilities in this area. Now, the biggest barriers to success are political barriers and the threat in the Congress of significantly reducing budgets in the technology transfer arena. It is my view that the rhetoric ("technology is the engine of economic growth") must be accompanied with a fiscal investment to support the technology maturation process.

Suggestions for Improvement...Commercialization Training Program Evaluation

Most of the suggestions for improvement came from the structured interviews and the mailed research survey. Several scientists commented that they would like a better link from the course to understanding how to access marketing and business resources in the laboratory. This suggestion falls into the category of *sustained* intervention. No matter how powerful the initial training is, it will lose value over time if supporting resources are not available to the scientists.

To increase the impact of the initial training, and to link to the various lab resources several suggestions were made and several courses of action were implemented:

- Conduct monthly "support group" meetings where CPW™ alumni and marketing personnel meet for two hours to highlight recent successes and discuss institutional barriers.
- Produce bi-monthly CPW™ Alumni Newsletter that include book reviews, action plan updates, and a listing of marketing and business contacts at the laboratory.
- Institute an e-mail network and /or possibly a home page that will encourage ongoing communication and the sharing of resources.

The survey ratings were lower for one specific CPW™ group. That specific workshop was conducted with an altered format that diluted the focus on the scientist. The scientist, a marketing person, and a technology transfer person developed the action plan in concert. There were three groups of three, and eight groups of two. In reviewing the survey results and survey comments it is clear that the four days were not considered highly valuable by the scientist. Perhaps this is because the focus on the scientist was diluted. Based upon the survey results, I recommend the workshop be conducted as originally formatted. That is, as a ratio of twelve scientists to ten faculty members.

VI. Interpretation of Results and Conclusion

"All my life's a circle and all my roads have bends. There is no clear cut beginning and no clear cut end." Harry Chapin

As previously pointed out, the group of scientists that enrolled in the Commercialization Planning Workshops™ may have been self-selecting which skewed the demographics to indicate a very high level of risk-taking, entrepreneurship and leadership. It is significant that 88% of the sample considered themselves entrepreneurial while at the same time considered themselves scientists. This data contradicts conventional wisdom that assumes an entrepreneurial individual is quite different from a research scientist. It is clear from reviewing the data that "entrepreneurship" is not an issue, instead, effective communication skills and a clearer understanding of the two different cultures of business and science is an area that requires training and education.

The very positive response in the post-workshop evaluations of every attendee recommending the course to their peers and their management, along with the research survey results obtained 24 months after the post-workshop evaluations, led me to believe that immersion training was effective. The research survey results showed 97% (all but one respondent) of the sample *strongly or very strongly agreeing* that "Training is a good tool to use in accelerating culture change" led me to think about the power and impact of a "grass-roots" movement when introducing change in an organization. Accepting the organizational goal to partner with industry was a significant change for many in the work-force. The new direction was spelled out in a memo to all employees. But, it was the intensive training and creation of commercialization action plans that seemed to mobilize people toward achieving the new goals.

Steven Covey writes in First Things First, "When we try to change behavior or the method without changing the paradigm, the paradigm eventually overpowers the change. That's why attempts to "install" total quality or

empowerment in organizations are unsuccessful. They can't be installed; they have to be grown. They emerge naturally out of the paradigms that create them." The results and feedback from CPW™ alumni about the impact of commercialization training in changing their approach to their work supports Covey's statement. Overall, the strongest and most consistent message I have received as a result of doing this field research project is the importance (and power) of each individual in contributing to an organizational goal.

Hypothesis 1: If immersion-style training is focused and effective, it can lead to significant attitude change.

The consistent responses of *strongly agree* in the areas of "Does training accelerate culture change" and "Does training enable one to work more effectively with industrial partners" indicate significant attitude change occurred as a result of the training. The immersion training approach received very high marks. Twenty-eight of thirty-two respondees *strongly agreed* with the statement that immersion-style training had more impact for them than a traditional lecture-style course. Also, as a result of informal interviews it was learned that the cultural differences between science and business indicate a need for "immersion" into the new culture and concepts.

Two-thirds of the sample acknowledged and *strongly agreed* with the statement, "The CPW™ training made me excited to work with industry." When asked to rate the statement, "The CPW™ training definitely changed my attitude about partnering with industry" 30% *strongly agreed*.

I interpret the strength of the positive responses about immersion-style training is due to the positive impact and high caliber of the CPW™ faculty. Nearly all faculty members were PhD level and all were very accomplished in their fields. The faculty and students were evenly paced and matched in accomplishment and prestige. Had the credentials and caliber of the faculty not been established in the first two hours of the workshop, the results surely would have been different.

Hypothesis 2: The Commercialization Training Workshops will foster greater productivity by increasing a knowledge base.

The structured interviews, email survey, and research survey all documented several areas in which the training helped people become more productive. "Increased teaming," "finding and using appropriate resources," "knowing when to cut a project because of diminishing returns," and "enhanced communication skills" are some examples that were cited.

The results of the survey indicate that implementing commercialization training as a means to achieve an organizational goal, (results and return in partnering with industry), is a worthwhile tactic. Respondees indicated they worked more productively toward the goal, achieved results, and indeed accepted the new direction. More than two thirds have actively implemented commercialization action plans and 25% have created additional action plans since the initial training. Many stopped work on a project (22%) as a result of developing an action plan and recognizing that the project had diminishing returns.

Nearly 70% indicated their comfort level in working with industry was raised significantly as a result of going through the workshops. Twenty-one people indicated they were excited to work with industry as a result of the training. This excitement could be interpreted as the work force accepting and embracing an organizational goal.

©

Hypothesis 3: Training is an effective tool to use in accelerating culture change.

The structured interviews, particularly of management and peers who observed the CPW™ alumnus, brought out many comments about the impact of training on culture change. Many people told specific examples of how the person approached their work differently. Many acknowledged that the immersion training process did in their view accelerate change. The research survey asked the alumnus directly to rate the statement, "Training is a good tool to use in accelerating culture change." All but one person *strongly agreed* with the statement.

Another phenomenon took place, that is ambassadorship. Many of the attendees took their new found "religion" about the commercialization process back to their organizational groups and peers. They tried to introduce the concepts of the innovation process to their peers in the workplace.

Also, not only acceleration of organizational change but sustained change was embraced by nearly all the workshop attendees as they established a "commercialization support group" to meet on a bi-monthly basis. This informal support group network allowed alumni to share successes and to collectively deal with institutional barriers as they arose.

I interpret these results to support the concept that organizational change starts with the individual, and that training is an effective tool to use in mobilizing an individual to focus on the organizational bottom line.

Hypothesis 4: Training is an effective tool to use in achieving organizational goals.

The survey confirms that there are several institutional mechanisms (joint-industry proposals, CRADAS, User Facility Agreements, Industrial Staff Exchanges, and hosted industrial visits) to use for industrial partnering. This supports a survey of Industrial Research Companies about industry interaction with Federal Labs conducted by J. David Roessner and Alden S. Bean in 1992. The survey points to the importance of industry-federal interactions, not just "technology transfer" alone. The range of interactions covered more than just transferring hard technologies and investigated the value of ten different partnering activities. Scientists surveyed in this field research project confirmed the importance of a range of partnering activities also.

The data shows the percentage of various industrial partnership mechanisms used in implementing the actions plans and developing industrial partnerships differed from July 1994 to April 1995. The rate of CRADA use has declined from 51% to 22% from July to April. This may be a function of time and funding as the matching funds for CRADA activities have been getting scarcer in 1995. In addition, the political climate has been changing resulting in diminishing support for cost-shared CRADAS.

Relation to Other Research

The Bean and Roessner study about industrial interactions with Federal laboratories indicated that industry benefited more from having access to the laboratories expertise and knowledge as opposed to using the labs for direct product development and profit making licenses. Their survey indicated that

the most important positive influence turned out to be "access to unique technical influences".

David Mowery and Rose Marie Ham from UC Berkeley completed an "Assessment and evaluation of DOE laboratories' contributions to industrial technology" in March, 1995. This study also found that industrial partnering is more than just CRADAS. The DOE labs typically are engaged in formal or informal technology transfer and/or co-development through a diverse array of mechanisms. The study also found that all of the firms interviewed stated that the DOE lab brought important capabilities to a co-development venture that were available nowhere else. Specifically, specialized equipment, facilities, know-how and large, multi-disciplinary science and engineering teams that typically can't be assembled within universities were cited as unique assets of the national labs.

VII. Perspectives for Further Research

"All of our inventory goes home at night."

Micheal Eisner, CEO Disney

There have been a few recent studies that have addressed the success and value of industry partnering with Federal laboratories. The Bean and Roessner studies previously mentioned were the first empirical studies that actually documented that industry works with the labs for access to unique resources, including the people, instead of acquiring access to a widget or licensable technology for a profit motive. The value of the human resource and the unique collective value of multi-disciplinary teams resident at national labs should be measured and documented.

The study "Industry Perspectives on Commercial Interactions with Federal Laboratories" completed in January, 1995 by Barry Bozeman, Maria Papadakis, and Karen Coker found that, "In aggregate, the federal lab-industry interactions do appear to create significant economic value and, from the standpoint of the firms involved, receive a quite positive assessment." However, there is tremendous variation in the economic value of interactions and effective metrics to assign value to these interactions have not been utilized.

This complements the findings of David Mowery and Rose Marie Ham that "Based on these findings ("Assessment and evaluation of DOE laboratories' contributions to industrial technology," March, 1995), as well as abundant economic evidence about the conceptual and empirical difficulties of making links between R&D outcomes and economic effects, we conclude that efforts to develop economic measures of the near-term effects of CRADAS are misdirected."

Clearly, an area requiring further research is the area of developing effective metrics that measure the short and long-term economic impact of lab-industry partnering. Perhaps measures of the technical quality of project outcomes such as "R&D 100 Awards," patents, and publications should be included with counting number of CRADAS and measuring the number of new jobs created by the partnership.

As studies have also indicated that the true value of lab-industry interactions is the access to the people and facilities of the labs further research is required in how to facilitate the access and how to bridge the cultural gap between laboratory scientists and industrial personnel. The research into motivating factors and effective incentives to encourage cross-cultural partnering would be very relevant and worthwhile.

And finally, as W. Edwards Deming writes in his February 15, 1991 letter to the Malcomb Baldrige National Quality Award Committee "The effect of education and training cannot be measured," the impact of commercialization training on improving productivity should be documented and valid measures of outcomes should be developed. Specifically, more research is needed in the field of the various training approaches and levels of effectiveness in achieving organizational goals.

BIBLIOGRAPHY AND REFERENCES

- Bartel, Ann P., "Productivity Gains from the Implementation of Employee Training Programs, "*Industrial Relations*, vol. 33, No. 4, October, 1994
- Barnett, Randy, "Conversion Confusion,"*Technology Transfer*, Fall 1994
- Beck, Nuala, *Shifting Gears...Thriving in the New Economy*," Harper Perennial, 1993
- Beckhard, Richard and Harris, Reuben T. , *Organizational Transitions- Managing Complex Change*, Addison-Wesley Publishing Company, second edition, 1987
- Bennis, Warren G., *Organization Development: Its Nature, Origins, and Prospects*, Addison-Wesley Publishing Company, 1969
- Bennis, Warren and Nanus, Bert *Leaders ...The Strategies for Taking Charge*, Harper Perennial, 1985
- Bennis, Warren, *On Becoming a Leader*, Addison-Wesley Publishing Company, 1989
- Bennis, Warren, *An Invented Life*, Addison-Wesley Publishing Company, 1993
- Berkowitz, Bruce D., "Why Defense Reinvestment Won't Work," *Technology Review*, July 1994
- Bozeman, Barry, Papadakis, Maria and Coker, Karen, "Industry Perspectives on Commercial Interactions with Federal Laboratories," *Report to the National Science Foundation*, Research on Science and Technology Program, January, 1995
- Branscomb, Lewis M., *Empowering Technology Implementing a U.S. Strategy*, The MIT Press, 1993
- Broad, William, *Star Warriors*, 1985, Simon & Schuster

- Campbell, Donald T., "Considering the Case Against Experimental Evaluations of Social Innovations," *Administrative Science Quarterly*, Vol. 15, 1970
- Campbell, Donald T. and Stanley Julian C., *Experimental and Quasi-Experimental Designs for Research*, Houghton-Mifflin Co., Boston, 1966
- Campbell, Donald T. and Overman, Samuel E., *Methodology and Epistemology for Social Science*, University of Chicago Press, 1988
- Campbell, Donald T., "Reforms as Experiments," *Urban Affairs Quarterly*, December, 1971
- Campbell, Donald T., "Administrative Experimentation, Institutional Records, and Nonreactive Measures," *Experimental Design and Statistical Analysis*, Chapter 6, 1965
- Caro, G. Francis, Editor, *Readings in Evaluation Research*, Russell Sage Foundation, Second Edition, 1977
- Cohen, Linda R. and Noll, Roger G., "Privatizing Public Research," *Scientific American*, Vol. 271, pg.72-77, September, 1994
- Cohn, Carol, "Nuclear Language and How We Learned to Pat the Bomb," *Bulletin of Atomic Scientists*, Vol. 43. pg. 17-24, June, 1987
- Collins, James C. and Poros, Jerry I., *Built to Last-Successful Habits of Visionary Companies*, HarperBusiness, 1995
- Cook, Brian M., "In Search of Six Sigma: 99,9997% Defect-Free," *Industry Week*, October 1, 1990
- Cooper, W. W., Leavitt, H.J. and Shelly II M. W., Editors, *New Perspectives in Organizational Research*, Consisting of Papers from a Conference of Research in Organizations Sponsored by the US Office of Naval Research at Carnegie Institute of Technology June 22-24, 1962, John Wiley & Sons, Inc., 1964
- David, Paul A., "Technology Diffusion, Public Policy, and Industrial Competitiveness," *a working paper*, Technological Innovation Program of the Center for Economic Policy Research at Stanford University

Deming, Edwards W., Comments on the 1991 Application Guidelines for Baldrige National Quality Award, *letter to the Committee*, February 15, 1991

Deutsch, Steven E. and Won, George Y.M. "Implications and Problems in the Training of Agents of Change: The Case of Government Sponsored Foreign Trainees," *Sociologia Internationalis*, 1966, pg 155-164

Dolan, Robert J. , *Managing the New Product Development Process*, Harvard Business School, Addison-Wesley Publishing Company, 1993

Donovan, Sandra S., "Flowing Past Organizational Walls," *Research•Technology Management*, August, 1993

Dumaine, Brian, "Mr. Learning Organization," *Fortune*, October 17, 1994

Etzkowitz, Henry, "Cultural Lag in the Valley of Death," *Technology Access Report*, Vol. V111, No3

Fierman, Jaclyn, "Shaking the Blue Collar Blues," *Fortune*, April 22, 1991

Fisher, George M.C., Council Chairman, Council on Competitiveness, "Industry As A Customer of the Federal Laboratories," *A Council on Competitiveness Report*, 1994

Fisher, George M.C., Council Chairman, Council on Competitiveness, "Competitiveness Index 1994," *A Council on Competitiveness Report*, 1994

Florida, Richard and Browdy, David, "The Invention That Got Away," *Technology Transfer*, Summer, 1991

Flower, Joe, "Come the Revolution...A Conversation with Noel M. Tichy," *Healthcare Forum Journal*, September/October, 1991

French, J.R.P., "Experiments in Field Settings" *Research Methods in the Behavior Sciences*, 1953

Froiland, Paul, "Action Learning...Taming Real Problems in Real Time," *Training*, January, 1994

Gaines, Harry, "Teaching Scientists to Talk Business," *New York Times*, September 18, 1994

- Geisler, Elie, University of Wisconsin-Whitewater, "Commercializing Technology From Federal Laboratories Study, *memo*, November 3, 1994
- Galvin, Robert, *Final Report of the Task Force on Alternative Futures for the Department of Energy National Laboratories*, February, 1995
- Gibbons, Jack, Assistant to the President for Science and Technology, *Remarks to the AAAS , AAAS Policy Colloquium*, Washington, DC, April 12, 1995
- Green, Stephen G., Markham K. Stephen and Basu, Raja (Purdue University), "Champion and Antagonist Roles in Innovation," *research paper for the National Science Foundation*, n.d.
- Guile, Bruce R. and Howard, William G. Editors, "Profiting From Innovation ", *The Report of the Three-Year Study From the National Academy of Engineering*, The Free Press, 1992
- Geppert, Linda, Associate Editor, "Industrial R&D: The New Priorities," *IEEE Spectrum*, September, 1994
- Grover, James, "Corporate Management of R&D-Lessons for the U.S. Government," *Research•Technology Management*, March-April, 1995
- Gutteridge, Thomas G., Leibowitz Zandy Band, and Shore, Jane, "When Careers Flower, Organizations Flourish," *Training & Development*, November 1993
- Johnston, Bennett J., Center for Strategic & International Studies, CSIS, "National Benefits from National Labs-Meeting Tomorrow's National Technology Needs," Project Chairman Senator J. Bennett Johnston, Stanley E. Harrison, Homer A. Neal, *Final Report Washington DC, CSIS*, 1993
- Handy, Charles, *The Age of Unreason*, Harvard Business School Press, 1989
- Hayes, Robert H., Wheelwright, Steven C. and Clark, Kim B. , *Dynamic Manufacturing...Creating the Learning Organization*, The Free Press, Collier MacMillan Publishers, n.d.
- Hayes, Sarah and John T. Whetten, "The Changing Dimensions of National Security: Energy, Environment, Economic Development, and

Education," American Society of Hispanic Engineers, paper and talk, Houston, Texas, September, 1992

Henkoff, Ronald, "Companies that Train Best," *Fortune*, March 22, 1993

Hecker, Siegfried S., Director, Los Alamos National Laboratory, "Performance Appraisals and Industrial Interactions, *Internal Memo*, June 7, 1994

Hecker, Siegfried S., "Retargeting the Weapons Laboratories," *Issues in Science and Technology*, vol. 10, pg. 44-51
Spring 1994

Hecker, Siegfried S., *Testimony before the Subcommittee on Military Procurement, Committee on National Security, United States House of Representatives*, March 29, 1995

Hilgard, E.R. and Marquis D.G, "*Conditioning and Learning*" , New York, London, Appleton Century Co., 1940

Hoerr, John, "Sharpening Minds for a Competitive Edge," *Business Week*, December 17, 1990

Hulton, David W., *The Change Agents' Handbook a Survival Guide for Quality Improvement Champions*, ASQC Quality Press, Milwaukee, WI, 1994

Industrial Research Institute, "Motivating, Appraising and Rewarding Engineers and Scientists," *Selected papers from Research Technology Management 1988-1994*, 1994

Kassicieh, Suleiman K. and Radosevich, H. Raymond, Editors, *From Lab to Market Commercialization of Public Sector Technology*, Plenum Press, 1994

Kennedy, Carol, "Re-Engineering: The Human Costs and Benefits," *Long-Range Planning*, Vol. 27, No. 5 , pgs.64-72, 1994

Lang, Sarah, "Corning's Blueprint for Training in the 90's," *Training*, July 1991

Livesay, Harold and Rorke, Marcia, "Accelerated Innovation through Education Programs Tailored for Independent and Small business Inventors: The American Experience, *an unpublished paper*, 1986

- Lux, David and Rorke, Marcia, "Unreported Technology Transfer at Los Alamos National Laboratory," *a commissioned report by Los Alamos National Laboratory*, January 1994
- MacArthur, Diana, Chair and CEO, Dynamac Corporation, "The Government's Role in Science and Technology: The Emerging Debate," *speech delivered to the Environmental Stewardship Information Exchange Forum*, Santa Fe, New Mexico, February 7, 1995,
- MacArthur, D.W (Los Alamos National Laboratory) and Ulbrich, Ron (Eberline Instruments Company), "Two Perspectives on a Successful Lab/Industry Technology Transfer," *a paper presented at Waste Management '95 Conference*, Tuscon, Az. February 27-March 3, 1995,
- Markusen, Ann; Raffel, James; Oden, Michael; Llanes, Marlen; "Coming in from the Cold: the Future of Los Alamos and Sandia National Laboratories," Center for Urban Policy Research, Rutgers, The State University of New Jersey, *a research paper*, 1995
- Markusen, Ann and Yudken Joel, "Dismantling the Cold War Economy," Basic Books, 1992
- McTague, John, Chairman, University of California Technology Transfer Panel, *letter to Dr. Sidney Drell, Chairman, President's Council on the National Laboratories*, September 26, 1994
- Merrifield, Bruce, "Stimulating Technological Innovation-Nurturing the Innovator," *Research Management*, November, 1979
- Mitchell, Graham R., "Technology and Tomorrow: Evolution of Technology Policy," *remarks before the Conference Board's Justifying Technology's Value to the Bottom Line Conference*, New York City, January 18, 1995
- Morison, Elting, "Gunfire at Sea: A Case Study of Innovation," *Men, Machines and Modern Times*, Cambridge: MIT Press, 1966
- Mowery, David C. and Hamm, Rose marie, "Assessment and Evaluation of DOE laboratories' contributions to Industrial Technology," Haas School of Business, UC Berkeley, *a preliminary report*, March 3, 1995

- Padilla, Belinda; Gritz, Russ; Garcia, Jerome, "A Case Study in Commercialization," Los Alamos National Laboratory, *a case study paper*, May 1995
- Perry, Tekla S., "Designing a Culture for Creativity," *Research•Technology Management*, March-April, 1995
- Preston, John, Director of Technology Development for MIT, *Testimony Before the Energy Subcommittee of the House Space Science and Technology Committee*, March 23, 1993
- Ramos, John, "Producing Change That Lasts," *Across the Board*, March 1994
- Rogers, Everett M., *Diffusion of Innovation, Third Edition*, The Free Press, 1983
- Roessner, J. David and Bean, Alden S., "Industry Interaction with Federal Labs Pays Off," *Research •Technology Management*, September-October 1993
- Roessner, J. David, "What Companies Want From the Federal Labs," *Issues in Science and Technology*, Fall, 1993, Vol. X, No. 1
- Rubenstein, Albert H. and Haberstroh, Chadwick J., Editors, *Some Theories of Organization*, Revised Edition, Richard D. Irwin, Inc. and The Dorsey Press, 1966
- Rorke, Marcia L., "The Innovation Process and Technology Transfer," *an unpublished paper*, August 1994
- Schofield, John, Chairman, Thermatrix, "Financial Flexibility and Advance Marketing Key to Commercialization...An Interview," *Environmental Business Journal*, Vol. V11 No. 5, May 1994
- Shaver, Phillip and Staines, Graham, "Problems Facing Campbell's 'Experimenting Society,'" *Urban Affairs Quarterly*, December, 1971
- Sherman, Daniel J. and William E. Souder, *Managing New Technology Development*, McGraw-Hill, Inc., 1994
- Shrednick, Harvey R., "Dismantle the Pyramid and Share Power," *Computerworld*, November 9, 1992

- Siegel, Sidney and Castellan Jr., N. John, *Nonparametric Statistics for the Behavioral Sciences*, McGraw-Hill, Inc., Second Edition, 1988
- Skinner B.F., *Science and Human Behavior*, MacMillan and Co., 1953
- Slocum, John W. Jr., McGill, Michael and Lei, David T. "The New Learning Strategy: Anytime, Anything, Anywhere," *Organizational Dynamics*, Vol. 23, No. 2
- Souder, William E., *Managing New Product Innovations*, Lexington Books, 1987
- Spann, Mary S. and Adams, Mel and Souder, William E., "Measures of Technology Transfer Effectiveness: Key Dimensions and Differences in Use By Sponsors, Developers and Adopters," *IEEE Transcript on Engineering Management*, Working Draft, March 3, 1994
- Spivey, Austin W., Munson, Michael J. and Flannery, William T., "Understanding the Environs That Impact Technology Transfer and Transition," *Technology Transfer*, August, 1994
- Stewart, Thomas A., "Your Company's Most Valuable Asset: Intellectual Capital," *Fortune*, October 3, 1994
- Suchman, Edward A., *Evaluative Research ...Principles and Practice in Public Service and Social Action Programs*, Russell Sage Foundation, New York, 1967
- Thompson, Charles W.N., senior member, IEEE, "Administrative Experiments: The Experience of Fifty-Eight Engineers and Engineering Managers," *IEEE Transactions on Engineering Management*, Vol. EM-21, No.2, May 1974
- Thompson, Charles W.N. and Rath, Gustave J., "The Administrative Experiment: A Special Case of Field Testing or Evaluation," *Human Factors*, pgs. 238-252, 1974
- Tichy, Noel M., "GE's Crotonville: A Staging Ground for Corporate Revolution," *The Academy of Management Executives*, 1989, Vol. 111, No. 2, pgs. 99-106, 1989
- Tichy, Noel M. and Sherman, Stratford, "Walking the Talk at GE," *Training and Development*, June 1993

Tichy, Noel M., "Revolutionize Your Company," *Fortune*, December 13, 1993

Tichy, Noel M., *The Transformational Leader*, Wiley, 1986

Tornatzky, Louis G. and Fleischer, Mitchell, "The Process of Technological Innovation," chapter 9, *Implementation*, Lexington Books

Uttal, Bro, Kantrow, Alan, Linden, Lawrence, Stock, B. Susan, "Building R&D Leadership and Credibility," *Research • Technology Management*, May-June, 1992

U.S. Department of Commerce, "To Ensure the Nation's Future: Sustainable Development and the U.S. Department of Commerce," *A Draft Policy for Public Comment*, 1994

U.S. Department of Energy, "Fueling a Competitive Economy: Strategic Plan 1994, DOE/S-0108, April, 1994

U.S. Department of Energy, "The Basis for U.S. Department of Energy Technology Transfer in the 1990's," Sink, Claire H. and Easley, Kevin, *a research paper*, 1993

U.S. National Science and Technology Council, "Technology for a Sustainable Future...A Framework for Action," *A report by the National Science and Technology Council*, 1994

U.S. Office of Science and Technology Policy, "National Critical Technologies Report," *a report*, March, 1995

U.S. Office of Science and Technology Policy, "White House Paper on Competitive Awards for Federally Funded Environmental R&D," *Draft paper*, November 23, 1994

U.S. Technology Transfer Council, "Technology Transfer Panel Report...Report to the President's Council on the National Laboratories," *a panel report*, September 26, 1994

Wiley, Carolyn, "Training for the 90's: How Leading Companies Focus on Quality Improvement, Technological Change and Customer Service" *Employment Relations Today*, Spring 1993

TABLE 1: THE INNOVATION PROCESS

Appendix A

Innovation Stage: Product Definition to Engineering Prototype

Technical Development	Market Development	Business Development	Skills Required	People Involved
Product Definition	Define Market	Decide to Develop; Find Money	Intuition to Technical	Inventor
Working Model	Define Three Points of Competitive Difference; Pricing Strategy	Find More Money	Technical to Engineering	Inventor
Engineering Prototype Test Refine	Identify Market Barriers Decide to License or Venture	Find More Money Protect: Patent/ Trade Secret Start Business Plan	Engineering Legal Market Analysis Capital Acquisition	Inventor Local Technicians Friends as Investors Inventor Engineer Patent Attorney More Investors Market Analysis Business Planner

Entrepreneurial Stage: Prototype to Production

Technical Development	Market Development	Business Development	Skills Required	People Involved
Production Prototype Scale Up Test Refine Production Engineering Product Safety Engineering	Full Market Analysis and Plan Niches Barriers Pricing Competition Cost Data Distribution Method Alternative Product Applications Risk Analysis Sales Projections	Find Big Money Complete Business Plan Form Business Meet State and Federal Regulations Arrange Insurance Price Production Facility	Engineering Production Product Safety Entrepreneurial Financing Marketing Cost Analysis Legal Management	Inventor (?) Entrepreneur Investors Engineers Production Safety Attorneys Patent Corporate Accountants Consultants Marketing Business Management Financial Insurance Brokers Trade Union Officers
Limited Production Qualification testing Running changes	Contact Customers Commence Distribution Seek Product Endorsements Follow-up Sales Advertise Publish in Technical Journals	Find Big, Big Money Start-up Business Build Plant Buy Equipment Hire Foreman and Labor Arrange Product Service Purchasing Transportation Record Keeping	All of the above -PLUS- Specialty Engineering Systems Engineering Sales Analysis Supervisory	All of the above -PLUS- Foreman Labor Sales People Specialty Engineers Systems Engineers
Full Production Start-up	All of the Above -PLUS- Expand Distribution Analyze Competitor Response	All of the Above -PLUS- Monitor Costs Finance Cash-Flow Deficit Refine Production System	All of the Above -PLUS- Delegation Market Forecasting Strategic Planning Long-Term Financial	All of the Above -PLUS- Expanding Management Sales Labor Force
Initial Growth	Increasingly Complex	Increasingly Complex	Increasingly Complex	Increasingly Complex

Managerial Stage: Production for Major Market Penetration

Technical Development	Market Development	Business Development	Skills Required	People Involved
Product Improvement New Products Sustained Growth	Complexities Intensify		Complex Management	Entrepreneur (?) Fully Bureaucratized management R&D Staff National Investment Firm

EVALUATION

PILOT ENVIRONMENTAL TECHNOLOGIES COMMERCIALIZATION PLANNING
WORKSHOP

SEPTEMBER 22 - 25, 1992

TTP # AL 114101

Principal Investigator: Sarah Hayes
Applied Environmental Technologies
Los Alamos National Laboratory

	excellent	good	poor
1. The quality and relevance of information presented was	90% (x)	10% (x)	()
2. The quality of presentation and expertise level of Mohawk Faculty was	90% (x)	10% (x)	()
3. In support of DOE/OTD's technology commercialization goals the content of the workshop was	80% (x)	20% (x)	()
4. My commercialization prospects are	50% (x)	50% (x)	()
5. The investment of my time in the is workshop I consider	100% (x)	()	()
6. I rate the overall workshop	100% (x)	()	()
7. The workshop: <u>90%</u> exceeded <u>10%</u> met ___ was below my expectations.			
8. Would you recommend this workshop to:			
a fellow PI	yes <u>100%</u>	no ___	
your management	yes <u>100%</u>	no ___	
others <u>DOE MGMT</u>			
9. Is the action plan you generated a valuable tool and relevant to your efforts? yes <u>100%</u> no ___			
10. Do you feel you have a greater knowledge of market analysis and its importance? yes <u>100%</u> no ___			
11. What follow-up support do you need to succeed?			

See Attached

12. Overall comments:

See Attached

THANK YOU FOR PARTICIPATING!!

**COMMERCIALIZATION TRAINING AND INDUSTRIAL PARTNERING
AT LOS ALAMOS NATIONAL LABORATORY
RESEARCH SURVEY**

This survey is part of my Master's thesis. The purpose of this survey is to investigate the impact of commercialization training and the organizational factors that affect the laboratory's partnerships with industry. Please return this completed survey to Sarah M. Hayes, MS J591, Fax 665-5118. Thank you in advance for your contribution to this research. Please return by Friday, April 14, 1995. Signing your name is optional.

SECTION A: ABOUT YOUR COMMERCIALIZATION TRAINING

1. I have attended a Commercialization Planning Workshop. 100% Yes No
2. If yes, I have actively been implementing an action plan. 68% Yes 32% No
3. If yes, I have created additional action plan(s). 23% Yes 52% No *25% na
4. As a result of implementing my action plan, I have:
 - (4.1) 7 Signed a CRADA. 22%
 - (4.2) 9 Applied for a patent. 29%
 - (4.3) 15 Hosted an industrial visit. 48%
 - (4.4) 0 Been issued a license.
 - (4.5) 5 Partnered with industry in a ATP, TTI or, TRP proposal. 16%
 - (4.6) 2 Sign a User-Facility Agreement. 6%
 - (4.7) 3 Hosted an industrial staff member exchange. 9%
 - (4.8) 8 Worked closely with a marketing professional. 26%
 - (4.9) 12 Work closely with an IPO staff member. 39%
 - (4.10) 1 Been issued a patent. 3%
 - (4.11) 8 Submitted a patent disclosure to legal. 26%
 - (4.12) 7 Stopped work on project as it had diminishing return. 22%
5. To date additional funds in from an industry partner to continue my science land research has been \$300K, 80K, 50K, 50K, 10K, = \$490K
6. How many years have you worked at the laboratory?
 - (6.1) 11 1-10 years (6.2) 21 over 10 years
7. Your training is in:
 - (7.1) 25 Science (7.2) 6 Engineering
 - (7.3) 1 Business
8. Your highest academic degree:
 - (8.1) _____ High School (8.2) 4 Bachelor
 - (8.3) 3 Master (8.4) 25 Doctorate

• * NA= no answer

• All numbers indicate numbers of responses, except for the percentages on questions 1, 2, 3.

• A total of 101 surveys sent, 32 surveys returned.

SECTION B: ABOUT YOUR VIEWS

B1. CPW was a valuable use of my time: _____ Yes _____ No

Please enter the degree to which you agree or disagree with the following statements:

	<i>Strongly Disagree</i>				<i>Strongly Agree</i>	
B2. Attending the CPW was a valuable use of my time.	1	2 ²	3	4 ¹²	5 ¹⁸	94%
B3. It gave me a greater comfort level in working with industry.	1 ¹	2	3 ⁹	4 ¹⁴	5 ⁸	
B4. It removed my sense of the mystery of a new discipline, commercialization.	1	2 ²	3 ¹⁴	4 ⁷	5 ⁹	
B5. It gave me the knowledge and insight about a project that had diminishing returns.	1 ⁵	2 ²	3 ⁸	4 ¹³	5 ⁴	
B6. It taught me how to recognize and obtain the added resources I need.	1	2 ⁵	3 ⁹	4 ¹⁵	5 ³	
B7. It led me to more resources and contacts.	1	2 ⁴	3 ¹⁴	4 ⁸	5 ⁶	
B8. It enabled me to do more science in the long-run.	1 ⁵	2 ¹¹	3 ¹²	4 ³	5 ¹	
B9. It enabled members in my group to do more science in the long.	1 ⁶	2 ⁹	3 ¹¹	4 ⁴	5 ²	
B10. It connected me with peers and colleagues doing similar work.	1 ²	2 ⁴	3 ⁶	4 ¹⁵	5 ⁵	
B11. It introduced me to commercialization and marketing support staff in the lab.	1	2 ¹	3 ⁸	4 ¹⁴	5 ⁹	
B12. It increased my understanding of the motivation and values of potential industry partners.	1 ¹	2	3 ⁵	4 ¹⁵	5 ¹¹	
B13. It gave me necessary skills to succeed in the 90's.	1 ¹	2 ⁴	3 ⁸	4 ¹²	5 ⁵	
B14. I am confused about the lab's position partnering with the industry.	1 ⁴	2 ³	3 ⁵	4 ¹²	5 ⁸	
B15. I am confused about my management's position partnering with industry.	1 ⁵	2 ⁷	3 ⁴	4 ¹¹	5 ⁵	

	<i>Strongly Disagree</i>				<i>Strongly Agree</i>	
B16. I am confused about the various roles and responsibilities of people in program and division offices, relating to industrial partners.	1 ²	2 ⁶	3 ⁹	4 ¹⁰	5 ⁵	
B17. I believe the lab should actively engage in technology transfer.	1 ²	2 ³	3 ¹	4 ¹³	5 ¹³	
B18. Scientist should have skills and knowledge about commercialization.	1	2 ²	3 ⁴	4 ¹⁴	5 ¹²	
B19. This lab has valuable technologies to co-develop with industry.	1 ¹	2 ⁴	3	4 ¹¹	5 ¹⁶	
B20. This lab is structured well to encourage technology transfer.	1 ¹³	2 ¹³	3 ⁵	4 ¹	5	
B21. There is currently support from my supervisor for the conduct of technology transfer.	1	2 ²	3 ⁹	4 ¹³	5 ⁷	INA
B22. Working closely with marketing and commercialization staff is good use of my time and resources and lets me do more science.	1 ⁷	2 ⁴	3 ⁹	4 ⁹	5 ²	INA
B23. Working with industry is a good use of my time and resources and enhances science in the long-run.	1 ²	2 ²	3 ⁹	4 ¹³	5 ⁶	
B24. Partnering with industry is within the spirit of letter of the lab's mission.	2		8	13	8	INA
	1	2	3	4	5	

SECTION C: MAXIMIZING THE IMPACT OF TRAINING

The following mechanisms have increased the effectiveness of my initial CPW training:

C1. On going CPW support groups.	1 ³	2 ⁷	3 ¹²	4 ⁸	5 ²	
C2. CPW newsletter.	1 ²	2 ⁶	3 ¹¹	4 ¹⁰	5 ²	1NA
C3. E mail communications.	1 ¹	2 ⁸	3 ⁸	4 ¹³	5 ²	
Additional training:						
C4. IPO technology transfer overview.	1	2 ¹	3 ¹¹	4 ⁵	5 ²	13NA
C5. Program Development course:						32NA
C6. Presentation skills workshop.	1	2 ¹	3 ⁹	4 ³	5 ⁴	15NA
C7. Working with Marketing and Commercialization staff.	1 ³	2 ⁴	3 ⁹	4 ¹²	5 ²	2NA

	<i>Strongly Disagree</i>			<i>Strongly Agree</i>		
C8. Working with IPO staff.	1 ⁴	2 ⁷	3 ¹³	4 ⁷	5	
C9. Working with library staff.	1 ¹	2 ⁴	3 ¹³	4 ⁵	5 ⁴	5NA
C10. The "immersion" format of the CPW had more impact for me than a traditional "lecture-style course".	1 ¹	2 ²	3 ¹	4 ¹²	5 ¹⁶	

SECTION D: INCENTIVES AND STRUCTURAL CHANGE

D1. My division needs a marketing department.	1 ⁶	2 ¹⁰	3 ⁴	4 ⁷	5 ⁵	
D2. The lab should have a marketing department.	1 ³	2 ²	3 ⁴	4 ¹³	5 ¹⁰	
D3. Royalty revenue would motivate me to partner with industry.	1	2 ⁶	3 ⁵	4 ¹⁰	5 ¹¹	
D4. Equity positions in spin-off companies using my invention would motivate me to partner with industry.	1	2 ⁶	3 ⁴	4 ¹¹	5 ¹¹	
D5. The lab should have a charge code I could use to account for my time in developing partnerships with industry.	1 ¹	2 ⁴	3 ⁷	4 ⁸	5 ¹²	
D6. The Director's office should have discretionary money to devote to industrial partnership cost-share agreements.	1 ¹	2 ³	3 ⁸	4 ⁷	5 ¹³	
D7. The divisions should have discretionary money to devote to industrial partnership cost-share agreements.	1 ¹	2 ⁴	3 ⁴	4 ¹²	5 ¹¹	
D8. The program offices should have discretionary money to devote to industrial partnership cost-share agreements.	1 ²	2 ²	3 ⁶	4 ¹²	5 ¹⁰	

SECTION E: ABOUT ME, ABOUT CULTURE CHANGE

E1. I am an entrepreneurial individual at heart.	1	2 ⁴	3 ¹⁰	4 ⁹	5 ⁹	
E2. I have always been interested in business.	1 ⁴	2 ⁵	3 ¹⁰	4 ⁸	5 ⁵	

	<i>Strongly Disagree</i>				<i>Strongly Agree</i>
E3. I am a scientist at heart.	1	2 ²	3 ³	4 ¹³	5 ¹³
E4. I consider myself a leader.	1	2 ²	3 ²	4 ²⁰	5 ⁷
E5. I consider myself a risk-taker.	1 ¹	2	3 ⁸	4 ¹⁴	5 ⁸
E6. Training is a good tool to use in accelerating culture change.	1	2 ¹	3 ⁵	4 ¹³	5 ¹³
E7. The lab's culture has definitely changed in the past 5 years.	1 ³	2 ¹	3 ⁷	4 ⁸	5 ¹²
E8. The CPW training definitely changed my attitude about partnering with industry.	1 ⁴	2 ³	3 ⁵	4 ⁵	5 ⁵
E9. The CPW training made me excited to work with industry.	1 ²	2 ¹	3 ⁸	4 ¹⁵	5 ⁶

ADDITIONAL THOUGHTS, COMMENTS, SUGGESTIONS:

NAME _____ (OPTIONAL)

**PLEASE FAX TO SARAH HAYES 665-8118
OR MAIL J591**

THANK YOU

CPW Action Plan Return on Investment Report July 1994

Program Growth		CRADA	User Facility	Small Business Agreements	
\$1 M Duncan MacArthur		\$320 k Minimeter, Larry Berkbigler	\$ 20 k Gac/BF Goodrich	\$112 k Rich Castro CRADA LaserFare	
\$350 k Frank Gac (internal \$)		\$500 k EG&G, Russ Gritz (being negotiated)		\$112 k Marty Piltch CRADA LaserFare	
\$220 k Dan Knobloch (TTI)		\$ 112 k MM&D, Steve Agnew		\$112 k Larry Foreman, CRADA Vision Ventures	
		\$200 k USCAR, Don Hastings		\$112 k Dave Janecky CRADA RKK, Ltd.	
Total: \$1,550,000		Total: \$1,132,000	Total: \$20,000	Total: \$448,000	
Consortia and Collaborative Agreements		University Partnerships and Staff Exchanges	Patents	Industrial Outreach Meetings	Projected Agreements FY95
TRP	Frank Gac	\$34 k U of Az, Gritz	DeQuan Li (1 in process)	Russ Gritz, Stack Monitoring	\$3 M CRADA BFG
NMTA Partnerships	David Stupin	Summer Student, Gritz	David Morris (1)		\$500 k CRADA Motorola
ATP	Robert Hollen	Post Doc, Knobloch	Duncan Mac Arthur (6 in process)	Larry Berkbigler, Heat Stress Monitor	\$500 k ISSECS
MOI	Several		Koskelo (1 in process)		\$3 M CAA Martin Marietta
			Proprietary Information Agreementss: several		\$5 M CAA ATP
			Gac		Total: \$12,000,000
			Janacky		User Facility (projected):
			Castro		\$ 50 k Li
					\$ 50 k Stupin
					\$200 k Castro
					Total: \$400,000
		Total: \$34,000			

Post CPW Training Interviews

1. Do you think immersion style training is effective in changing attitudes? Why? Have you seen this phenomenon (attitude change) as a result of CPW training?
2. Do you think CPW training increases productivity of the worker? Why? How? Do you have examples?
3. Is training an effective tool to use in accelerating culture change? Have you seen any examples or results as a result of CPW training? Be specific.
4. In your view can training be an effective tool to use in complementing and accomplishing organizational goals? Why? Has it worked for the Los Alamos partnering with industry tactical goal #6?

α

Los Alamos

Commercialization Timeline

Large Volume Flow-Through Detector

This report has been reproduced directly from the best available copy.

It is available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831. Prices are available from (615) 576-8401.

It is available to the public from the National Technical Information Service, US Department of Commerce, 5285 Port Royal Rd. Springfield, VA 22616.