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A qualitative study of technology transfer in sustainable green manufacturing

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ABSTRACT

A QUALITATIVE STUDY OF TECHNOLOGY TRANSFER IN SUSTAINABLE GREEN MANUFACTURING

**by
Susan Muldowney**

The Sustainable Green Manufacturing Project is an initiative of the United States Army to develop environmentally-friendly technologies for Army-designated facilities. In pursuit of this goal, the Army has sought the research capabilities and expertise of outside organizations including the New Jersey Institute of Technology and Concurrent Technologies Corporation. The groups interact and exchange knowledge and tools with each other as well as with potential end users of the green technology. This exchange of knowledge and tools is known as technology transfer.

Researchers and Subject Matter Experts who are working on the SGM Project were interviewed in order to learn about the technology transfer process in a green innovation project. Their responses were analyzed and results were used to determine the successful and problematic aspects of the technology transfer in SGM, and how it is impacted by the environmental aspect.

**A QUALITATIVE STUDY OF TECHNOLOGY TRANSFER
IN SUSTAINABLE GREEN MANUFACTURING**

**by
Susan Muldowney**

**A Master's Thesis
Submitted to the Faculty of
New Jersey Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of
Master of Science**

**Department of Humanities and Social Sciences
Environmental Policy Studies**

January 2000

APPROVAL PAGE

**A QUALITATIVE STUDY OF TECHNOLOGY TRANSFER
IN SUSTAINABLE GREEN MANUFACTURING**

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CHAPTER 1

INTRODUCTION

1.1 Objective

The objective of this thesis is to describe qualitatively how an environmental orientation impacts the technology transfer process of an innovation project. The assessment will be determined through analysis of structured interviews with researchers and subject matter experts (SMEs) in a sustainable green manufacturing (SGM) project. This study will provide an overview of green innovation and technology transfer; advise policy makers and program managers of potential obstacles to technology transfer in green projects; and suggest ways of anticipating or overcoming these obstacles.

Eighteen researchers and SMEs in an SGM project were interviewed in order to learn about the technology transfer process. Their responses were analyzed for recurring themes, and specific suggestions for improving the green technology transfer process were formed based on their opinions, suggestions, worries, complaints, and success stories. The interviewees were from two organizations, one academic and one commercial, that are partners in the project. Their experiences were compared and suggestions from both groups were incorporated into the concluding recommendations.

1.2 Background Information: The SGM Project and Technology Transfer

This study focusses on an Army-funded green innovation project. This SGM Project came about because of the Army's need to reduce its negative impact on the environment. In 1993 it was required by President Clinton, in Executive Orders

EO12856, EO12843 and EO12873, that all Federal Agencies including the military comply with more stringent environmental standards. These standards had been set in the 1990 amendments to the Clean Air Act and Pollution Prevention Act. The SGM Project could also be seen as the Army's strategy to reduce its liability for future clean up or remediation of its sites.¹ Environmental damages would be paid for, whether the Army's cost would come from pollution prevention efforts or from clean up. Over the long term, it would be far cheaper and efficient to prevent pollution than to clean it up

The Executive Orders can be seen as a case where policy was put into effect *without the existence of technology* that would make the standards reachable.² In other words, if the Army was unwilling to give up its guns and bullets because the manufacturing process was harmful to the environment, it needed to modify or invent the necessary green technology to comply with the laws.

The goals of the SGM project make it clear that the Army would like to keep many existing products, such as tanks, guns and bullets, but with modifications to reduce pollution or waste. The Army is also interested in developing entirely new processes for manufacturing, as opposed to modifying existing ones. Due to the limitations of Army laboratories, and due to the vast scope of the research area, the Army solicited research partnerships from civilian organizations. NJIT succeeded in its proposal and received funding for ten segments of the overall project, called *subtasks*. As part of the SGM research team, NJIT has been working with military facilities and with other researchers at CTC in Johnstown, Pennsylvania.

¹ National Defense Center for Environmental Excellence (NDCEE) web site.
<http://www.ndcee.ctc.com/overview.htm>

² NDCEE web site. <http://www.ndcee.ctc.com/overview.htm>

Some of the tasks are exploratory research to find out if a new process is feasible. Other tasks are expected to deliver a specific process for the Army or its contractors to use. The NJIT subtask titles are listed below:

Green Process Simulation: Environmental Lifecycle Model
Green Ammunition: MIC Primer Scale-Up
Green Ammunition: New Synthetic Routes
CMA – Laboratory Studies and Target Production
Lifecycle Environmental Impact
Supercritical Fluids: Process/Synthesis/Recovery
Membrane Separation Process
X-ray Absorbing/Scattering Structural Characterization
Demilitarization and Disassembly
Education and Training

These NJIT subtasks fall into the broader project goals which are shared by CTC and other participating research centers: Recycle/Recovery/Reuse; Treatment and Remediation; Environmental Management; Technology Transition and Insertion; Cleaning and Removal. CTC employees worked on similar projects, such as finding substitutes for chromium processes or evaluating risk. However, they were not necessarily working jointly with NJIT on a regular basis. Some were working on the same topic, but in a different area or application.

Just as the subtasks differ widely, the expected deliverables are different for each group. Some tasks will result in a written report, such as a risk evaluation. It is possible that a deliverable will simply be the conclusion that an experimental process is *not* possible for manufacturing use. So this study involved researchers who are in the very early stages of fundamental research, all the way to researchers who have a fully-developed process or recommendation – Those who are not only communicating research

ideas but trying to get the technology implemented. This difference in deliverables seemed to be a significant influence on the researchers' SGM experience

This section will introduce concepts of SGM and technology transfer which will be used throughout this thesis. Sustainable Green Manufacturing (SGM) is a general term while SGM Project is the name of the Army-funded project. SGM aims to reduce the impact of a product on the environment. The impact may come from the materials, pollution, energy consumption, or waste generated during manufacturing or when the product is discarded. So SGM looks for ways to consume fewer virgin resources, to improve the recyclable content and recyclability of a product, and to use less hazardous materials. The SGM Project applies this philosophy to military products and processes. Where SGM was not part of the original design process, it is necessary to re-engineer an existing product or create an entirely new product or process. This is called green innovation.

Since the impacts originate at many points, from raw material to disposal, SGM considers a product in terms of its *life cycle*. Life Cycle Analysis (LCA) first pinpoints the potential environmental impacts, then looks for ways to reduce or eliminate the impacts.

This way of thinking is a departure from end-of-pipe solutions, which was how regulation first approached the problem of reducing pollution. The problem with end-of-pipe methods is that there is still waste to dispose of, it is costly, and it has limits as to what levels of environmental quality can ever be achieved. It also has no effect on improving efficiency or reducing cost, since materials are handled in the same wasteful

way. End-of-pipe methods are still used, such as scrubbers on smoke stacks, but they are not the foundation of current environmental innovation.

SGM has the potential to reduce costs especially in the area of disposal, because there is an effort to create a product that is made from recycled materials, reusable, or easily dismantled and recycled. SGM also looks for ways to reduce input energy, so even a simple step like insulating a pipe can result in greater efficiency and cost savings. In terms of input materials, SGM engineering considers environmental impact as a parameter, just as chemical properties and cost are usual engineering parameters. The environmental parameter will influence a decision to use a more expensive, less hazardous material because over the life cycle of the product, it will be cheaper.

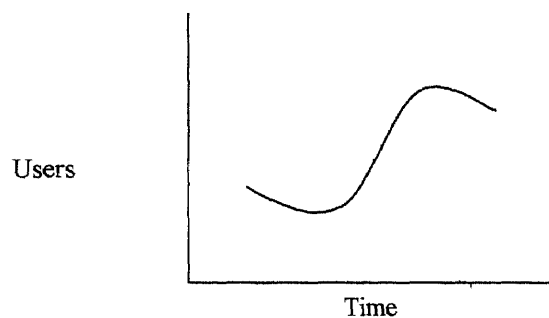
An important aspect of any innovation program is *technology transfer*. This is the process by which new technology is conveyed and/or implemented. While it might seem that *technology* is a physical tool, this term also includes ideas and knowledge.

Technology transfer is not a final phase of research project, as if the technology were a package to be delivered from the lab table to the office. It is the day-to-day flow of information among the research team members, and may also involve the *end user*, or intended recipient. The end user is often the funding source that commissioned the research, but may be simply a target audience for the technology.

Good technology transfer can help a team meet its goals. Bad technology transfer can stifle a project and frustrate the research team and end users alike. The goal is to get the knowledge over a boundary, from source to user, and some boundaries are harder to hurdle than others. *Point-to-point* transfer occurs when there is one end user. *Diffusion* is the spread of a technology throughout a population.

The rate of adoption, whether the transfer is point-to-point or diffused, can be described by an S-curve (Figure 1). Just as marketers know that it takes some time for a new product to "take off," technologies also take time to find acceptance. There is a slow initial acceptance by first users, which then accelerates into a rapid growth of adopters, then tapers off as interest wanes or there are fewer potential converts left. The rate of rejection does not necessarily ever find an S-curve. The technology may appear on a graph as a blip or a swift downward curve towards oblivion. A researcher must persevere to get the technology successfully transferred and adopted. There may not be a *pull* from eager clients to get the new technology from the lab. So the researcher must *push* to get it out, to get the S-curve rolling.

Figure 1: The Rate of Technology Adoption is Represented by an S-curve



Technology transfer occurs in exchanges of information which may involve discussion and negotiation. There is no simple drop-off from source to receiver. The *mechanisms* of transfer can be journal articles, written reports, manuals, meetings, debates, conferences, e-mails, web pages, telephone calls, face-to-face talks, and so on.

There may be restrictions on the channels of communication. For instance, it may be necessary for a researcher to convey information to a project manager, who then speaks to the other work group to get the idea across. There may be levels of confidentiality among the organization that restrict one's access to personnel or data. There may be cases where the information flows only one-way, usually from the researcher to the funding source.

CHAPTER 2

THIS STUDY

2.1 Structure and Methods

The goal of this study is to aid policy makers and managers in understanding problems that may arise during green technology development. While building upon previous technology transfer studies that looked for mechanisms of communication, this study asked researchers for their preferences, successes, difficulties and recommendations for technology transfer, based on their experiences in SGM. So while many innovation studies concentrate on succeeding in the marketplace, or finding out what the end-user really wants, this case focussed on enhancing technology transfer for the researchers and Subject Matter Experts (SMEs). Where possible, obstacles to the technology transfer should be minimized.

In this study, the US Army wants a perfect technological solution to its pollution problem. But what does a highly trained researcher expect from SGM? What can a manager or policy maker do to better understand the attitudes of the research and development team?

The researchers in the Sustainable Green Manufacturing project shared by NJIT, CTC and the U.S. Army will be the focus of the study. Structured interviews will ensure that all interviewees will discuss a variety of aspects about their work. The interviews will then be transcribed and studied using *Nvivo*, a social science research software that aids in finding recurring themes and associations. The results will be qualitative, shedding

light on how environmental technology transfer really works, or where it fails, and how it may be different from other kinds of technology transfer.

The methods of Grounded Theory Building (GTB) were used to uncover recurring themes and characteristics of technology transfer in Sustainable Green Manufacturing. Like all qualitative work, the goal of GTB is to develop an understanding or to characterize a situation, and to make some sense of how and why it is that way. However, the methods of GTB may be a bit looser than some researchers are used to. Grounded Theory Building encourages the researcher to look for meaning in the data, to analyze and interpret it, and to make qualitative observations of the situation. These phases take place in parallel, meaning that writing, analysis, verification and research can take place on the same day, in the same minute, and there is no sequence that must be followed. GTB would look at technology transfer as an instance where two or more different groups interact and exchange information. At such meeting points, things and events have different meanings to different people. GTB would look for the key values, the meanings and significance of the interactions. Other people's work and theories are considered, but the goal is to extract observations of the data in order to draw conclusions.

2.2 Analysis

Eighteen interviews were conducted with the research team, which consists of nineteen people at NJIT and CTC. (One researcher was unable to participate due to work conflicts). Ten subjects were academic researchers from NJIT. The others were CTC employees. Due to scheduling difficulties, sixteen interviews were available in time for

this study. The interviews were organized as two distinct sets and results from each set were compared and contrasted. For confidentiality, all names were replaced by a code label such as R2, for NJIT Researcher 2, or C4 for CTC Employee 4.

In order to find recurring themes in the responses, each response was coded for its content. There were ten broad categories or “nodes”, some of which were further defined into sub- nodes, for a total of 30 nodes, as seen in Appendix A. Each interview did not cover all 30 nodes, but due to the structured nature of the interview, the responses were certain to cover a range of topics.

To test the inter-reader reliability of the coding, Dr. Nancy Coppola and I independently read and coded two interviews using a node set that I developed using Nvivo recommendations. The coding patterns were very similar except that I tended to have more nodes per interview. I saw some comments as problems and some as remedies for that problem. These comments could also be categorized simply as a summary of the research, a deliverable, or work experience. I believe the additional nodes refine the results rather than distort it.

Once all the interviews were coded for content, *Nvivo* software aided in the study of the data. For this study I first divided the interview subjects into two groups based on their workplace, NJIT or CTC. However, after studying the transcripts, I noticed that the participants divided into three groups, which I call *Satisfied*, *Mildly Concerned* and *Dissatisfied* (Table 1).

Table 1: Breakdown of Subjects into Groups

Satisfied (10)	Mildly Concerned (2)	Dissatisfied (4)
C1, C2, C5, R1, R2, R5, R6, R8, R9, R10	C3, R4	C4, C6, R3, R7,

There were ten Satisfied subjects. They had not encountered any significant problems or difficulties as they pursued their tasks. Their comments were generally positive, and had 0-2 criticisms of the technology transfer. They reported that all was going according to plan, that this was no different than any other type of research, and that they foresaw no problems. If they had any mild complaint, it was that the funding was insufficient for what they wanted to do. This comment on insufficient funding was expressed by 4 out of 5 subjects. Insufficient funding seemed to be the only significant complaint of the Satisfied group, yet was not mentioned as a huge obstacle, just something that restricted their research.

The two Mildly Concerned participants had zero or one complaint, and 1-4 mild difficulties that did not prevent them from doing their job. A lack of direction or feedback, rather than too much conflict, seemed to be the leading issue with this group. It did not impede their progress, but did not enhance it either.

The Dissatisfied had serious problems and were openly exasperated by one or several aspects of the project. They commented four or more times or at length on how the project could be improved. The Dissatisfieds tended to bring up their grievances early on in the interview, without being asked; i.e. as part of the answer to another question. The severity of the problems interfered with their work.

It might be said that the personality of the subject could determine whether they are optimistic, pessimistic, likely to complain or more reserved. I chose to look at what was said, and assumed that no false complaints were brought up, and that all answers regarding problems were candid.

2.3 Results

As the interviewer of eighteen different people I was struck by the different experiences of people working on one program. I expected more similarity among the NJIT researchers, but found wide variations in terms of type of research, stage of research, satisfaction with the technology transfer, and recommendations for improving the transfer. The responses ranged from satisfied to very frustrated, even exasperated with the project. The CTC group was also varied in their responses on these topics.

In looking for trends regarding technology transfer in SGM, I found some responses were exactly as expected. For example, all participants in the SGM project had written the required SGM monthly and annual reports. All had attended the in-process review meetings with Army personnel. All the interviewees showed prudence in the ways that they chose to communicate with others, and an awareness that communicating with the Army required more formality. They communicated informally (e-mail, web, telephone calls) when it was allowed, and otherwise used the formal channels of communication: project managers and formal reports. All interviewees had had some face-to-face interaction with Army personnel, and it seemed that the Army visited as often as the SGM group went to their sites. However, there were some researchers who seemed immune to the frustrations that were clearly bothering some other members of the SGM Project. Something was affecting the quality of the technology transfer for certain task teams.

What is the source of dissatisfaction? The Dissatisfied group did not have particularly arduous tasks. In fact, one researcher came aboard with a fully developed process to test, and so was not required to do exploratory research at all. This same researcher had the

most aggravation of all the participants of the study, with nearly every response to every question expressing exasperation with the project. Another one of the Dissatisfied had a fairly routine survey as a task but was consistently thwarted in his work. The aggravation of working with Army personnel could be blamed at first, except that all the researchers worked with the Army at some point.

The key to understanding the Dissatisfieds' complaints is to consider the audience of their ideas, questions and technology. The audience is not only the end user but also the people with whom the researchers and SMEs had to communicate in order to do their work (Table 2). The Army is not one audience, but a diverse group of differently skilled people. Some Army personnel were highly trained researchers who were pursuing parallel projects at military labs. Some Army personnel were depot managers, plant managers and other officers. The greatest influence on the quality of the technology transfer was the green motivation of the audience. In other words, if cost and performance mattered more than environment to the audience, the technology transfer was delayed or halted. The subjects of the study expressed ways that they thought would remedy the problem. The heart of the matter seemed to be overcoming the rift where the green aspect fails to have importance to the end user.

Table 2: Subjects and Non-SGM Contacts

	Researcher or SME
Work depends on colleagues/ other researchers in SGM	R1, R2, R5, R6, R8,R9, R10, C1, C2, C3, C5
Works depends on people outside of SGM- not always researchers	R3, R7, C6, C4
Works Alone	R4

Is green technology transfer any different? Is there such a thing as typical technology transfer versus green technology transfer? Typically, products are engineered for cost, performance, ease of production, or consumer appeal. Green innovation means products are refined or developed in order to reduce the item's impact on the environment. While it may result in cost savings or other economic benefits, such as reduced energy waste, green technology may appear to cost more at the point of manufacture. It may not be as durable or easily manufactured as an existing technology. Green technology transfer asks people to take pains in order to improve environmental quality, and the gains are not always immediate.

If the environmental parameter is still considered optional, what is the typical technology process? An R&D project usually has a goal of developing a cost effective technology - something that works and yields a profit. The six stages of a typical technology transfer are:

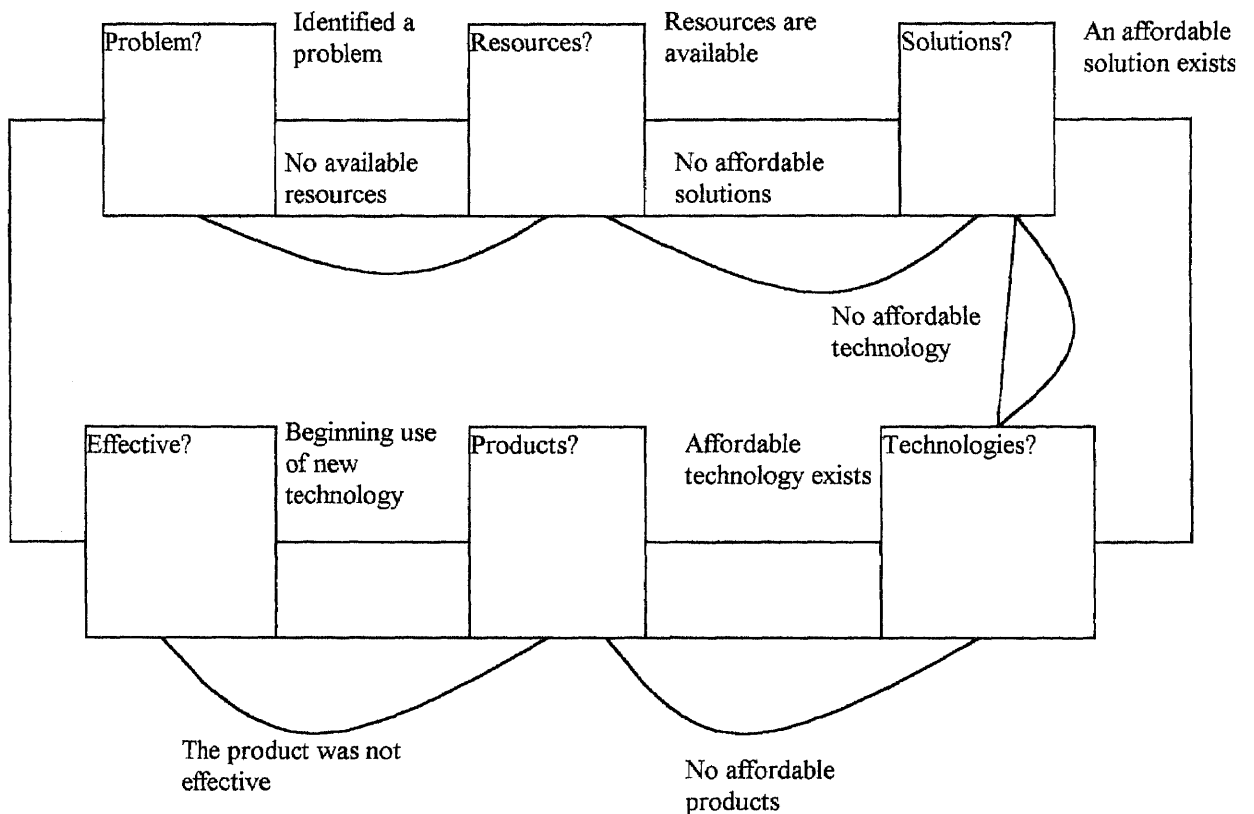
- Identifying a problem
- Finding resources such as money, time, space, people to work on the task
- Identifying possible solutions, and from these affordable solutions.
- Identifying possible technologies, affordable technologies
- Identifying possible products, affordable products
- Implementing and evaluating the idea, technology or product.¹

No progress can be made unless there is a satisfactory result in each stage. For instance, no project can start without identification of the problem, and can't proceed without resources. Figure 2 does a better job of showing the key concerns in the progress of a technology transfer project: money and effectiveness. If the cost of a technology is

¹ Kilduff, Blewett (1994) p. 160

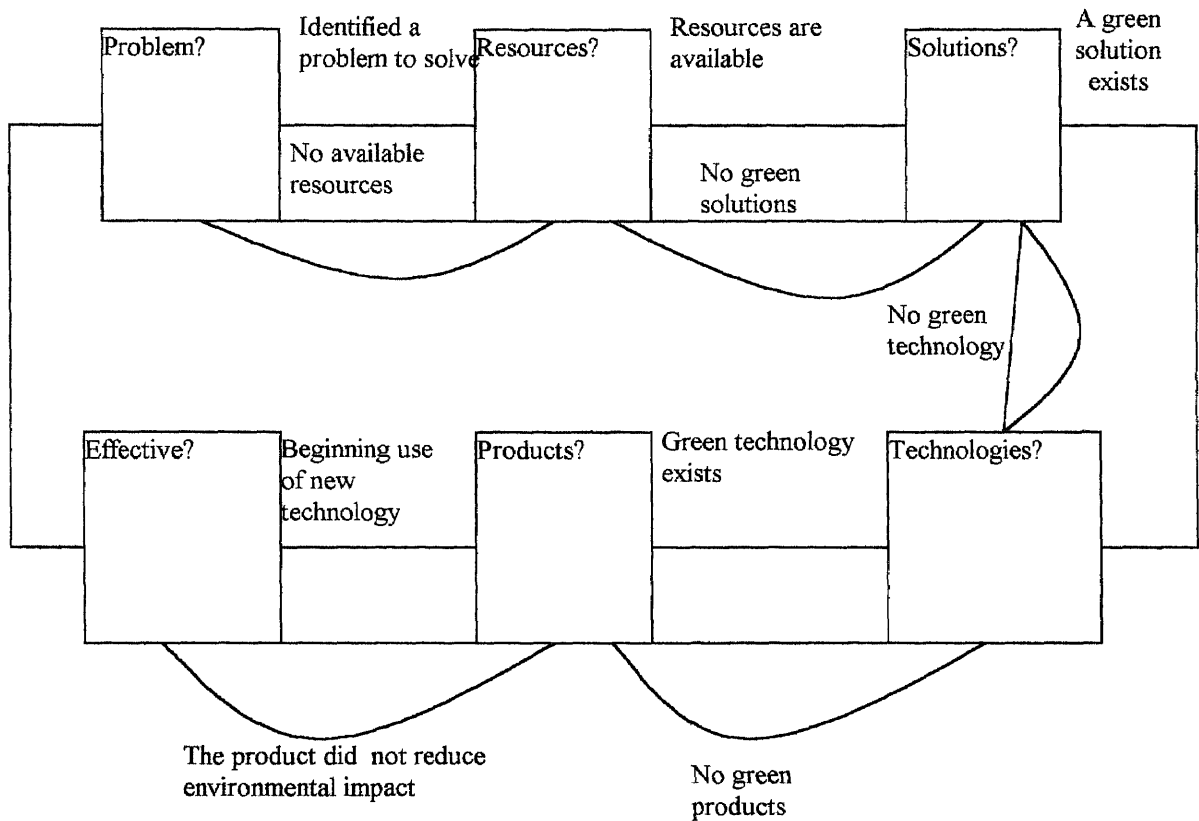
out of the range of the budget, it can't achieve implementation. The project stalls or retreats to a research stage, where a cheaper alternative is sought.

Figure 2: Typical Technology Transfer Process



The issues of cost and performance cannot be overlooked simply because the technology is environmentally-friendly. This is where the green aspect of a technology transfer can become a problem, rather than an attractive feature. A green technology transfer places environmental impact as a key concern, more than cost. See *Figure 4*.

Figure 3: Green Technology Transfer Process

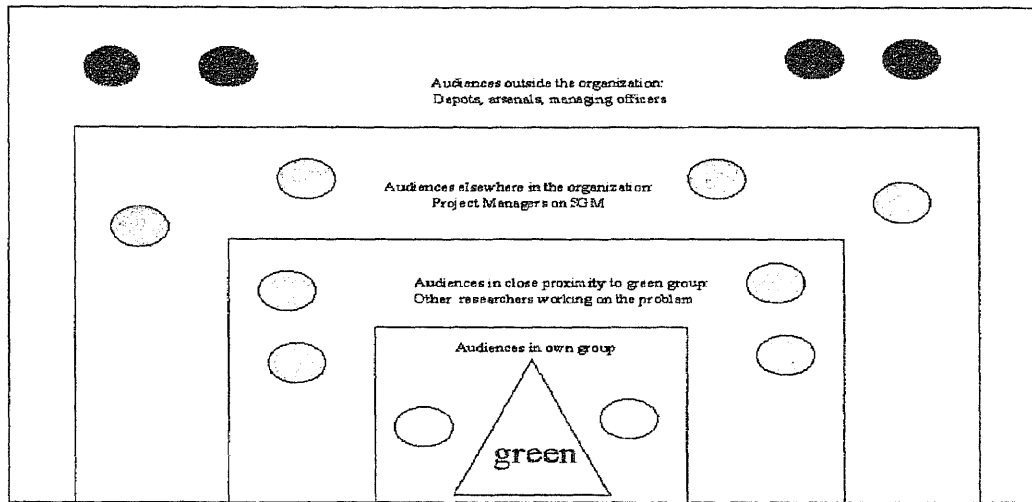


Green technology does want to consider cost and performance, and strives to at least match existing technology. But it is important to realize that the technology transfer will stall as soon as the green aspect fails to have leading importance in the decisions of the end user.

The receptivity and comprehension of the audience can be determined by its distance to the green technology source, the researcher or SME. Colleagues within the program have similar interests and education. People who are outside the research team may not have the education to fully understand the tasks, but still place a value on the green

aspect of the technology. Moving further out, to people who are not affiliated with the SGM program or are outside the organization, they are least likely to value the green aspect of the technology and will most likely think in conventional ways of input *cost* versus immediate *benefit*. See Figure 4²

Figure 4: Audiences Increasingly Removed from Green Concerns.



Before judging the technology transfer to be effective simply because the Satisfied outnumber the Dissatisfied, it should be noted that many of the Satisfied may simply have not yet encountered a non-green audience. The Mild Concerns have had some exposure to an unenthusiastic, or unresponsive audience. Perhaps due to the solitary nature of their assignment, the non-green audience has not halted their work, but it has not helped it either.

² Mathes and Stevenson (1976) p. 15

While this may seem obvious, that green technology transfer will have problems that other types of R&D projects do not, it is not obvious to the people working on the project. (Table 3). Many of the researchers and SMEs claimed that the green aspect made no difference in their work. Others, particularly the Dissatisfieds group, were aware that it could have an impact on the acceptance of the technology.

Table 3: Does the Green Aspect of the Project Make it Any Different?

Satisfieds	Yes
C2	Not only on this project but on all our projects. Us being an ISO 14000 compliant company, we already look at environmentally friendly types of things.
R8	Naturally it will be slightly different because here we are dealing with the army. When you deal with companies there is a different objective, they have profit making goals.
C5	Usually in my regular job I don't look at neurotoxicity or teratogenicity as <i>critical</i> , as I do in sustainable green.
R2	I think technology programs with the green is always a special case because the project is being sold because it is green. As opposed to being more profitable or productive.
Satisfieds	No
C1	I think it was the same when I was back at Company X and it was Total Quality Management... I think it's called something different now but I don't think it's any different.
R5	No, it's chemistry.
R6	No, not really. I teach this, I do all my research regardless of who funds it in this general area.
R9	I don't think the green aspect is any different.
R10	I don't think so. Because in particular, we're looking at it from a fundamental perspective, so it doesn't really matter what you call it, outside.
R1	All my work is environmental.
Dissatisfieds	Yes
C6	Yes. Justifying it. Green products are typically not less expensive than their counterparts. They're usually more expensive.
C4	I think as far as green goes, I think all depots are pretty much, how do I want to say it, <i>numbed</i> to the word environmentally-friendly because there's just so many technologies out there that just don't fit the mold for whatever they're trying for.
R7	The process of technology (transfer) is somewhat more difficult in the sense that the person or the facility where you are transferring must be very interested. See, normal technology transfer processes, there may be a market pull.
	No
R3	Probably not.

Table 3 (continued)

<i>Mildly Concerned</i>	<i>No</i>
C3	All our projects are like that.
	<i>No Comment</i>
R4	I wouldn't comment too much because I don't have much experience working on R&D for companies.

Is there a connection between the own motivation to pursue environmental research and their level of satisfaction? Does it relate to their thoughts on whether the green aspect makes a difference in the technology transfer? First I looked at responses to see who said that the green aspect of the project made it appealing to them (Table 4).

Table 4: Green Motivation of Interview Subjects

	Motivated by green aspect?	Believe green makes the project different?	SGM Experience?
C1	No	No	Satisfied
C2	Yes	No	Satisfied
C3	No	No	Mildly Concerned
C4	No	Yes	Dissatisfied
C5	Yes	Yes	Satisfied
C6	No	Yes	Dissatisfied
R1	Yes	No	Satisfied
R2	Yes	Yes	Satisfied
R3	Yes	No	Dissatisfied
R4	No	No answer	Mildly Concerned
R5	Yes	No	Satisfied
R6	Yes	No	Satisfied
R7	Yes	Yes	Dissatisfied
R8	Yes	Yes	Satisfied
R9	No	No	Satisfied
R10	No	No	Satisfied

There does not seem to be a correlation between the green motivation of the researcher or SME and the positive or negative comments on the SGM project. There is some connection between the people who think the green aspect makes the project different, and the people who had a negative experience. In the case where a CTC

employee (C5) said that the green aspect made a difference, yet he was happy with the task overall, it should be noted that the difference, for him, was in his thought processes. He did not mention problematic differences that were connected with green technology transfer, as the Dissatisfieds did. R3 thought the problem was with the Army itself, not the green aspect, and so stands out among the Dissatisfieds as the one who did not feel that the problems were related to the green aspect.

Before going into problems, it is important to look at the expectations of the researchers and SMEs regarding technology transfer. When asked about their ideal technology transfer situation, the responses ranged from the realistic (R1: "I think it's important to have meetings.") to a purely imaginary feature of the technology transfer process, such as a necessary employee for the project, or a data base on the Web. In general, the researchers and SMEs wanted open communication, convenience, responsiveness and timeliness.

Satisfieds:

C1: I've offered to some folks to be able to come back here and actually see the technology up and running so they can get a feel and understand how that works, so that would kind of be my view.

C2: For the best possible transfer of information, timely response is important because we have fresh ideas

R2: People will come to you.

R8: We have to work jointly. We have to continuously keep people in industry who are going to be the users of our design processes, whatever. And they should continuously give us feedback and review.

R9: We prefer to be quite open about it and there is a tradition of a university of disseminating knowledge for everybody.

Mildly Concerned:

R4: I would actually prefer to have more closer contacts. Some feedback, I would put it this way.

C3: I don't know whether we do anything after we send out a report for these projects, do we then follow up six months, a year later and call the client? ... That's never been explained to me. Hopefully we do. To keep the pot boiling, so to speak.

Dissatisfieds:

C4: I've noticed, with military depots, and actually every person that I've met, vice president, salesperson, they all want to be treated like a normal person. I mean the best way to do that is to take them out for a beer and that just breaks the ice.

C6: Well, let's see. I'm lazy and seek instant gratification. So I'd love it if it just showed up somehow electronically... My ideal goal would be a centralized website that would have a database that would have all of the products that are available, as well as information on up-and-coming products.

R3: I would say that it could only work if there is a specific person whose job depends on making this work, translate into what they are doing here. Then I think everything kind of falls into place.

Of course, what the subject describes as the ideal technology transfer situation is either something that has been experienced in SGM, or has not. The Satisfied group mentioned situations that they had, to some degree, experienced in SGM. The Mildly Concerned group hoped for qualities that they had not experienced, and the Dissatisfieds had suggestions for overcoming their present problems.

To see how the groups differentiate themselves on specific areas of technology transfer, I looked at their responses regarding funding, time and timing of the project, direction that they received, responsiveness from contacts and end users, and accessibility of data. I coded the interviews to note where the SGM project had effective performance in these areas, and also to note where there were problems (Tables 5-10).

Table 5: Satisfied Group and Effective Aspects

	Funds	Time	Direction	Response	Data accessible
C1	X	X	X	X	X
C2		X	X	X	X
C5	---	----	X	X	X
R1	---		X	X	X
R2		---	X	X	X
R5		---	X	X	X
R6	---	---	X	X	X
R8	----			X	X
R9			X	X	X
R10	----		X	X	X
Totals	1	2	9	10	10

Table 6: The Satisfied Group and Problematic Aspects

	Funds	Time	Direction	Response	Data accessible
C1					
C2					
C5	X	X			
R1	X				
R2		X			
R5		X			
R6	X	X			
R8	X				
R9					
R10	X				
Totals	5	4	0	0	0

Table 7: The Mildly Concerned Group and Effective Aspects

	Funds	Time	Direction	Response	Data
C3		---	X	---	X
R4	X		---	---	X
Totals	1	0	1	0	2

Table 8: The Mildly Concerned Group and Problematic Aspects

	Funds	Time	Direction	Response	Data
C3		X	---	X	---
R4			X	X	---
Totals	0	1	1	2	0

Table 9: The Dissatisfied Group and Effective Aspects

	Funds	Time	Direction	Response	Data
C4		---		---	---
C6	---	X	X	---	---
R3	---	---	---	---	
R7	X	X	---	---	---
Totals	1	2	1	1	0

Table 10: The Dissatisfied Group and Problematic Aspects

	Funds	Time	Direction	Response	Data
C4		X		X	X
C6	X	---	---	X	X
R3	X	X	X	X	
R7	---	---	X	X	X
Totals	2	2	2	4	3

The key points of concern for the Dissatisfied group are the lack of response from the end user or point of contact, and the inaccessibility of the data needed to complete the task. These cause frustration, perhaps even halt the project. When each subject with serious problems was asked to pinpoint the source of the problem, C4 gave some examples:

C4: So anyway, one of the air logistics centers we went to, they, the guy straight out told me, he said, you know I don't want you, I don't want to give you any of our processing data because this is proprietary information and if commercial vendors knew this information they could bid against us and get the projects... So you touch a few sensitive nerves when you go prying into these different places.

C4: One way to get into depots, or just to maintain friendships with these people is not to ask something of them without providing something to them. And in this instance I'm asking the army depot to tell me all their problems which is one thing they really don't want to do... So you go down there and you ask him, all right, what took you so long to do this. What I was asking him to do was rehash all of his problems.

C4: One thing I'm kind of stuck on right now with this project is I'm not getting all of the cooperation that I'd like to get.

C4 hopes to overcome these problems by building trust, letting them know that the purpose of the project is to help them, not lay blame on engineers who are unable to make a process work. C4 would also like to make the SGM project more attractive to the depots who will be providing information. Money interests them, productivity interests them, but the green aspect does not.

C4: I know if I took a trip down there I'd be able to straighten things out, and it would kind of help if I had a little bit more funding to say, "Hey, this is what we're going to do for you," not just go down there and say, "Here, give me this, give me that."

C6 had difficulty accessing all the data that he needed to complete the task.

C6: Because right now it's hit and miss. If you happen to hear someone's working on something, and you get a hold of a phone number or something, you give them a call, then you find out. Otherwise you never hear about it until someone else is already testing it, and you're thinking about testing it. And by that point you're already allocated money to possibly do the same thing over. We've been able to ensure that we don't duplicate effort but it's very difficult to do on a long-run basis.

C6 would like to see the development of a centralized database on his task topic, but does not have a serious hope for it. C6 also spoke at length about the inability of the end user, the Army, to actually implement the green technology:

C6: You know, when Heller wrote *Catch-22* he was way ahead of his time. Right now, if you talk to a program manager with the Department of Defense, they'll tell you that they have to meet certain environmental objectives. They'll also tell you they have no money to do that, and on top of it, they have to prove that whatever they'd be moving to is a cost benefit to them. And so what you're being told is, you have to cut money, but you have to make this environmental impact which is not going to reduce your costs, it's actually going to increase them. And they get nowhere. They run into each other and they stop.

What C6 is describing here is the point where the green aspect of a project runs into the cost parameter of typical technology transfer, where affordability matters and greenness does not. His solution for overcoming this barrier is to make the green technology appear cost effective, using the life-cycle, long-range outlook.

C6: What needs to be done- and I'm not saying it's simple but it needs to be done- is a way of quantifying in dollars or whatever, what it means by worker exposure risk or environmental impact.... What does that really mean in terms of dollars.

When I asked C6 why the Army would fund a research project without intending to implement the results, C6 responded:

C6: Politics. It looks good. It's a way of saying, "We're trying to reduce worker exposure, and we're trying to become more environmentally-friendly." And sadly enough, I think in some ways that's what a lot of DOD green money is. They're almost like PR (public relations) dollars. They're able to say, "Hey, we spend X number of millions of dollars a year on environmental issues." If you look at the efficiency of those dollars, I don't think it'd be very good.

While C6 may be pessimistic about the SGM Project, those comments are interesting in relation to the project-wide complaint about funding, even among the otherwise Satisfied group. R3 discussed the issue at length, and said where more funding was needed in that task.

R3: I think the biggest complaint is that the funding is quite tight. And it turns out we are promising, at least in the mixing project, more than what the funding allows us to do. Particularly the second year. The first year seem relatively reasonable. The second year funding is too little. And part of the student funding is very little. And that really hurts, overall, productivity of the project

R3: Actually more for the equipment and the students than just the salaries. Salaries also are very low. I think it's really difficult to solve this problem because you start with such an amount, and you started so many projects at one point in time. And then the money is cut. Then you either have to cut all the projects an equal amount. Or you have to cut some projects. So cutting one project is harder than cutting all the projects an equal amount. That has been really a problem. I don't know what I would have done differently if I had been running the show. Once the money is low, what can you do. That is very difficult to figure out. My needs are, the priorities are, the students, equipment, and then the salaries.

R3 also encountered the point where the green aspect of the project was not of interest to the end user in the Army. He thought that it was a management problem that could be solved by having a responsive person on the receiving end. He did not phrase it exactly this way, but what he was suggesting was extending the influence, if not the authority of

the SGM project by having an SGM-responsive person stationed at the other organization.

R3 on the poor response of the end user:

R3: We feel is happening... It's the one entity funding the project, another entity overseeing the project, and the end users are not made clear about what advantages they're going to get from all this. They'll keep doing what they're doing. This is something that is very frivolous in some cases to them. And I think that's a little bit an annoyance. Because we believe that we can help them, and it's probably because they don't think that this may end up with something directly. They don't even know exactly, oh okay, we hve to keep doing this, our priorities right now are this and next year we will talk to you. There needs to be a little better type of coordination type between the end user and the researcher. That I think is lacking now.

R3: Yeah, if everybody had clear agenda. That okay, this guy has to talk to this guy, and then the other guy also needs this person, then it's going to work. Otherwise it doesn't work. It's very easy for me to pick up the phone and call somebody else. But then that person has to follow up also. And he or she may have other priorities at that time. It's a management problem, I think. It's such a huge project and everybody has other huge projects. I think that might be it.

R3: It's just that we still need a person there who really, really desperately is waiting for our results. And that's probably not the case yet. (*joking*)

Of all the subjects, R7 seemed to have the most frustration over the longest period of time. This is in spite of the fact that he had a fully-developed process ready to test at an Army facility from the beginning of the project.

R7: And I find it somewhat disturbing that literally one and half years have gone though and even *more* probably, and still we are unable to deliver anything.

The reason for this is lack of interest from the end user. His task cannot proceed without cooperation from DOD facilities. In spite of visits, e-mails, letters, and complaints, R7 has encountered:

R7: *Nothing* happened from that side. They were not able to do anything for whatever reason. They did not get back to us... They haven't allowed us to do anything.

This is clearly a case where the end user has no green interest and sees no other incentive in the new process. Rather than suggesting that the end user use a new economic analysis to see the potential benefits, R7 believes that it is better to transplant the green motivated person to the DOD facility:

R7's recommendations:

R7: I think at the DOD level they must identify champions. People who are accountable for this particular project. ... A certain amount of scientific training is essential. A certain amount of management perspective or capabilities is also essential. But the whole point is obligation. They have to have some sense of responsibility towards the program. I think that is critical.

Trust, obligation, responsibility, responsiveness: These qualities are shared and exchanged by the SGM Project researchers and SMEs. Working with each other, whether in a lab or on a testing ground, the idea generators are usually happy to exchange information in a way that enhances creativity of the group overall. Going beyond the comforts of the project and host organizations, conflicts arise. Is it just a "management problem"? The question is, why do the end users feel that they have the option to ignore the SGM project? They have priorities such as cutting their budget, boosting productivity. Environmental improvements do not help them meet these goals, so the technology goes unused. It is not a management problem in the sense that a strong enough authority figure could force the technology through. It is a management problem in that the decision-making values do not give the green aspect as much consideration as cost.

The interest at hand is money, not environmental quality. Although it is not necessary for a researcher to be particularly green-motivated in order to work well on the project, it is necessary to have someone at the end user facility who is interested in the green aspect of

the project. The green is what "sells" the project, and if the end user is not interested in that, it is a hard sell indeed.

Could it be that the Army is, after all, funding the project just so it looks good on paper? They can say that they are trying, but allowing all the hard work to stay in the lab without interfering with "real" Army business. This suspicion could be partly true, but there are laws and other drivers that will put increasing pressure on the Army to change. While the Army may want the public to know that they are trying to reduce their environmental impact, it is also likely that the actual needs far outweigh the available funds for research.

If the Army is serious about improving its environmental performance, it must make this clear to all its personnel, in every factory and depot. It is not enough that the Army funds research if its facilities ultimately ignores the results. The Army must overcome the barrier that stands between green technology transfer and cost-conscious facilities. There are at least three ways to do this.

1. It must end the Catch-22 policy of requiring better environmental quality while promoting cost as the leading factor in decision making at Army facilities. If it cannot value the environment for its own sake, the Army must view green technology as a long-term investment that will reduce future clean up costs.
2. It must recognize the authority of the United States environmental regulations, the Executive Order, and the Environmental Protection Agency. Eventually it must comply to those standards or risk incurring penalties, including lawsuits and fines.

3. Army personnel, even those outside the research project, must have a sense of obligation towards SGM. It is not acceptable for a facility to ignore the offer of new technology or refuse to provide information. If Army personnel have been informed of their responsibility towards SGM, and yet continue to ignore the project, they should not be excused because the environment is a "low priority."

In this case the Army has been a willing co-researcher, and at times a resistant end user. It has funded its own laboratory research and provided funds and resources to NJIT and CTC employees. Ten out of sixteen researchers and SMEs have experienced satisfactory flow of knowledge and technology. Several participants are still aware of a financial pinch that can hinder their ability to meet the project goals. Of course, money is not the most pressing issue for the project members who have been stonewalled by the end user.

When it comes time for all the research projects to leave the lab, when most of the researchers will have to deal with a non-green end user, will the green aspect still affect the technology transfer? Unless the Army makes an organization-wide decision to value green technology, the implementation phase will be at risk for failure. Perhaps there are already responsive, interested Army personnel at the facilities. But if upfront cost is the Army's only consideration, the new technology will do an about-face before it gets past the laboratory door.

CHAPTER 3

DISCUSSION: THESE RESULTS WITHIN BROADER ISSUES OF SGM

3.1 SGM and Innovation

Q: A successful wheel manufacturer in Italy has decided that it must develop an entirely new manufacturing process for its truck tires. Which of the following could have inspired this decision?

- a) Company as money to throw away on reinventing the wheel.
- b) Hopes to maintain or increase market share.
- c) Personal ethics of the business owner.
- d) To reduce costs.
- e) To avoid lawsuits.

The only answer that is completely *unlikely* is a). No competitive company wants to squander money. So a successful production formula is not changed on a whim. Answers b) and d) have always been typical business goals. Modifications of a product, especially to reduce costs, improve performance or quality, are part of maintaining a niche in the marketplace. However, it is becoming increasingly common to innovate a product or process for no other reason than to reduce environmental impact. By *greening* the process or product, the company may satisfy many needs: answers b) through e). Since this question is based on a real case, it turns out that the main reason for making the change was the need to conform to German environmental laws.¹ In order for the Italian manufacturer to maintain its customers in Germany, it had to prove that the product was environmentally friendly, so that it could be sold in that country. The Italian market did

¹ Noci and Verganti, 1999 p. 7

not require it, it actually cost more to introduce the product, the business owner's conscience was not too worried, but the law and economics forced a change.

This is a case where the driver of innovation was an outside force: the laws of one country influencing the decisions of a foreign manufacturer. While the impetus may or may not come from the manufacturer, the result will be the same: The development of a product or process that is less harmful to the environment. With the green product, the manufacturer can stay in business, stay competitive, and perhaps even increase profits due to improved efficiency or increased market share. There is also the economic benefit of reducing liability, clean-up costs, and fines if violations would otherwise occur. So does the decision to innovate all boil down to economics? Almost, but not quite. A recurring comment in the SGM Project interviews was that economics was *not* a motivation for Army facilities to use green technology. Economics was one of several drivers for change.

3.2 Economics

In the field of economics, goods or activities are described within the framework of a market. Some forces that affect the market are supply, demand; and public and private benefits and costs. These forces act against each other to ensure the efficient allocation of resources. A market is functioning when there is no discrepancy between the private costs of manufacturing an object and the social costs of having this object. A market failure is when costs of production are borne by society far beyond the private costs of the manufacturer. So a good may be produced cheaply, as far as the business ledger is concerned, but result in costly pollution that society must deal with.

The type of market failure that is most often discussed in environmental innovation goals is an *externality*. An externality is an unintended consequence associated with market transactions. Pollution is not the goal of manufacturing, but an unintended result of many processes. Green innovation seeks to reduce or eliminate the unintended consequences.

When interview subjects said that the Army was going to spend more to use green technology, they were speaking of input costs. Over the long-run, the entire life-cycle of the product, it would be more expensive to pollute. However, it is cheaper in the short-term to let society pay for the externality of pollution.

Another important source market failure is called *imperfect information*. A material may be used in a manufacturing process because its hazardous nature is unknown. While it is difficult to know or understand all the risks associated with materials, a growing awareness of the sources of environmental damage can be a driver for innovation. And as knowledge of the risk increases, laws and regulations are sure to be put in place. The associated fines are a way of ensuring that it is not cheaper for manufacturers to pollute.

3.3 Laws and Standards

Laws and regulations can act as drivers of change in at least six ways: by

- Creating pressure for companies to innovate, even when corporate inertia wants to delay a change;
- Improving environmental quality even when there is a high cost to compliance;
- Alerting companies about likely inefficiencies and potential areas of improvement;
- Increasing the likelihood that innovations of any kind will be environmentally friendly;
- Creating a demand for environmental quality among consumers and manufacturers.

- Leveling the playing field during the transition phase by requiring all companies to invest in improvements in the same time frame.²

To ensure that manufacturers consider the social costs as well as the private costs of their operations, there are laws and regulations that set environmental standards, which often carry fines for non-compliance. In the United States, the Clean Air Act (CAA) is the set of federal standards for ambient and point source pollution levels. It was introduced by Congress in 1963 to replace earlier regulations such as the 1955 Air Pollution Control Act (amended in 1959 and 1962). The 1963 CAA increased the federal government's involvement in pollution control by way of funding research, aiding states in development of their control agencies, and resolving cross-boundary disputes between states. The CAA did not set any national standards of environmental quality until the 1970 amendments. The amendments set standards that were designed to provide "an ample margin of safety" for hazardous pollutants, and "an adequate margin of safety" against common air-borne pollutants. One interesting aspects of CAA is that the *states and localities* are responsible for monitoring and enforcing these national standards, meaning there could be variations in local air quality and enforcement ability.³ Since the U.S. military is a nationwide, and even a world-wide organization, it makes sense that it must develop a consistent standard of environmental quality, regardless of the locality in which it is located. Otherwise it would be free to pollute *more* in a remote part of Wyoming, where the air was already above the national standard. In 1993 President Clinton issued three Executive Orders which said that all federal agencies, which would include the military, had to meet the standards of the CAA, as it was amended in 1990, and the Pollution Prevention Act (PPA) also of 1990.

² Porter, van der Linde (1995) p. 7

The military is an enormous employer, and also a huge customer of many types of products in materials. By requiring the military to meet environmental standards, the Executive Orders were indirectly affecting the behavior of many contractors and suppliers nationwide. So the CAA and PPA were the initial drivers, the Executive Orders the driver of change within the military, and by chain reaction many smaller companies were forced to reach a higher environmental standard, or lose their business arrangements with the military.

Perhaps the most influential US environmental statute is the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund). Superfund shifted the cost of clean up from society back to the responsible party. It did not set quality standards, but gave the president (via the Environmental Protection Agency) the authority to compel the clean up of hazardous sites and to recover the cost of clean up from the polluter. Any business could be held indefinitely liable for clean up costs associated with the materials used in production or operations. This legislation, while often inefficient in terms of the funds spent on litigation versus actually clean ups, has been important for insisting that "The Polluter Pays." It forces manufacturers to recognize their potential liability for clean up costs, and their duty to run a clean life cycle: All aspects of the product's life cycle need to be examined for potential to pollute. If the clean up costs are too high, then that product becomes too costly to produce.

The 1986 Superfund Amendment and Reauthorization Act (SARA) added a community right-to-know provision which required local businesses to inform the public of the location, nature and volume of its hazardous materials and processes. SARA also

³ Portney, p.

held polluters financially responsible for habitat destruction and indirect damage to natural resources.⁴ The cumulative effect of these laws and regulations is that all business are driven to make long-term, environmentally-conscious decisions.

The U.S. standards are strict, but there are certainly higher standards in existence around the world. Overseas, Germany stands as a leader in environmental laws, making it illegal for a business to sell a product in important market if it falls below Germany's standards. These standards regulate the amount of packaging, the recyclability or recycled content of the product, and other waste-related parameters. For example, the Toepfer law regulates the disposal of packaging material, which increases the German demand for less wasteful packaging.⁵ Another "driver" law forces firms to pay one deutschemark for each kilogram of non-hazardous material sent for disposal.⁶ That is a high price to pay for wastefulness.

Another influential environmental standard is ISO 14000, which is an environmental quality management system recognized worldwide. In essence, ISO 14000 audits and inventories a company's energy, chemicals, wastes, and processes and requires a higher standard of environmental quality than many national laws around the world do. Some governments or businesses make it a requirement of all its business partners to be ISO 14000 certified, so the demand for this certification acts as a driver of green innovation throughout the world.

⁴ Buck, p. 24

⁵ Noci and Verganti, p. 7

⁶ Azzone and Noci, 1998, p. 97

3.4 Ethics

One task in the SGM Project is to implement the ISO 14000 environmental management system at Department of Defense sites. ISO 14000 is, for the most part, a voluntary program of environmental management. However, not having ISO 14000 certification does not mean that a company is not already environmentally conscious. Many times the corporate philosophy requires a higher environmental standard than the laws. Managers may implement recycling programs, encourage energy conservation, or purchase recycled paper products, based on conscience. Respect for the environment comes in many guises, but three broad justifications of green behavior are the Future Generations argument, a values-based argument, or an ecocentric outlook.

The future generations argument is a favorite of politicians, among them Vice President Al Gore, in his best selling book, *Earth in the Balance*. Whether the goal is to justify the development of parks, the preservation of wilderness or the introduction of a new regulation, it is often said we must protect the environment so that future generations may experience it. While the action may be noble, the reasoning behind it is selfish some because it preserves the environment for human use and enjoyment. There is no guarantee that future generations will want or need the resources that is protected today, because their preferences may be completely different. There is also no respect for the environment apart from its usefulness to humans.

The “values” argument goes beyond preferences, which can change from year to year, and seeks to preserve the environment because it is part of the culture, “our way of life.” Mark Sagoff, in his book *The Economy of the Earth*, makes a distinction between the

citizen and the consumer.⁷ The citizen is capable of recognizing a set of values which serve as motivations for behavior. In other words, a company might voluntarily limit its use of a chemical, regardless of cost, in its effort to protect our national symbol, the bald eagle. This justifies green behavior, but again rests the value of nature in the mind of mankind.

A third way of considering nature can be an ecocentric approach. It may be the corporate philosophy to limit its impact on the environment, recognizing that its business takes place within an environmental system. While some companies will cut down a stand of trees because the lumber has great market value, another company might refuse to do this because it does not want to disrupt a habitat – and will sacrifice a profit for that reason alone.

None of these belief systems simply sprang up in a boardroom without outside influence. Business ethics are certainly influenced by the community in which the company operates, and by the ethics of the consumers. This can be called a market demand for green products. For example, the Royal Swedish Academy has reported that a significant market share of Scandinavian customers look for products that have a limited impact on the ecosystem.⁸ Knowing that some customers will pay more to have an environmentally-friendly product, or favor a green company, some corporations publicize their green efforts, no matter how minimal. A company's boasting of "good" environmental behavior makes some customers suspicious of *greenwashing*: a dishonest attempt to enhance a company's reputation by small gestures of environmental consideration. When the CTC Employee commented on the Army's SGM Project as "PR

⁷ Sagoff, p. 11

dollars," this is what he meant. However, publicly announcing that an organization is "going green" can be a first step towards a committed effort to reduce environmental impact.

3.5 Business Strategy: First Mover Advantage?

First mover advantage is a management concept that is sometimes known as the *first mover disadvantage*. Either phrase indicates that timing does influence a company's decision to change in any area, including environmental innovation. The first mover advantage can be described as "a major move by a focal business, ahead of its adversaries, which allows it to secure an advantageous position"⁹. This is possible with green innovation: for example, to meet the demand for environmentally-friendly products as mentioned in the previous section. Another advantage is the possibility for streamlined costs once wasteful practices are reduced.¹⁰ In this sense, pollution is seen as a sign of inefficiency and reduced productivity.

However, there is often an economic disadvantage for the first mover. The high cost of improved standards can be seen as a trade-off between ecology and profits. The first company to voluntarily eliminate the use of a cheaper, but hazardous chemical may lose a competitive advantage over other companies in the market. For this reason, regulations are a good driver of innovation because all companies are required to make the change at the same time, and there is no first-mover *disadvantage*.

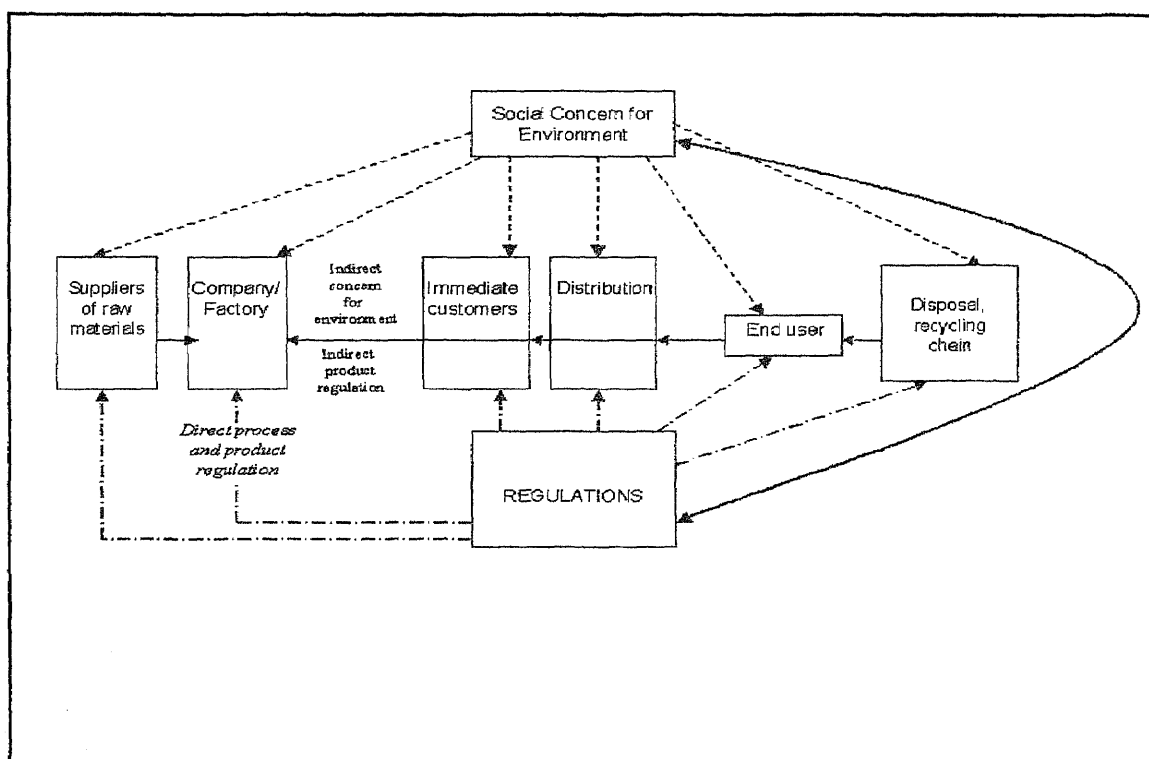
⁸ Azzone and Noci, p. 97

⁹ MacMillan, 1983 p. 16

¹⁰ Porter, van der Linde p. 121

It is not only the first mover who has to strategize and think about timing. Any company has to figure out what drivers are most affecting it, and why. One way to determine this is to view the company as part of a supply chain, from raw materials to intermediate suppliers, final producers, sellers, customers, and finally to disposal (Figure 5, following page). The effect of drivers on each of these segments accumulates as one travels down the supply chain. So even if an intermediate manufacturer is not yet feeling the effects of a new regulation on raw materials, it should expect to experience some changes in the way it does business. The drivers for green innovation are not always explicit, but they influence the entire supply chain.

Figure 5: Drivers on the Supply Chain



Knowing that environmental improvement is inevitable, a company can choose three paths: reactive strategy, anticipatory strategy, or innovation-based strategy. The reactive

company simply waits for regulation and reacts to it. This usually involves end-of-pipe solutions as opposed to reworking the whole product and process. The anticipatory company tries to determine the future drivers before they are direct influences. There is on-going investment in improving the entire process in order to meet or even exceed the anticipated environmental standard. The advancements are not necessarily shared with other companies, since this a greener process is a strategic gain. The innovation-based company ny looks outside itself to acquire the knowledge and equipment that it needs. The investment is not as large because it merely has to buy what is already developed, not fund the research phase. The Army is so vast, and has so many different needs, it is willing to try any of these strategies to meet its environmental goals. However, the SGM Project looks like an anticipatory strategy because they are making an investment to improve the whole process.

3.6 Modifying a Product vs. Developing New Technology

There are two possible approaches to SGM: modify existing methods, or research and develop entirely new ones.¹¹ The lower the cost of an innovation, the more likely it is to be implemented. Insulation, energy efficient bulbs, and recycled material packaging are all small steps that pay for themselves almost immediately. While these can effect the overall efficiency of a manufacturing process, they result in limited improvement.

Modification of an existing product is a matter of reengineering components. This usually requires less investment than a complete product development, for obvious reasons. The turnaround time is shorter, the implementation easier because it is

replacing a product that is already in use, and the learning or adoption phase is more likely to succeed. For example McDonald's decision to switch from plasticware to paperware was an effort to control its nonrecyclable waste, but it was a painless transition that actually led to cost savings.¹²

Development of a new product or process will most likely require more exploratory research to find if a new method is practical or even possible. The research and development phase can take much longer than the time required for modifications of an existing product.¹³ There may be difficulty finding market acceptance of something new, and people may be reluctant to learn a new method. However, in many cases this type of work is vitally necessary because there is no existing technology to remedy an environmental problem. To share the burden of funding and problem solving, as well as the benefit of results, many organizations choose to collaborate on the research and development.

3.7 Mechanisms and Modes

There are different ways to go about R&D. The choice to work with other organizations is called *technological partnering* which can involve one of several technology transfer *modes*. These modes differ in their purpose, benefits for each participant, degree of collaboration and duration. It is interesting to note that technology transfer modes are different from one country to another

¹¹ Porter, van der Linde, p. 125

¹² Kleiner, p. 38

¹³ Anonymous, Wheel Reinvention: A Study, p. 5

A partnership is founded to achieve common or complementary objectives¹⁴ but there are many choices for the structure of the partnership. These can be divided by the level of integration that occurs between groups. A high level of integration means one group acquires the other in order to obtain the technology, as in a merger, or deliberate recruitment of outside experts as new employees. A low level of integration is commonly called *outsourcing*, where there is a limited duration and degree of collaboration. Research funding, licensing, R&D contracts are examples of low level integration. In the mid-range are activities such as consortia, joint R&D and inter-university research. There may be shared equipment and researchers for the duration of the project.¹⁵ The NJIT-CTC-Army project is a consortium because the funding source also participates in the research, and resources are pooled, but not necessarily co-owned.

The partners in a collaboration typically fall into the category of academia, industry or government. One reason governments get involved in technology transfer is because the development of new technology is good for a nation's international competitiveness. A government may have its own laboratories, but solicit partnerships in academia or industry in order to rapidly develop and deploy the technology. Or the government may fund outside sources with the intent to benefit from the technology that is developed there. The understanding is that the sharing of technology is crucial in order to achieve the best, most economical, and fastest results.

In the United States, the main technology transfer policy is the Cooperative Research and Development Agreements (CRADAs) between one of the 700 Federal R&D facilities

¹⁴ Chiesa and Manzini, p. 199

¹⁵ Chiesa and Manzini, p. 200

and a private company.¹⁶ A CRADA is an agreement between one or more Federal labs and one or more “unlike” institutions such as a company or university. The benefit to the Federal lab is outside funding. The benefit to the other partner is expanded research capabilities and possible patent rights. This can be a boon especially to a small business. A consortium, which is also a collaboration between “unlike” institutions, is different from a CRADA in that there is less confidentiality in a consortium, and rival firms may take part at the same time.

Japan relies heavily on a technology transfer practice called *shuko*. This occurs in government sponsored R&D consortia which may involve several companies in one industry. For example, one electronics research consortium involved NEC, Toshiba, Hitachi, Mitsubishi Electric, and Fujitsu.¹⁷ The method of technology transfer was to take a few employees from all these companies and have them work in a central lab. When the project ended, these employees brought the new ideas back to their home company. This type of personnel transfer is called *shuko* and is widely used in Japan. In addition to consortia, the government sponsors *shuko* programs of one or more years so that employees from around Japan can work at a government facility and bring the experience home with them.¹⁸

Germany’s main technology transfer methods are a main foundation like the National Science Foundation in the U.S., the Max Planck Institutes, which are analogous to the US

¹⁶ Rogers, Carayannis, Kurihara, Allbritton, p. 79

¹⁷ Rogers, *et al*, p. 85

¹⁸ Rogers, *et al*, p. 86

Federal labs, and the Fraunhofer Institutes, which involve private and government research in certain areas, such as semiconductors or solar energy.¹⁹

An interesting difference between the methods in the US, Japan and Germany is that the American CRADAs result in a low level of integration between the government lab and the outside organization. There is a vast organizational difference between a Federal lab and a private company, which can be a barrier to technology transfer.²⁰ The Japanese shuko and the German Fraunhofer Institutes bring the different organizations under one system, and reduce the differences between the unlike groups.

3.8 Strategy and Technology Transfer Methods

There is some strategy that goes into selecting a technology transfer method. In addition to considering the budget and time frame, a manager must anticipate the barriers to technology transfer that may arise. This is not to say that an academic partner should avoid a government partner. There may be benefits such as increased funding, access to equipment, and increased knowledge that make any difficulties worthwhile. However, it is important to realize that there are different technology transfer modes, from CRADAs to consortia to acquisitions, that a company may consider. The intellectual property rights, budget, timeframe and impact on the organization vary from one mode to another, and achieve different goals for the instigating partner.

For the purpose of the study, it is important to determine why the U.S. Army chose to innovate, and what its effect on the rest of the supply chain will be. The most direct drivers were the Clean Air Act, the Pollution Prevention Act, CERCLA and the

¹⁹ Rogers, et al, p. 86

Missing Page

CONCLUSIONS

If a manufacturer's goal is to reduce its environmental impact, there could be several inspirations for this decision. Laws may make it mandatory. Economics may say it is cost efficient to be environmentally-friendly, especially because it prevents higher clean up costs in the future. A manufacturer may change its ways due to a sense of duty to protect the environment, or may want to win an environmentally-conscious customer. Whatever the reason, if the old way does not work, a new way must be found. Green innovation will not always yield profits so the manufacturer must be truly motivated either internally or externally in order to chose green technology over cheaper alternatives.

If the motivation does not come from within, some prodding will be necessary. In this study, the Army has been funding a green innovation project partly on its own initiative, and partly due to the Executive Orders which made compliance with environmental laws mandatory. Because the Army is a huge customer for many types of products, this will create a green ripple effect throughout the supply chain, since suppliers will be competing to meet the Army's needs.

However, in many cases the green technology does not yet exist on the market. The Army made the decision to seek technology partners with NJIT and CTC in order to expand its research and development capabilities. The Army provided the resources, rounded up suitable personnel, and set the goals for greener technologies. The task teams are producing results. Will this take care if the Army's environmental needs?

Actually, the R&D phase cannot promise successful technologies. Processes must first be explored and tested. As one NJIT researcher said, “This is research. If you know the answer, don’t bother with research. Just patent it.” So the innovation phase is a critical time. If an organization depends on new technology to meet its environmental goals, it must ensure that the project runs well and that productivity and creativity is boosted by the technological partnering. Good technology transfer can improve the chances of success. Knowledge and tools must be exchanged and tested in order to come up with a workable solution.

In the exploratory phase, technology transfer may be mostly among researchers and SMEs. If the research is truly fundamental, it may never require the input from end users who are outside the R&D program. However, any green technology intended for actual use in the workplace will eventually have to interact with people outside the R&D structure. It may be necessary to get data from another location, or to test a process off-site. It is at this point that green technology transfer suddenly appears to be unlike other types of technology transfer.

What if the end user doesn’t want to change? If time is limited and there are other pressing matters to attend to, environmental quality slides down the list of concerns. A good technology could be mothballed because there is no interest from the end user.

How can the green aspect retain its importance, and thereby retain its end user’s interest? If the end user has no concern for the environment, a new employee could be hired who will do that job for the facility. Or outside authorities could make it easier for the facility to take a risk on a green technology by granting a suitable budget for environmental quality expenditures. At least the outside authority could remove any

penalty that may come when a facility can't cut its budget. If it was permissible to stay at the same level of spending, yet reduce environmental impact, that should be rewarded as a good decision, instead of criticized because the budget was not reduced. Lastly, there is the possibility of improving green motivation at end user facilities through *shuko* type practices. In Japan a common technology transfer method is to have employees work at a different site for a short term, and then bring that knowledge and experience home. This exchange would help facilities overcome resistance to green technology by seeing how it works at another site. The exchange-visit was suggested by one CTC Employee (C1), and site visits were praised by an NJIT researcher (R1) as being very helpful for understanding a process.

The green technology transfer process is different because the technology does not necessarily possess appealing qualities such as the ability to boost profits, performance, productivity and market share. The green technology may do no more, and no less, than reduce pollution and waste. If this is not important to any decision maker in the transfer process, the technology will collect dust on a warehouse floor. The smartest move is to anticipate resistance or apathy from the end user, and try to create ways in which it is easier to accept the new technology. The next best strategy is to make it very difficult for facilities --anywhere in the organization-- to avoid implementing the technology. Follow up visits can ensure that technology is actually being used. End users should be told that they do not have the option to dismiss the green technology because they consider it a low priority compared to other issues.

Where does the money come for all this? It might be said that funds are better used on research projects, rather than on technology transfer. However, if the goal of the research

is to produce a workable technology, it is equally important to make sure that it gets implemented. It may take some extra pains, and may take some extra employees to prod end users into making a change, but it is a necessary expense.

APPENDIX A

NODE LISTING

Free Nodes

1. summary of task
2. green streak (history of green projects in career)
3. knowledge of end user
4. deliverable
5. ideal transfer situation
6. green project difference
7. green motivation
8. previous tech transfer experience

Tree Nodes

1 Methods

- 1.1 journal article
- 1.2 conferences
- 1.3 SGM reports/meetings
- 1.4 grad student
- 1.5 Project Manager
- 1.6 Army to NJIT
- 1.7 NJIT to Army
- 1.8 e-mail, web
- 1.9 phone
- 1.10 Other professors
- 1.11 NJIT to other Labs

2 Effective Aspects of SGM

- 2.1 funds
- 2.2 time, time demands
- 2.3 direction
- 2.4 response
- 2.5 data accessible
- 2.6 recommendations /what works

3 Problematic Aspects of SGM

- 3.1 funds
- 3.2 time, time demands
- 3.3 no direction
- 3.4 lack of response, interest
- 3.5 data dispersed

APPENDIX B

CTC INTERVIEW QUESTIONS

Introduction: We are interviewing CTC employees who are developing new technology within the Sustainable Green Manufacturing project. Our goal is to learn more about the technology transfer process within a consortium of government, academia and industry. As you may know, technology transfer has been defined as the movement of scientific research from the laboratory to the marketplace. In the case of Sustainable Green Manufacturing, the movement is from the research task teams through the government to Army designated users.

Please be assured that what you share in this interview will be kept confidential. You will not be identified by name or by task team. So feel free to say what you really think and feel.

1. Please describe the work you are doing for SGM.
2. Is this your usual research interest or something you were asked to do just for SGM?
3. Who do you think the end user will be? Have you met them?
4. What methods have you used to let people know about your SGM work? Journal article, SGM reports, conference, graduate student, face-to-face with Army?
5. In your opinion, what would the ideal technology transfer be like?
6. Has that happened in SGM?
7. Does the green aspect make this project any different?
8. What kind of impact might your SGM work have on the outside world?
9. How does this compare to other technology transfer experiences you have had?

NJIT INTERVIEW QUESTIONS

Introduction: We are interviewing NJIT faculty who are developing new technology within the Sustainable Green Manufacturing project. Our goal is to learn more about the technology transfer process within a consortium of government, academia and industry. As you may know, technology transfer has been defined as the movement of scientific research from the laboratory to the marketplace. In the case of Sustainable Green Manufacturing, the movement is from the research task teams through the government to Army designated users.

Please be assured that what you share in this interview will be kept confidential. You will not be identified by name or by task team. So feel free to say what you really think and feel.

1. Please describe the work you are doing for SGM.
2. Is this your usual research interest or something you were asked to do just for SGM?
3. Who do you think the end user will be? Have you met them?
4. What methods have you used to let people know about your SGM work? Journal article, SGM reports, conference, graduate student, face-to-face with Army?
5. In your opinion, what would the ideal technology transfer be like?
6. Has that happened in SGM?
7. Does the green aspect make this project any different?
8. What kind of impact might your SGM work have on the outside world?
9. How does this compare to other technology transfer experiences you have had?

APPENDIX C

CTC EMPLOYEE INTERVIEWS

CTC EMPLOYEE INTERVIEW-Satisfied Group

December 1, 1999

C1= *CTC Employee 1*

I= *Interviewer: Susan*

I: Can you tell me a bit about the research you're doing for SGM?

C1: My involvement at this point in time is, I'm a sub-project lead. The piece that I'm involved in is the ISO 14000 portion of it. So a lot of the research that we have been doing was in terms of looking at environmental metrics as part of ISO 14000. I believe the one piece that we did was looking at various GAP analyses that had been done under 14000 to look and say okay overall DOD-wise, what are some common kind of things across the board.

And what we're going to do going forward is all the current pilot participants, we're going to do case studies and hopefully capture any tools and methodologies that they were using as part of their implementation process and make that available then for other folks to use. So that's kind of been my involvement at this point.

I: Okay, and is this your usual line of work or is this something you're just doing for SGM?

C1: It's actually my usual line of work. I'm the management systems manager for concurrent technology, so I am the ISO point of contact for our own ISO 14000 system. We are assisting several of the pilot facilities in that we're helping their implementation efforts. We've done GAP analysis at several of the facilities, so this is another portion that's kind of been built on and some existing efforts have been under way in terms of ISO within DOD.

I: This one question would be, when you deal with the outside offices or systems that you're dealing with, are they all familiar with ISO 14000, are they reluctant to listen to you, or do you encounter any resistance to environmental suggestions or anything like that?

C1: With the folks that we're working on through SGM?

I: Yeah, I guess in SGM training.

C1: In SGM I'd say most of them are voluntary pilot participants at this point in time, so they have been willing to listen, willing to learn. I think their biggest challenge issue is that nobody has said you have to do this by a certain time frame, so there's no driver, no push to make it happen. They've not been handed a blank check that says here you go, go ahead and make this happen, so everybody is looking to this group of pilots saying well how well are you doing? And they're saying well wait a minute, you know we have all these other priorities that come up before ISO, where somebody is saying you must do this by this date and we have funding to do these things, this is kind of when we get to it.

So I don't think it's a resistance, I think some of them are very open to the idea, some of them believe there's a lot of benefit in it. Some kind of have fallen by the wayside with it, and some, there's probably one or two in the group that's said you know, gee we're not sure how exactly that's going to benefit our organization,

I: What methods are you able to use or have you been using or you would like to use to communicate with these different people? Do you have to do face to face meetings or reports or anything like that?

C1: We do, and part of it's SGM and part of it is part of another task that we have. What we primarily do with this group is we've been having quarterly meetings where we get together and talk about the implementation status of each pilot, where they're at and how they're moving forward. The reports that we do, we collected information, I talked about the various metrics that are out there. We did a study on that and evaluated what kind of metrics and then we shared that with the pilots at one of the meetings. We've done some training at the meetings for the pilots. The GAP analyses that we have done was funded under various projects and then rolled together under SGM and we shared that information and come up with that DOD baseline. So there have been probably a number of different ways that we've worked with the group.

I: And so you don't work at all with NJIT people?

C1: No.

I: Here's a question that's sort of open ended. How do you think technology transfer is supposed to operate? And I know that's kind of an odd one, but it's just how are you able to do your work best when you're dealing with somebody who is on the opposite end of, like the receiver of the ideas and so forth.

C1: See I guess in our case, our technology is a little bit different because it's a management system, it's not putting a piece of equipment in someplace. I think it's, for us because we've done it here at CTC I see it as a great tool and it's very easy for us to go out and talk to other people about it because we so much believe in what we've done here and have seen benefits and have been able to easily talk about it. And I've even offered as to some of our pilots, we go through, I don't know how familiar you are with the ISO process, but one of the things that happens once you're certified, they come back every six months and they do what they call a surveillance audit. I've offered to some of the folks to be able to come back here and actually see the technology so to speak up and running so that they can get a feel and understand how that works, so I guess that would kind of be my view of.

I: That's very interesting. So have any been taking you up on that offer?

C1: One of them, one was supposed to come in on the last audit and they didn't make it in and I'm trying now to convince Fort Louis, I think they see the value in it, it's a question whether they want to come to Johnstown in January which is when my surveillance audit is. So if the weather holds out and they're able to make the trip in I think they're going to come in and sit through the audit.

I: Just out of curiosity, what kind of changes do they have to make? I mean I know what the requirements are, I know it's very strict and you have to have the surveillance and the review. I know it's not an easy process to become certified, but just off the top of your head, what sort of change would some organization have to do?

C1: What the DOD pilots, what we've seen so far is that they have a very strong emergency preparedness and response which is one of the pieces of ISO. And they typically have a very strong compliance program. What they don't have is the management piece of it and how do you tie all the pieces together and how do you look at the management system behind the compliance to figure out how well you're doing.

They don't have an audit in terms of what kinds of things can impact the system and how do we issue corrective action. So it's that management system piece that's mission typically of the ones that we've dealt with, they have been sixty to eighty percent ISO compliant when we went in there. But how do you put those remaining pieces in place to make the full compliance?

I: Well this is something you can just compare to any other work you've done apart from this particular job. Do you think anything is different because it's a green project, because the motivation is to be environmentally efficient or friendly. Does that, as opposed to say making a profit, do you think that effects the way people interact?

C1: I think a lot of it depends on the kind of environment that people come from. And by that mean where resources have been dedicated before. Like some of the folks that we work with are very environmentally proactive, and those folks are a lot easier to convince than some folks that that's maybe not a priority. Which would be the case anywhere, I'm sure.

I: Do you have any other technology transfer to compare to this? I know you're management and you're doing more of a management perspective, but you could even compare it to a job you did years ago or anything you've done in your life where things went better, or the same, or do you think this is pretty much an ideal situation, the type of people that you work with, the response times you get, things like that.

C1: I think it's probably typical. A lot of my background has been quality management, I worked at Bethlehem Steel before I came to CTC and that was when the big buzz words were TQM and I think all of this is very similar to TQM in looking at where your biggest areas for opportunity are. And putting together a plan requires change management which I think is difficult in any organization.

I think once people start seeing it's not as bad as I thought it was going to be and I actually get some benefit out of this, people fall into line. And I think, I talked, the last week I was at one of our organizations doing a, helping them do some implementation and when CTC went through it, there was a point where we thought we were so unique because we don't just do manufacturing, and we don't just have people sitting in the office all the time, we have a big mixture of things. And that's why it was so difficult for us to implement.

And as well, helping these other organizations, they all go through that same process. And I talked with the management rep for the company that we're helping and she was, and I said you're exactly where we were at this stage of the game and I guess it's just a process that everybody goes through. And I think it was the same back when I was at Bethlehem and it was TQM, I think it's just a different way of doing things and it's just a common sense approach so I don't think the people are any different and I don't think the process is really all that different. I think it's called something different now but I don't think it's any different.

I: Okay, so you don't have any particular advice to give someone if they're going through some sort of management change? It's just you have to bear down and handle it?

C1: I think in terms of advice would be to not complicate, I think a lot of people make it into something way more complicated than it is. And I think my advice would be to look at what you're already doing and how that meets the requirements of ISO and then to figure out what you really need to do. And a lot of DOD organizations in particular are so environmentally conscious anyway that it's not a big jump for them I don't think.

I: So I guess I'm just curious, because I know that a lot of companies or manufacturers don't bother to become ISO 14000, it's not required. They're volunteers in this project for the most part you said. So there isn't a current motivation to reach these requirements. Do you think that something could be changed to, or would your job be easier if they were required?

C1: Oh absolutely.

I: And this is just a question, it's not really related, but I'm just curious, do you think the US is going to start requiring it more?

C1: There is currently a draft executive order that is going to require any Federal facility to evaluate an environmental management system. It doesn't say that management system has to be 14000, there are some, you know EPA has their own version, there's a bunch of different systems out there. But the requirement, I believe, is going to come out that says you have to at least look at some type of environmental management system.

And so I believe that will make, like actually it scares me because I think we'll be busier than we know what to do because people are going to need assistance in that. So I think, yes, that we probably will see something, and I think even in terms, and this is not at all related to SGM but even in terms of our own implementation, we have an energy conservation program that CTC would never have initiated without doing ISO.

We stopped to look at what's our biggest impact on the environment, we've saved something like ninety thousand dollars. We have people that very much pay attention to turning your lights out at the end of the day when you leave the building. We've started a recycling program that nobody ever paid attention to before. We're looking at a chemical inventory kind of thing and looking at before you go out an buy something, do we have something.

So there's a whole lot of things we've uncovered, areas during internal audits that could have been a potential problem down the road for us that we caught earlier enough in the process to make a change before it could impact anything. So I think, these are all kind of things that it would be hard for somebody to say I don't find any value in that.

The question that people always have is about is it worth the extra step to register. And in my mind, having that outside third party come in and evaluate you and to know that they're going to be back every six months, everybody has a whole lot of I think conflicting priorities and demands on their schedule. And it's easy to let things slip or whatever. But when you know that guy's going to be back like ours is coming in January, you really can't let things slip. So I think it makes you stay on top of things better than you would normally have to do I think.

I: Is there anything you'd like to comment on about the project in terms of monthly reports, funding, how you've been interacting with anybody?

C1: We really haven't, John and I work together and I really haven't had any problems at all.

I: You had a previous position that probably was not environmentally related, or maybe it was? I know what it was, it was more of a straight forward management. So you can answer this or not, it's not required. But how did you make the transition over to something that's very environmentally related?

C1: I think several years ago when I started at CTC I was working in the National Defense Center for Environmental Excellence, I was always on the environmental contract. I, when I started I did more quality kinds of things in terms of looking at metrics and measurements and how do we tell how well we're doing and how do we simplify reporting mechanisms and that continuous improvement kind of thing. At some point in time I was asked if I would be interested in spending time with Texas Instruments who was developing their strategic plan for implementation of ISO 14000 worldwide.

And being as bad as I hate winter I decided that Dallas was probably a good place to be for a couple of months. So I spent five months with Texas Instruments working with their lead environmental auditor, their compliance auditor, in putting together their approach to implementation across the board. So we really spent a lot of time digging down through the standard, by background is not at all compliance. I have compliance folks that work for me, and they're very patient thank god with explaining things to me from an environmental point of view.

But I truly believe by putting the management systems in place you're going to get the compliance if you have the right people and the right systems that that's an ultimate outcome. And again that goes back to, it's called different things now, it has an environmental focus but it's that same, how do you put a plan together to improve your bottom line performance, whether that bottom line is cost or quality or in this case environmental.

I: I think that was interesting because in a way that helps me to understand why you invite people here to see an audit. Because I think you have to kind of be immersed in it to start to absorb it.

C1: And even people, it's hard, and somebody had allowed me to, you put this system in place and you go to training class and you think okay, I understand the management system. But until you understand what kind of questions your register is going to ask of you, it puts it in a whole different. And for me that was helpful in putting our own system together to go and watch the register asking questions to somebody else, it was like oh my god, I hadn't thought about that.

So I think for folks that we've allowed or have invited in, I think that would be very helpful for them.

I: And I guess the one last question I would say is, I guess the final deliverable, or the final outcome, or I shouldn't say final either, I should say the outcome. Basically what sort of benefits can an organization expect? You were mentioning electricity bills, but reduced I guess less waste when buying chemicals you already have in stock.

C1: I guess two different approaches, one from the outcome in the SGM, and the effort that we're doing there. We will hopefully have some lessons learned what the pilots went through. We will have some case studies that somebody can pick up and read, another organization can pick up and say okay, we want to avoid this mistake, we want to do this, we want to do that.

We'll have some tools in looking at how do you do aspects and impacts, which is one of the requirements. How do you put together objectives and targets. So hopefully we'll have handbook's probably not the right tool, maybe a guidance document that somebody that was looking at doing this another DOD organization. Outside the green manufacturing, I think any company that puts an environmental management system in place, one of the things that I think DOD benefits from is all the organizations that we have worked with, DOD has handed down these requirements, you shall have a pest control management plan, you shall have a rain gutter, whatever.

Whether or not the organization has any pest or rain gutters, you know what I mean they just don't. What ISO 14000 forces somebody to do is to say okay, what are the key drivers within our organization and do we have plans of ways to address this? And so almost looking at a bottoms up, one of the organizations that I'm working with now has said well wait a minute, this is great, all this time I have all my project managers put together these requests for funds, and then I take these requests for funds and I sit down and look at our strategic plan and I recommend to our colonel these are things that I need funded.

Wouldn't it be great if I had something that said, these are your top five priorities, the top five priorities we reflected in our overall strategic plan, and the colonel, I go to him and say here's your five things and here's what I'm asking for and it's a done deal. And he said I've never been able to tie those things together before like that. So he sees it as a huge benefit to tying all the lose pieces he has together.

Another DOD benefit I believe is this they're going through this commercialization activity. Another one of the organizations that we're working with says whether I get the work or somebody else gets the work, by being 14000 certified, we can require that of anybody that would be in here doing this kind of work and that would ensure that our facility and minimum is protected to this level of environmental protection. So I mean that was angle that I hadn't thought about before, but that's a strong driver for one of the organizations that's pursuing registration just to protect their facility.

I: Well thanks, that's a lot of information and I really appreciate it.

C1: Sure thing.

I: So I think that was all the questions I had. Anything else you wanted to add?

C1: No. That's it, I'll be here all day if you need anything else.

**CTC Employee Interview- Satisfied Group
December 1, 1999**

I= *Interviewer*: Susan
C2= *CTC Employee 2*

I: Now first, could you tell me about the research you're doing for SGM - - or the work or the project you're doing?

C2: There are three separate tasks on the SGM that we're kind of working on right now. One is, it's the ion beam equipment, and we're doing a maintenance manual for that. And we have draft for of that currently done and what we're been doing in order to develop that is work with the subject matter experts, the folks that are technically competent on the equipment.

I have a team of two instructional designers working on it, gathering that information, and then it goes back in the review and that whole thing. So we have a whole process set up to do that. Another one is a powder coating manual. And that is something that was already in place that is being revised, revamped and it's going to be sent down to Corpus Christi I believe.

And then finally there's a brochure that's being put together for composite recycling. And there are two recycling technologies that are out there and we're waiting for data to come back from that. And it's basically an awareness brochure, that these technologies are out there to recycle composites and it's more of an awareness piece than an actual training. So those are the three separate tasks that we're doing for training underneath these.

I: So these are meant for the military? Who is going to be the reader of these?

C2: For the ion beam, the audience is anybody that has this machine, and to my understanding they're aren't a whole lot of these ion beam machines out there. So the maintenance manual in that case is for even, I guess for people at CTC here if we have a new person take over or something to that effect. So I think it's meant more of a guide line.

The composite recycling is of course an industry that's looking for and involved in that sort of area, or somebody that could maybe benefit from it. And then the powder coating specifically is for Corpus Christi which is an Army depot down there.

I: In the past, have you had to do similar types of projects? Like I guess that's your main line of work, but is this in any way an unusual project for you?

C2: I wouldn't say it's unusual. It's the first major project that I've had with the NDCE which is the portion that covers the sustainable green project. I typically work under either external clients directly or, in a little bit different fashion, and I typically also work on multimedia presentations, computer and webpage training, that sort of thing.

So paper based, I have experience in it and I've done it before, it's not been my main thrust area as far as work goes. And then working with the NDCE is also a little bit different area. But as far as being really unique or challenging in a different way, not so much. Just because we have a process that we follow on that and it kind of transfers over to all these areas.

I: So you said that you talked to the researchers or the developers when you were writing the manual, do you also have like a test copy that you send to an end user to see how they feel? I don't know how you work, but how does it go through the editing process?

C2: Yeah, that is part of the process and we're not there yet on any of these. But typically what we would do is once we have the audience identified and we have all the information brought together into a draft form, we would send it out to them, have them take a look, so we could get feedback. And we can put a comments sheet in there with that to extrapolate that type of information from them.

What to change, what's good, what's bad, that sort of thing. You just have to be careful with those sometimes because you can get a lot of different opinions and you just have to make sure that you have

your focus areas nailed down from the person that's making the final decisions so you can be discrete about what changes to make or not. So yes, we do do that as part of the process.

I: And just out of curiosity, how long does it take, I mean from the time the project is given to you to the time that the reader is responding with comments and stuff, how long does that take?

C2: This being project work, that could vary, depending on response time from the subject matter experts and that sort of thing. Typically for the entire project to be finished I would say between three and six months. But it depends on the level of effort, obviously. I mean if you have a five hundred page manual that's going to take a lot longer than an awareness brochure. So that's, it's really, it's tough to nail down exactly how long.

Typically we would say somewhere around four hundred and eighty labor hours for approximately one hour instruction, complete, all done. So that's not in writing or anything, that's kind of a ball park. But like on the one project that I have, the subject matter expert was called away on other business and couldn't respond, so I had a lot of down time where I couldn't really do much on the project. So all those things come into play though on any project really. So that's a rough estimate.

I: Now I know that you are more a writer or, instructional developer, so how do you interact with the researchers? Do you send them samples of the work, or do you just extract it out of them, how does that go?

C2: Extract it out of them. Actually, I went to a conference one time and another company that does this sort of thing was talking and they said that they lock the subject matter experts in a room with instructional designers for X amount of hours until they get what they need. But no, on this project and recently on various other projects I've been doing more of the management of the entire project.

So I have a couple of instructional designers, two in fact that are actually working on this project. And the direction I try and give them for the most part, I give them guidance and say this is one way to try and do it. You can put together an outline of the information, put together a draft and sent it to the subject matter expert and have them tear it apart or have them do whatever they want to do.

That's just one way to do it, that's one way to transfer the information. I tell them to interact with the SME, with the subject matter expert, ask what's most comfortable for them, would they feel best in doing, what they would think would be the most efficient way to do it, and then let them go with it.

So there are certain ways that we do that, you know via email, and there's certainly a certain process that we have, we send it to the subject matter expert and they would send it back to us and then we would send it to a technical writer for grammatical and technical accuracy, that sort of thing.

So there is a process, but there's leeway in there, I guess is what I'm getting at, there's leeway within the process of how the information's exchanged.

I: Are there any difficulties because --I don't think any of this stuff is confidential exactly, but some of the researchers might be in a setting where they have to go through proper channels, communication, get things cleared. Did that create problems or have you noticed that you get more leeway and you're allowed to communicate freely with them without much problem?

C2: I haven't run into really many problems communicating with the SMEs, with the subject matter experts, with the technical folks. Most times when I'm talking to them about their specific technology, they're kind of the voice on it, and if they want to talk about it they're free to do so. I would say that it's possible that that could be a problem on certain projects, I haven't run into it.

I: I guess it's a silly question because if they read the manual it can't be that top secret but -some people especially if they're in a line of work where they're constantly thinking "I can't tell people", they might just by habit have a hard time coming out with the answer or speaking freely and letting you know what you should know.

C2: Absolutely. No, that's not silly at all. I mean it's something that kind of happens. Another thing along those lines, I don't want to steal this if you're going to get to it but just something to think about.

I: Oh no, say whatever you want.

C2: When you have technical information and you're talking with the subject matter expert about that technical information, a lot of times they're really concerned that it's going to sound too dumbed down so to speak, for lack of a better term, as far as the audience is concerned. And they can't really conceptualize okay I need to get this information to this level just because of the audience, not because of that's where the information is.

But if they're highly technical they're concerned, well, I don't want this to sound unintelligent, or lower than where it actually is. For a layman to understand though, you have to do that. So anyway, those lines cross sometimes and they get nervous about how their information is perceived. Rightfully so, they do a lot of work there, so, just a side note there, that happens.

I: So do you think it's more a case that they want to write their own manual and think that no one else can understand it or explain it the way they want it? Sometimes there can be a bit of control, like some people get so used to doing everything that they can't let go, no one else can help them write the manual?

C2: Oh sure, absolutely. Absolutely. And that's why we have instructional designers and training personnel, because if they just did all the manuals, I mean everybody has their niche. Theirs probably isn't training, I'm not saying they can't do it, but they're not going to think about the audience and they're going to think of what looks good and sounds good to them, because they're very close to it.

So you need somebody who's a little bit more objective to come in, take a look at it and evaluate the whole situation and the send out the best training piece from that.

I: Do you have to do SGM annual reports, monthly reports stuff like that?

C2: Yes, yes, I just finished up, I just did a monthly end and there's an annual coming up too actually, so yes I do, I do both.

I: And you have the face to face meetings I guess with SMEs and so forth. Are they mostly at CTC or are they at Army labs or are you also working with NJIT people? I'm not so familiar with all the tasks that I know where everyone is.

C2: Right now they're all here. At one of the big kickoff meetings I did meet somebody else in training from NJIT but we haven't collaborated a whole lot, we have our own separate tasks and that sort of thing, so yeah, it's mostly here.

I: Now, I guess you covered this in other questions, but I'll just ask it one more time. But how do you think technology transfer is supposed to operate? I know that you are someone who makes the mechanisms for communicating, but there's also the transition from the SME to you, so in an ideal sort of situation, do you like to have them very easily accessible? Here I guess they're in another building or maybe within this building, but how do you like the interaction to take place?

C2: For the best possible transfer of the information, timely response is important because we have fresh ideas and those things that come up with, you know, that sort of thing is helpful. But most of the time they're very accessible here, because they're right here at CTC and if they're just in another building we can job over there, or it's pretty easy to me, and that sort of thing.

Getting their time sometimes is the rough part, if they're away on travel or something to that effect and that can be difficult at times. But these are the types of projects that, their focus is their technical area, it's not necessarily training. So this is probably low on their totem pole most of the time. So sometimes you have to push a little bit more, you have to say, just stress the importance, hey we really need to get this, and this is why and explain why if necessary.

But we definitely are looking at it from two different sides of the fence, the training folks and the technical folks. All with the same purpose in mind, but us looking at it with a lot more importance than they may be. So, communication is fairly good with the subject matter experts, probably as well as could be expected and as far as changing it or trying to do something differently, I think our process works fairly well, I wouldn't change a whole lot. Maybe strapping in the room like this.

I: As for timely response, I'm not looking to dig people up or anything, but, so far there's been...

C2: Oh no, we could dig. (joking)

I: There's been no case where someone was just totally unresponsive? I know people are extremely busy and they're traveling, but I have heard other cases where they absolutely got no response from somebody that they called and faxed and emailed. You don't ever run into that here with this project at least?

C2: Not with this project I haven't. I've run into, hey let's set up this meeting, let's do this, let's do that, yeah, okay let's do that, and then three weeks later we're having the meeting. But that kind of, those sorts of things happen on things like this, on training. And if it's incredibly critical then you make it be known and you get the information one way or the other. You get the information however you can. But I haven't run into just out and out totally ignoring emails and everything else. Maybe a little bit delayed, but I think that's understandable, because this is kind of above and beyond what they do normally do on their daily jobs.

I: I'm not saying your work isn't important or anything like that, but since this is new technology, how do you feel about the data reports that you're doing and the work that's coming out? Do you think that helps to explain why the new developments are being made, why the effort is being made or just explain how to use it technologically? Is it like "follow these steps to use it", or is it more like "This why we're making the change."?

C2: It's kind of different for each of the tasks. There's a couple of different answers. The maintenance manual is just that, it's a maintenance manual. Now we have in the works an operations manual as well, which is going to be a lot more in depth. And it would be for somebody just coming in, they could use that as a supplement to on hand, or on the job training or sort of thing. If somebody was coming in and learning this technology.

It's not for distribution if somebody that doesn't know anything about ion beam and then they go well isn't this fascinating, and read through it. It's an application type of document. The powder coating is for specific use in a specific area, Corpus Christi on powder coating. So they have a new line down there. I'm not trying to be facetious.

I: Oh no, no, because I understand that these questions are a little bit odd but I'm trying to see... Well, one question I'm going to just ask you now and might as well. Is that is this any different because it's a green project? Are the manuals you're writing or anything any different because it's supposed to be environmentally friendly and that type of stuff. Does that come into it at all?

C2: I would say not only just on this project but on all of our projects. Us being an ISO 1400 compliant company, we already look at environmentally friendly types of things. One would be paper use, and that's a huge one for us. Was that the line you were going with on this.

I: Oh this is all very good, you can explain this or anything that would help me to understand what goes on here.

C2: You know, as far as we have documents, fairly large page documents that we're going through and editing and that sort of thing. And some of the things that we'll try and do is, unless it's in a final draft stage we won't print it out on paper, we view it electronically, we make changes electronically, that sort of thing. Or we'll just make one copy of it and have that sent around for distribution, that sort of thing. So there are efforts always to be made concerning environment. I start turning lights off around here, I know that's a little bit, that's probably more anal on my part, but those are just things that I think about personally as far as that goes. Whether it's green project or not, it probably doesn't hurt that it's green project, it keeps it in the back of the mind a little bit more.

I: Is that one reason why you came to work here, because of your interest in it, or is it something that you began to learn here? Or is it something that you pretty much had all along?

C2: No, it's not, I mean I've certainly learned a lot more as far as environmental issues are concerned since I've been here. Although I have no technical expertise in environmental area, I took a few environmental bio classes as an undergrad, I had a little bit of interest there. You know I do kind of the normal, I recycle, and that's all stuff I kind of did on my own before I came here.

I was, it was another pleasant surprise, another part of working here and being in the ETF building, the Environmental Technology Facility here. Those were all just kind of bonuses and armed me with a little bit more information, just making me a little bit more dangerous than I probably already am.

But I was in the Air Force actually before this and so those types of things were stressed there as well. But I think it's more of a personal thing with me.

I: That's interesting. I didn't think the Air Force would encourage –Well, I guess they have to, they've got to pay the utility bill like anybody else.

C2: Yeah, they do. They got more into recycling and keeping an eye on hazardous wastes and those sorts of things.

I: I'd like to move onto another question here. So when you look at what's going on at CTC, and the project and so forth, do you yourself believe that it's going to have a positive impact on the working world, the outside world? It's not your technological judgment of the work. But in general, do you think it's going to have a good impact? You can say no, because some people don't.

C2: No, I, gosh the overall picture of the SGM is something that I'm not really really close to and I don't want to sound like I don't know anything about the project. I'm just stuck in my little training world with a lot of this and this is my first year that I've come onto it. So as far as the big picture of green, I've heard bits and pieces but I don't even know if I'm really that knowledgeable about it to make an assessment on that.

I would hope so. I would certainly hope so. And now I sound like I'm working on a project I don't know anything about.

I: No, not at all, if anything, it's a question that's different for every single person and for every different task. Because some people are doing something like, with obvious, enormously obvious benefits like we're going to stop painting tables with lead or something like that. And they're like sure, right away we're going to have immediate change. And other people are like, well, I really have no idea. And that's why it's important to ask, to get a feeling for how everyone in the group thinks about the project.

C2: If we're talking about mine specifically, I can answer to mine specifically. The overall project, the whole project, I don't know what type of impact that would have exactly. But for mine, when you're talking about in the one in this brochure you hope that those sorts of things get out to people and that they respond to it and there's a change that comes from it. So that's one.

The ion beam, not necessarily a big, it's not a big technology that is everywhere, so it's certainly a useful technology but it's not that wide spread right now. And then the powder coating, if we could train more folks on powder coating then that's always a good thing because whatever they were using before, whether it had hazardous air pollutants in it or VOCs or something like that.

But the powder coating it's an alternative that's a lot more environmentally friendly in most cases, it's recyclable, all those sorts of things, so hopefully that'll have a positive impact as well.

I: And I don't know if you've worked at another company that did the type of on line editing as opposed to print editing. Do you think that's going to be the basic trend for how writers and other instructional developers are going to be working, do you think it's unique to CTC, do you know anything about that?

C2: To start at the beginning, this is the first company where I've done this type of work specifically, so I haven't seen it anywhere else. I haven't seen it anywhere else since I've been here. That doesn't mean it isn't happening somewhere else. As far as a trend, I think that, I hope that it becomes a little bit more of a trend.

I mean I think, and certainly it's not conducive for everybody, editing on screen and reading on screen is very tiring. It's something that definitely takes its toll. If you could limit thought, the number of copies that are printed, like I said if you just had one copy and then maybe comments are incorporated from there and then it's given to somebody else or that sort of thing that could certainly be helpful. But I'm sure that eventually it's going to be an issue because everybody goes through paper like, not, and it's a limited resource. You know it's recyclable but it's still a limited resource. But you know, it depends. There are some folks that get an email with a fifty page document and they go oh, I wonder what this is and they'll print it out.

I: Now the last question is, do you have any technology transfer experience to compare with this? Say a project that went better, or worse, or could you just say this is a typical one?

C2: I don't know that there are any necessarily better or worse. I've done so many over the last couple of years that have all been technology based for the most part, computer and webpage training. Which, they're certainly different but some of the same rules still apply. So as far as being wildly better or worse than even those, even though it's a different format than you're delivering it, no, it's on track for the most part. And I haven't seen any problems that I haven't seen before and I haven't seen anything come up that I haven't seen before.

The biggest one, one of the biggest things with any type of project like this is communication and response. Because that's what you're talking about and that's one of the things that'll get you sometimes. Nine times out of ten it's not technical accuracy, because the subject matter experts are incredible in their areas and they're right on the money.

But sometimes it's just the flow of the project and that's part of my job to keep that together and to keep it moving.

I: Okay, well thank you so much.

**CTC EMPLOYEE INTERVIEW – Mildly Concerned Group
December 1, 1999**

C3= *CTC Employee 3*

I= *Interviewer: Susan*

I: Could you tell me about your work for SGM?

C3: I would say I'm the non technical person in the group. I handle the management side of the green man project. That is subcontract work, getting contracts in place through our people in contracts. I get all the invoices, I take care of the spending within the program. I'm the watchdog for, you know we have about ten or fifteen projects going on here, I don't know exactly the number right now.

And they each have a budget to work to and I make sure they stay within the budget, keep up with their spend plans and things like that. And it's, any anything else that □ thrown my way. And Dave's the program manager for the task. So I'm more or less the non tech guy that looks from the outside and makes sure we're on schedule within budget.

I: So I was just wondering about the origins of this and how did CTC become involved with SGM? Was that the military contacting you?

C3: I can't answer that question. I truly don't know. R. would be the one to answer that question. I suspect it came through our □ that's where our contracting officer is, all our contracts go through them. And I feel, I suspect it was initiated with them and G. our vice president and whoever else got into this. But that's about all I know and what I know is actually, it's more hearsay than anything else, because no one told me where it started so I can't really answer that question for you.

I: So at any given point are there all kinds of projects going on simultaneously with SGM?

C3: Yes.

I: And some people might even be working on two or three different things at once.

C3: Oh yes. You mean, well let me explain the structure.

I: Okay.

C3: We have, this is a program management organization. And so there are many projects. We have like, again I don't have any exact number, but I'm going to take a stab, maybe sixty projects going on, or seventy going on at one time. And you may have a person like U. who just came out of here, he may have a piece of this task, SGM task, but he way be working on two or three other tasks also because there's not enough money in here for him to be full time, so he has other things, like I do.

I've got other things, so yeah, if that's what you mean, a program manager who has a piece in the pie of SGM may have a piece of a pie in three other programs, you see, or four. Yeah.

I: So, do you have to, I was just wondering, do you interact with people at Picatinny or do you interact with people at NJIT, how do you, or do you stay mostly with CTC people?

C3: Okay, the program, we're on the NDCE program, National Defense Center for Environmental Excellence. Within the program, the projects come through from Picatinny to us. The program manager works within the program, if he is the program manager he is the chairman of the board, he's the president, the vice president, secretary, he handles his project and he brings people on as he needs them, okay, to run that project to conclusion.

Now, monthly reports and things like that, deliverables as we call them, go through Picatinny to our client, to whoever else is on the list to receive those. So our projects are run within the program. We are solely responsible for the execution of those tasks to conclusion. Picatinny is more like the monitor. Let me explain how we do that. There's a task monitor at Picatinny assigned to every task we have, every project.

That person may have five or six projects because they don't have as many people poised, we have, they may have, one person may have eight or nine projects. And they're the task monitor. We deal through that task monitor to talk to Picatinny. Say we want a deliverable date change, we have to go, the program manager here goes through the task monitor at Picatinny at the same time our program manager contacts the client and says hey, this deliverable was due thirty days after a certain date, or a certain event, and that's impossible because the event was twenty five days late, so the date we have this deliverable is not correct. So the client then has to write a letter to us saying it's okay to change that date, we go through our task monitor, he has to agree, then it goes through the contracting officer at Picatinny to change the date.

So that's how we interact. Now that's only one example. If there's problems within the task, something isn't, you know the statement of work tells us to do a certain thing, we work by a statement of work. And if it turns out it's impossible to do something within that statement of work and we need to change it, we have to do the same thing. We go through our client and our Picatinny task monitor to do all that. So what I'm saying is the project is run here at CTC in its entirety but we have this task monitor at Picatinny and of course our client who's paying us, they're also in the loop. So I don't know whether I'm answering the question.

I: No, no, that's excellent. It seems like a complicated process. Do you see the benefits of it or do you think it's just a lot of stuff to take, a lot of channels you have to go through to get anything done? And you can speak freely too, because this is all confidential.

C3: Yeah, yeah. I came out of the steel industry. I was in the steel industry for thirty four years before I retired. And coming into this environment, the paperwork is maddening here, it drives me crazy. Now we had paperwork in the steel mill, but not nearly like we have here. In the steel mill the paperwork you did have got processed very quickly. Here it's like pulling teeth.

You've got to go through certain channels to get, you know, getting a deliverable changed at the steel mill I would have said call the customer up and say hey I can't deliver this on a certain day, here's why we can deliver it two weeks either before or after that date. And the client on the phone says okay, and all I do is go upstairs to the correction scheduling guy and say change that order to this date and it's done, you do it all within ten minutes.

Here, you've got to write a letter to change it, then you've got to go to your client, on paper he has to respond. The task monitor at Picatinny gets our view plus the client's view, he agrees by letter, then it goes to the contracting officer with all the everybody agreeing before you can change that date. That process I just described to you may take a month, it may take a month and a half.

I: And by then the date might even be past.

C3: Well then that's what you've gotta be conscious of that you're not going to be doing the same thing again because it took so long to make the loop. So stuff like that, very, very pains taking. Getting a contract with the NJIT people. We're doing Green Man 98 as we call it now. And we're just about concluding that. And I believe the contract was just signed with NJIT just this past couple of weeks ago. We've been on the project since January. Now we've been on what you'd call a letter sub contract that they're allowed to do the work until the contracts people do all the particulars to get the main contract done. But it took this long. The project's almost over. There's a lot of things we do here that I personally feel could be done quicker, but who am I to change the system?

I: Is this done for-- I'm trying to think of a justification for a very slow paper route people have to take. Is it like to protect themselves, is it legal?

C3: That you are spending the taxpayer's dollar, I believe that is what it is. And if you ever get audited by the government, which happens, general accounting office has come in here to do some audits, maybe not in contracts maybe, but if they come in here and audit a specific project, which I guess they could do, I've never seen it, or if the client comes in to audit. The client can come in anytime and do an audit. And they want to know why, do we have all the paperwork in place to pay Picatinny, or New Jersey so many dollars? Show me the paperwork. So you're spending taxpayer's dollars when you're doing

government work and I think you just need to do this. That's the government way of doing things, talking to other people that are involved in the government side, they got to go through the same paper trail.

I: So it's not enough to just do email and zip it out, it has to be a big production, that kind of thing?

C3: Got to be. Now you can do some things with email that's quicker, but there's other things you can't. Like that changing a deliverable date, you can get email from the client saying it's okay, and then for getting that email to the task monitor at Picatinny, then he puts his okay on it, then that email goes to the contracting office.

And I don't know what paperwork the task monitor at Picatinny has to go through. I'm just telling your from our end, after he gets all this stuff he's got to do some things too I'm sure. So, yeah, it's a lot of paperwork.

I: So do you think when they're planning to start with they build in dates that might even be more than they need just to anticipate what they might need to be able to meet this deadline in case anything happens? We're going to say it's due in April instead of February or something like that?

C3: Yeah, I don't really know how that is. Normally the procedure is this. A client will come to us with a statement of work. Normally, this is the procedure. The client will come to us with a statement of work before any money is here. And say the project. So we know the money's coming so you have to do what we call a CAM Package, that's a Cost Agreement Memorandum. What we do is itemize our costs, labor, travel, ODCs, that's the definition of that is other direct costs, of materials, of equipment, sub contractor. We itemize all that and say it's going to cost X amount of dollars. Along with that, with the CAM, we do what we call a task plan. A task plan is a, it's really the same thing as a statement of work, we only change some words saying that we can do the work. Now when that contract then goes through and we, through Picatinny and the channels and we have a signed contract then. Then we do what's called a program management plan. That's where the PMT itemizes or lists when he can deliver the items that need to be delivered as stated in the statement of work from the client.

And so it's up to the PMT, and he'll talk to the client while he's doing this, he'll say hey, you want a certain technical report done, I feel I can do it four hundred days, or three hundred days after the contract is signed, or you need to see a certain coupon painted a certain way, and we can do that twenty five days after we see the coupon. So he'll go ahead and itemize this and itemize all the deliverables and put in the dates. Then that's agreed upon with everybody. That deliverable then goes to the client, that program management plan goes to the client, he signs off on it and says that's okay, or he may ask questions and say hey I need to change this to this, this doesn't sound right, and we go through that.

They get a draft first, then we get comments from our task monitor, from the client and anyone else who's involved with the client. The client may have a laboratory involved with him, somebody else. And then when those comments come in we change the draft to a final report incorporating the comments and that's how these dates are decided upon. Now, through the course of the project, things happen. You know if you're working with a sub contractor and you're building a piece of equipment say, and they have a break down, and for three weeks they're down and they can't complete the construction of this whatever you're making. Well then that throws all these deliverable dates off. Then you have to go in and change things. But that's the procedure.

I: So I guess you have to go to a lot of meetings. Do you have to have a lot of face to face meetings? How do you coordinate such a project?

C3: Quarterly reviews, the main thing. With the clients we have, we're going to NJIT next Tuesday for a quarterly review, Z, myself, and a couple of other people, we're going to meet with Q and Y from Picatinny, he's the client in this case. And we'll go over everything there. Monthly reports go out, every month on every project, to the client, to Picatinny, and they read the monthly reports, if there's any questions on them they'll call us. If there's no questions we'll move ahead. And that's how we communicate.

Plus there's a lot of telephone conversations, we call the clients all the time on the phone, you know, give them, we may talk to them by email to keep on track. That's how everything is, we close the loop. So mainly monthly reports and quarterly reviews that draw everything in.

I: And maybe you could explain to me, because I'm not really sure even at this point. What exactly does Dan Watts do at NJIT, is he like the project manager there?

C3: Yes, that's what he is.

I: Okay, I've heard his name over and over and I've asked people.

C3: He's the program manager for the projects that we're doing with NJIT in the green man task, yes.

I: Well let's see now. Do you consider this project to be different in any way, different in the aspect of technology transfer because it's a green project?

C3: No, no, our thrust in the NDCE program is the environment, pollution prevention, cleaning, stripping, painting basically. And this falls right in. This is corrosion protection there, and that's what we do here. All these projects are by that. We transition environmentally safe technologies to the DOD, basically.

I: So you have a lot of similar experiences, it's really something you've done... So have there been any what you consider to be any problems in this, anything you wish had been avoided or...

C3: With the program?

I: Yeah.

C3: No.

I: No? It's pretty much going as it's supposed to?

C3: It's going as it's supposed to go, yes.

I: Okay. I think I covered everything. This is a question that's a little bit off the wall, but it has to do with, do you believe that this project is going to have a positive impact on the outside world or the working world? Do you think SGM is succeeding in it's mission, or would you say well, it's tentative right now, we're not really clear, or how would you characterize the project?

C3: If you're asking me if we've had any positive results in anything we've done so far, no. But that's an unfair quick answer. You know with the kind of projects we do here you don't normally see results, or people changing what they do out there because of what we did in here over night. Keep in mind the government's a big thing, the DOD's a big thing. So if we come up with a technology that can do something better than they're doing now, and is environmentally safe, in the long run they're saving money, okay, by making the conversion.

These reports go to whoever they go to. I mean they go to our client, Z., and he disperses these reports and talks to people about what we've done. He talks to captains, generals, I don't know who all he talks to.

They're just not going to get up with, oh I like that, let's do it tomorrow and he takes it, it's the government, it's a big thing, it takes a long time. It may take three four years for something to be implemented if it's implemented at all. There's the other side, that some things I don't like. You tell me this is confidential, but there's things I don't like. There are some reports that go out that I know will never even be looked at, they get put on a shelf. Money was spent and nothing was done and they're good projects.

So you'd have to hope at the other end that the people see them and say hey, these people did this. And I don't know if CTC does a follow up with clients like we did in the steel industry. If I ship you, in the steel industry, a truck load of steel, if I don't hear from you in a period of time, we would make a telephone call and say hey, you got this steel from us, I know we got another order just came in, but did that first truck load work okay? Or that new thing we did with it, did it go okay? And we had salesmen out there that contacts the customer, they talk about this all the time.

I don't know whether we do anything after we send out a report or reports for these projects, do we then follow up six months, a year later, and call the client that we did the project for and say hey, we did the project, there were some good things, has it gone beyond you, have you contacted anybody to implement. I

don't know whether we do that or not. That's never been explained to me. Hopefully we do. To keep the pot boiling so to speak.

I: That's something that I didn't think about, that a good report or a good idea could just sit on the shelf, yeah, that's disturbing.

C3: It can sit. It definitely can sit, absolutely, as a potential. Unless we follow up somehow and push the client to implement.

I: If the client should actually have a bit of enthusiasm for it too, but there's no way to guarantee it.

C3: He's the client. He's asking to do it. And he's the one that gives money to do it. So he should, there should be some kind of follow up and I don't know if there is, to be honest with you. I would assume there is, the directors do things that I don't know about, they don't communicate to us very well here on what's going on beyond our own jobs.

I: For this to be clear, the way it happens now, when the project is done, basically it's determined by a deadline date, it's done, and then everything's sent out, and then you go on to another project basically, that's the way it goes?

C3: That's right.

I: That's a lot of effort and then you don't know what happened to it.

C3: Well it doesn't, like I say that doesn't happen all the time. For the majority I'm betting it does. You do it and you move on to something else, this is we did a project, it's over, the client was happy, he signed off on the final report, it's up to him to implement it, it's not up to us. We can call him and we can, but if he doesn't want to implement.

I: Do you think the executive order that required the military to make environmental changes is sufficient prodding or enough to get them moving on environmental issues or do you think it's still at a stage where they could decide oh, I don't know if I want to do this?

C3: No, I don't think so, I think you've got to make the changes or EPA is going to be on you whether you're government or not. I know private industry we spent millions in the Johnstown plant here cleaning the air up and that's all money off the top, you don't make money doing that, that's like replacing your driveway in your house. It may increase the value of your home a little bit but it's really not a big significant amount but it's something that you do, if it's torn up you've got to replace it, you replace it. If the furnace breaks down you gotta replace it. So yeah, I think there is an initiative and EPA means business, oh yeah. And that's where most of these projects are coming from, that's where all these projects are coming from. If it wouldn't be for somebody that's worried about putting lead into the ground from using paint that has lead in it, and spraying a jeep with lead, they're coming to us to find an alternative because they know they can't continue doing that.

Oh yeah, I think it's there, I think there is interest, absolutely, oh yeah.

I: Well that's good then. Those are all the questions I have, but if there's anything else you want to bring up. That's excellent though, you really explained it to me.

C3: Yeah, it is, it's just a paper complicated thing.

I: Well it's always hard to coordinate everything.

C3: You don't need to be a Ph.D. to do the job it's just.

I: You have to keep after people like a bull dog.

C3: As a matter of fact a Ph.D.s do a lousy job of doing the paper work, they're more on the technical side and to get them to do the paper work the proper way is sometimes like pulling teeth. They love the technical end and want to hold onto that and they forget about the schedule and the cost and all the other

stuff that has to be done in order for them to build that piece of equipment or find out through a beaker test whether this paint is better than that paint.

I: That's actually a question I should have asked, since the management side and the research sides are always kind of at odds with each other. And maybe it's very simple to tell them you should just do what I tell you. But if you were trying to persuade them to hand in their reports on time and stuff, would you just tell them look, we cannot possibly carry on this project unless you follow this pattern?

C3: Well, yeah, that's pretty much. But the way we do it, like I say, you're assigned a project that the company feels you can handle, of course. And you are the company, that's your project, you're the president, secretary, vice president, you're everybody. And if you don't deliver monthly reports on time, if you don't deliver a technical report when it's due and a client is feeling uncomfortable because you're not doing right, well then you don't work here very long. I mean that's made very clear that you have a responsibility.

Now there are people to help, like I, I help X and other program managers do whatever they need to do to be successful within their project, there's people out there to help you. But it's the program manager that's got to, he needs to initiate that help, he needs to get people to give him a hand so.

I: This is very interesting, I might think of a question later that I want to ask and have to give you a call and follow up on stuff, but this is amazing.

**CTC EMPLOYEE INTERVIEW-Dissatisfied Group
December 1, 1999**

C4= *CTC Employee 4*

I= *Interviewer: Susan*

I: So can you tell me about the work you're doing for SGM?

C4: The project I'm working on right now is with N. He's pretty much the project manager. And what we're trying to do is survey vehicle based applications for each technology. And the whole thrust behind this is to basically replace chrome chrome replacements on heavy machinery. Right now each BF is primarily used on there as base components and with they're doing a lot of work in implementing on components. And we just want to take the existing technology and find new and improved uses for it so to speak.

I: So is this your usual line of research or is this something you're doing just for SGM? This type, not necessarily the exact topic.

C4: I have a little bit of background in HVOF with removing various types of coatings. I mean there's just tons of different kinds of coatings you can HVOF apply. And I have a lot of experience with removing those types of coatings. And I have a little bit of background in the technology plus the people that we're trying to transition this to, so Eric thought I'd be a good match for this project. Because a lot of the problems that we have is getting our foot in the door and getting data. Because usually when somebody comes in from the outside they see them more as a threat than a help.

I: So what kind of a threat, like a commercial threat or a security threat?

C4: Just to give you an example. A different project that I'm working on was doing a chrome plating survey. This is in conjunction with what the H Cat is going with HVOF in the aerospace industry. We're trying to find plating technologies other than HVOF that can replace chrome. I don't know how better to explain it than that. Maybe you'll be able to decipher this after you listen to the tape.

I: I've heard enough about this project that it makes some sense to me.

C4: So anyway, one of the air logistics centers we went to, they, the guy straight out told me, he said, you know I don't want you, I don't want to give you any of our processing data because this is proprietary information and if commercial vendors knew this information they could bid against us and get the projects basically any and all work being {INAUDIBLE} could easily be moved to the commercial market which a lot of it has done with the {INAUDIBLE} closings that have gone through Sacramento and □ and San Antonio center.

So you touch a few sensitive nerves whenever you get prying into these different places. And I don't really remember what the original question was.

I

: Oh no, I was just trying to find out a little bit about your background and the type of stuff that you do. Now, do you know what the end, or the outcome of this study will be or do you know if there's an end user already set up who will want this information?

C4: Yeah, originally the project was to survey commercial applications of HVOF that were aerospace related. But depots like Corpus Christi Army Depot and Aniston Army Depot, and Aniston in particular is currently using HVOF on ground based vehicle applications. So it only made sense to say, all right, you're doing this, why not learn from your mistakes, and then help other depots get this equipment set up. Originally when the project started, Aniston was just getting their system, how do I want to say, laid out on the factory, never been used, just setting up the pieces. They had a few problems with grinding at the very beginning and I thought, like at the beginning of the project I was asking questions and one of the questions that E. down there at Aniston had was, how do you grind this stuff? I mean we can put it on okay, but to get the type of finishes that we want, we're having difficulties with it.

So I gave him a contact on it, {INAUDIBLE} by the name of D. and he's pretty much the grinding expert on the H Cat aerospace HUF chrome replacement task. So there's all sorts of stuff going on. So after they got in connection everything worked out after that and they've been learning a lot of things along the way which is what we're trying to capture with this project. And then take what they've learned, fly to different depots and basically simplify the process of getting these equipments installed, and set up and get their operators trained.

I: Now how do you go about contacting these people, do you go to meetings or do you attend their conferences or just phone them up?

C4: All of the contacts that I've dealt with have been previous clients, customers, people that I've gradually gotten to know over the past four years that I've been here. And after you've worked with people they either like you or don't like you and that's another reason for putting people on different projects because if you have a good contact they like to deal with the same people over and over. Because in this business what you don't want to do is send somebody that has no experience or no prior contact with the person because it's really difficult to make cold calls and half of the business is just knowing people.

I: Do you think that's a matter of trust, that they want to be able to trust you?

C4: Yeah.

I: Or they just don't want some young kid just out of college or something like that.

C4: Yeah, the funny thing about it, especially that I've noticed, with military depots, and actually every person that I've met, every vice president, salesperson, they all want to be treated like a normal person. I mean the best way to do that is take them out for a beer and that just breaks the ice. I mean it's, I never would have thought of it, but it's the truth, you know, if you want to get business, if you want to earn somebody's trust, just take them out.

I mean you'll find the more successful engineers are pretty much the more outgoing, the kind that just likes to go out and have fun. Whereas the tight lipped intelligent ones that just sit in a cubicle all the time, they just won't go anywhere, they'll go nowhere fast.

I: Well, now here's just a question, you were saying the way you'd like technology transfer to operate. I guess what you're saying is you have to have a more human touch or friendly interaction and that's how it's happening at SGM now, pretty much usual business?

C4: Yeah, what I would like to see, one way to get into depots, or to just maintain friendships with these people is not to ask something of them without providing something to them. And in this instance I'm asking this army depot to tell me all their problems which one thing they really don't want to do because I know the guy, the primary engineer was getting some slack for not getting the equipment up and running. I think the equipment's been sitting on the shop floor for two years.

I mean the equipment that could have been in use has been sitting down there. And one of the guys I was talking to said it was basically because of this guy's attitude or lack of engineering skill, one of the two. So it's a sensitive subject, just to be. So you go down there and you ask him, all right, what took you so long to do this. What I was thinking to do was to rehash all of his problems.

I: Although you might want to say exactly what happened, it probably would help him.

C4: Well, I've been trying to get a hold of him for the past two weeks.

I: I mean this is the thing, in some cases people don't get back because they're busy, some people don't get back because they're just uncooperative. But I guess in some cases people don't cooperate because they feel they've got something to lose by cooperating. That's weird. And is that an obstacle that you can't overcome or is that something that you just, how do you handle that?

C4: Well, it's getting towards the holidays and another thing about Army depots is they're a little bit less productive than, I hate to say it, but on average they're a little bit less productive than the normal private enterprise. So especially around the holidays you really can't expect much at all.

On thing that I'm worried about this project in general is to be able to get enough information in time. To get everything wrapped up before Christmas. Because that's one of N.'s goals and my goal as well.

I: So you think that's not going to happen? I mean what's the worse case scenario, that you don't ever get the information and it just fizzles out?

C4: Well, the worst case scenario is that I go down there without any information, just go down there and start cranking heads around, get a few stones or one of the two.

I: So you start out with a nice approach with beer and so forth and then if that doesn't work then you just have to be stern with them and get it one way or another.

C4: I don't necessarily know about that. In the past I've had no problems with Aniston Army Depot. And the clients down there and I kind of hate to get into too much detail but I think somewhere along the way somebody ruined, or at least messed up my contact down there. Because I used to be able to get an instantaneous response from them, now, I think the last email I sent out was earlier this week and either they're on extended vacation from Thanksgiving or.

I: No, this is all confidential, talking to me. But what do you think could have happened? I mean how does something like that get ruined? Is somebody suddenly. It doesn't have to be personal.

C4: The way something like that gets ruined is, once you develop good contacts at a place, right, you've established a good rapport with them, what will happen is new projects will open up and different people get into the communication. And certain people don't follow the same proper procedure to schmoozing and wining and dining people and providing a symbiotic relationship and give take relationship. A lot of people expect something from like, we're doing you a favor type thing. Which Army depots don't care who you are, what you're doing, as long as you are providing them something instantaneously and you're not taking too much from them. And it's, I don't know how to explain it better than that, but it's difficult.

I: But even if it's just your coworker or, I'm not saying your coworker exactly but somebody else on the team that somehow things get a little bit frosty that spills over into even to you?

C4: Yeah, yeah. Because it gives your company a bad reputation, and if the company has a bad reputation then they don't want to deal with you.

I: Um hmmm.

C4: I mean this is all just speculation. It could be just the holidays and stuff like that.

I: But if you sense it sometimes that's true. Usually people don't imagine stuff that isn't there.

C4: Yeah, it kind of, the impact that I'm starting to notice is the fact that I'm not getting information as fast as I used to, which is a fact.

I: Well, do you consider SGM to be a different project because it's a green project or is it just a regular essential study and it doesn't matter if it's green or not? Do you think that effects the way people respond to you or anything like that?

C4: I have no input on that. I'm not entirely familiar with all the different areas that SGM is in and I'm not very familiar with what the whole thrust behind SGM is.

I: Well more like in your own words, do you think because the goal has some environment-leaning component in it --I'm not trying to -- in fact you don't have to answer the question, I'm just repeating it in case you feel like it. You can just say again it really doesn't make a difference. But for some people they find that other people they're dealing with are particularly interested because they have a great need for

something that's a substitute or a new process and they're very motivated because they're trying to conform to new standards.

But for other people who say that the people they're interacting with aren't very driven and if they are it's certainly not for the green aspect, it might be the commercial aspect or something. So do you consider the green aspect to be a driver in how the communication flows occur or not really? You don't have to answer.

C4: Well that's something that, you know I've been dealing with over the past four years and originally with the Montreal Protocol and the Executive Order 12875 or something like that where the DOD has to reduce their overall solid hazardous waste by fifty percent and you have to get rid of those ODCs and □ and stuff like that.

Back when I first started here four years ago, those types of issues were big. And those were key words that all the military folk were kind of pressured into solving. And now that it's almost the year 2000 these issues have been around such that they've all been beaten in the head a hundred thousand times. So as far as green goes, most depots are of the thought that we're about as best as we can get and there's a lot of processes that have trying to be improved to no success.

I've heard a lot of stories and seen equipment that's been purchased specifically for green applications that never got installed that are just sitting being moth balled somewhere. Which basically means if you're going to install something you have to go from step one to a thousand or whatever it is to get the equipment installed and your operators trained and to actually prove the technology. So back to your original question is do I think the green aspect of it.

I: The green aspect probably isn't necessarily a particularly attractive one, people aren't sitting around saying I can't wait for the results of your study.

C4: I think as far as the green goes, I think all depots are pretty much, how do I want to say it, numbed to the word green, numbed to the work environmentally friendly, because there's just so many technologies out there that just don't fit the mold for whatever they're trying for.

I: And as for the moth balled equipment, whatever happens to it, does it just sit around? I mean I know it's in moth balls, literally or figuratively it's not being used. That just seems a little bit shocking. Do you think it's just too much effort that goes, that must be □ to get it up and running, is that the obstacle? Or is it funds, do you think lack of money.

C4: Half of it's funds, half of it's having skilled people, skilled project engineers to get the thing up and running like it said, that HUF system down at the Aniston Army Depot took, I don't want to say two years, because I don't know the exact number, but I know it was a significant amount of time since the time it was purchased. It sat there and never got installed. I believe there were some environmental regulatory issues that had to have been resolved with their environmental engineering department and there's a lot of bureaucracy paperwork that has to be shuffled through to get these systems installed, make sure that any union shop that this labor is going to do this and that guy's going to do that and there's not going to be any conflict of interest so to speak.

That was one of the successes that CTC had was you minimize all that paperwork, they could just call us up and say hey, we need this piece of equipment and we'd go down there and install it and train everybody and badaboo badabing, you have the thing up and running as opposed to it being moth balled. But it's not something that happens and it's something you just have to deal with, something that the military people have to watch out for.

I: Now here's a question, we're getting near the end, don't worry. Do you yourself believe that there'll be a positive, or what connection do you see between your work and the outside world, or what will happen when your study is done? Do you yourself believe that it will have a positive environmental impact when it's done?

C4: Oh yeah, the HVOF project that I'm working on definitely is something that needs to be done. And it only makes sense to take the lessons that Aniston learned and hope to apply it in the other depots. Now I'm not entirely familiar with what depots we're going to be targeting, but there are quite a few out there that need repair and overhaul of every type of vehicular system out there.

Aniston Army Depot specifically focuses on track vehicles, other depots focus on wheeled vehicles and basically whatever, every type of, all the different types of applications have similarities that HUF has applications for, so I think this is a project that definitely should be highly considered so to speak. I'm not particularly fond of writing reports so if there's a way to minimize the report writing that's just getting down to the nitty gritty I think we'll have something going.

I: Now there's a question that I'll just ask very quickly. When you say writing reports do you mean that, in a joking way like you don't like doing the monthly and all that other paperwork reports, or are you talking about the final result, you don't want to write that report because it's going to be huge and that's a big job? Do you think there's a lot of stuff that gets in the way of what you consider being the essential part?

C4: Yeah, well for this project we had the technology overview report and the technology application report or something like that and I think those reports were over twenty pages long. And then like you said there's a final report, so you have three reports and you don't have a running piece of equipment to show for it.

And I'm the type of person where you put together a proposal, everything gets checked off on it, you put the equipment in and if you have to write a final report you write a final report. But reports should be no more than five pages long, because if they're any longer than that nobody's going to read them. And that's I think a point that a lot of people here miss. You have to show results. A one page report will explain everything better than five twenty page reports.

I: And have you had an experience like that where you were able, and I'm talking about your whole career, where you were able to do this the way you wanted, or a technology transfer experience that was better, or if I hear what you're saying is this a typical one do you think?

C4: Yeah, I think this typical, yeah, you write two reports, hopefully we'll go ahead and take the information that we learned from the reports, provide it to other depots, they can use that information to get justification for funding and then once they get justification for funding the final report will also help them to set up, install, train, get everything going. What was the original question?

I: Do you have any technology transfer experiences to compare to the SGM one?

C4: Yeah, I did another job down at Aniston Army Depot that was vapor degreaser retrofit. The vapor degreaser was essentially an OSHAP end compliance, I don't know if you're familiar with what an OSHAP is.

I: I know every acronym there is by now.

C4: So you're familiar with the whole thrust behind OSHAP?

I: You can give me some background.

C4: An OSHAP is just a policy and basically what the OSHAP regulation was I think by October of '98 or January of '99 certain pieces of equipment had to meet certain criteria to reduce the amount of air pollutants that were emitted by that particular piece of equipment. And a particular vapor degreaser that used, I think we were using --um, I always get the two mixed up. But anyway TCE is emitted by these vapor degreasers, just as part of the way they function. And TCE is a hazardous air pollutant which causes cancer and the rest of the other stuff, supposedly causes cancer. One of the equipment vendors told me they've been inhaling that stuff for years and no problems whatsoever. So anyway there's just thousands and thousands of gallons of this stuff being evaporated every week. And as part of the whole technology transition thing we went down there and put together a few reports, bada-boo bada-bing got the equipment, wrote a couple of reports afterwards and everything was hunky dorey.

I: So you'd like a little more results.

C4: Yeah, I'm a results person. And I guess you have to write a few reports to get justification and to get people's eyes opened to gain project manager support and get the whole ball rolling, but I like to see results. And the specific project that I'm working on has a lot of potential. It's relatively new, I mean it's actually kind of old but the equipment is being updated right now so it provides good results, consistent results. It's not difficult to operate, the turn around time is significantly increased and the cost pay back is going to be, I would assume, a year, but it's definitely going to be less than two years which is the normal goal that you try to shoot for whenever you implement any technology.

I: So I guess the future of the project is that it will actually lead to system changes as opposed to just being a report.

C4: I think the thing I'm kind of stuck on right now with this project in particular is I'm not getting all of the cooperation that I'd like to get. I'd just like to be able to call these guys up and say hey, because we sent them down a survey and I'm still waiting to hear back from them. That said hey, just fill out the survey and typically you know within one or two days I'd get the survey back. But that hasn't happened, so that leads me to believe either that somebody's taking an extended vacation or somebody is either blackballing us or I don't know. But I know if I took a trip down there I'd be able to straighten things out, and it would kind of help if I had a little bit more funding to say hey, this is what we're going to do for you, not just take it, not just go down there and say here give me this, give me this, give me that.

I: Pay them to do the survey you mean?

C4: Not necessarily pay them but either provide them with information, provide them with sources of funding such that if they need to do additional training, either point them in the right direction or give them equipment or say that you're going to install such and such equipment down there.

I: Well, I mean this is all very useful. I just wanted to say those are all the questions I have. I think we covered just about everything. I just want to thank you.

**Interview with CTC Employee-Satisfied Group
December 1, 1999**

C5= *CTC Employee 5*

I= *Interviewer: Susan*

I: Just for background, could you tell me about the work you're doing for SGM?

C5: Right now I'm evaluating risks associated with the technologies for the CTC group. Potential and perceived risks associated with things like the HVOF coating process, the IBAD process. The HVOF is the High Velocity Oxy Fuel. The IBAD is the Ion Beam Assisted Deposition, the qualitative power coating process, the natural coating systems. What are the risks associated with each of these processes? In order to provide the decision makers, the managers, a means to evaluate alternative technologies. What are the risks associated with Technology A? What are the risks associated with Technology B? Are we really going into the green or are we jumping into the rough? With switching the technologies. So it's a way to compare alternative technologies in terms of human health and ecological risks. And in one manner they are simplified to look at. Are we using carcinogens, mutagens, teratogens, neurotoxicants, things like that.

I: So you're mostly working with people who are at CTC to start with?

C5: Yes. That is correct.

I: Is this the typical kind of research you're doing? Or do you just have to do this for SGM?

C5: This is a typical type of project that I carry out at CTC. With SGM I guess they realized that risk assesment is an important process in decision-making processes. It fits right up there with economic decisions, political decisions, cost decisions. So human health risk is an important component of decision making. And other companies recognize that risk analysis is an important part of legislative, you know, policy making processes, establishing standards. So I do other projects associated with risk assesment because that's my specialty.

I: So what is the deliverable you'll have when you're done with this? Are you going to have a report? What is your final output?

C5: My final output is a deliverable we call - I call it an Information Summary, and what it does is summarizes the real or perceived risks associated with each technology whether it be the alternative or the baseline. And depending on the process, the stage of the process, some reports are more detailed than others. I brought a couple along with me. You can see the larger ones have a lot more information mainly because the baseline technology was available and you can really evaluate the baseline technology and the alternative technology to a greater detail. Some of the smaller reports pretty much summarize the chemical hazards associated with the process in terms of carcinogenicity, teratogenicity, among other things. And it summarizes in a table form exposure limits, what the percent compound is in each, maybe the chemical that's used in a process. It gives a toxicological profile, the type of health risks that are associated with component of a process. Maybe it's a chemical they're switching to.

I: So even the new version has its risks. I know everything has its risks, because a pencil in your hand can hurt you. That's interesting. I guess there's no way to make it perfectly safe. It's meant to be just a lesser of two evils.

C5: That's correct. They look at, number one, nothing is risk free, every thing has risk. And so what they're looking at, is this a more acceptable risk? This documents that hey, we have final technology that is less risky. Now let's look at this element along with its cost, along with its acceptability-- You know, maybe the workers are afraid because maybe the baseline is a carcinogen, but maybe the alternative is a mutagen. It's a comparison, compare the two and determine, maybe there's a winning element here, but maybe it's lose big or lose little. Do you follow?

I: Oh yeah. So have you come up with anything so far that is clearly a problem? Shouldn't be making the change?

C5: No, each one pretty much demonstrates that we have been jumping into the green, to put it simply. A lot of them eliminate carcinogens and carcinogens have traditionally been a problem because people fear and dread carcinogens more than anything else. A lot of the compounds that we're jumping to are newer and maybe some of them are questionable carcinogens. It just hasn't been confirmed yet. So that's one issue. Maybe there are some data gaps with the chemicals that make it *look* safer. So that's one uncertainty that has to be addressed. One limitation of the process. But overall, each of the processes appear to moving towards a more environmentally benign process.

I: So who is going to read the reports and make decisions with them. Do you know who they are?

C5: I submit them to the project managers and the project managers are then more informed about their process. And from there I believe it goes to Picatinny. I do not know what happens after the management review but I assume the decision makers in the arsenal take a look at this new process. Because, let's say, hey, we're interested in using this IBAD technology. Now this document, this risk assessment documents that it is safer because of component A, B, and C being less risky.

I: Okay. And aside from these types of reports, before you write the final report do you convey information to the project managers along the way?

C5: Yes. Yes, I'm in contact with the project manager because I rely on them for information. Because my knowledge about the engineering system is limited. It's not my area of expertise. So I have to speak with them, you know, where is this compound used? What are the maintenance compounds? Are there synergistic effects between these two compounds? So I rely on these project managers to inform me about the process so I understand it better. Following my report we talk and discuss and I give them an opportunity to do a peer review. So they review the information summary and they comment, "Hey, we never use the compound like this. This is off-base.. or this is right on target!"

I: Do you have one main contact or a bunch of people?

C5: I deal with four or five different project managers, you know the technical expert and then project manager for sustainable green, and then during internal progress reviews with Picatinny Arsenal I do talk to Picatinny people and summarize results and findings.

I: Have there been any problems you'd like to bring up? Has there been a case when you didn't get the response that you hoped for?

C5: No, I tell you, a lot of the new technologies are data gaps. That's just because it's a new technology. That's to be expected. As far as obtaining information, it's readily provided. I work with engineers who are very responsive and the peer reviews are fair and critical. They don't just say, Hey, you misplaced a period. They *look* at the process, they look at the report and they tell me, Hey this is on base, or Why did you do that? They do some critical thinking when it comes time to reviewing the product.

I: Would your work be any different if you weren't working on a green project?

C5: With the green I know its goal is to look at sustainable manufacturing technologies so I know its looked at with a critical eye. So I try to make sure that my assumptions are not overly conservative. I make sure that I don't omit things that would be looked at under sustainable green. Usually in my regular job I don't look at neurotoxicity or teratogenicity as *critical* as I do in sustainable green. So there are some elements here that I do include here that maybe would be left out in standard risk assessment practices. I give a little bit more focus on some of the things that would be associated with sustainability and would have a significant environmental importance with this particular project.

I: Do you see a positive connection between your work and what will happen with SGM the outside world, the working world.

C5: I think so. Because these are every day risks that workers are exposed to, people are exposed to. And it goes beyond just having the Materials Safety Data Sheet available. It's looked at more critically in terms of toxicity and exposure limits. Laws and regulations that are available out there, it supplements that and I think adds to it. So I think it does provide a positive aspect.

I: Do you have any other technology transfer experience to compare to SGM? I know you do, but I have to ask it anyway.

C5: I worked on previous sustainable projects, you know with risk assessment support. And I do risk assessment for other projects.

I: So you would describe this project as going pretty much the way you want it? Do you have any suggestions for improvement?

C5: Uh, larger budget.

I: Really?

C5: Yeah.

I: No, no, we can talk about this at length.

C5: Well, there are constraints. I mean, things take time, obviously, in research. Looking up information takes time. And depending on how much information is available for each project each project can take more, and more, and *more* time. And time costs money. A larger budget would be nice. That would make more software available. Newer software, software updates.

I: Okay...I think that pretty much wraps it up. Thanks very much. It's very informative.

**CTC Employee Interview-Dissatisfied Group
December 1, 1999**

C6= CTC Employee 6

I= Interviewer: Susan

After explaining the nature of the study and that all results would be confidential, I began the interview.

I: Could you tell me about the work you're doing for SGM?

C6: Yeah, actually, the work that I'm involved with so far is focussing on -- looking at non-chromate conversion coatings.

I: And is this your usual line of work or something you're just asked to do for SGM?

C6: Nah, it's usual.

I: So I guess you're trying to use something that's less damaging as a coating. The primary goal is to find something that works as well as chromic acid for prepping aluminum but doesn't contain the chromates. Because hexavalent chromate is toxic to most living creatures. So the goal has primarily- unfortunately the these things like this work - What a lot of initial people did in trying to develop something that did not contain chrome, they actually took things that were just as hazardous or *more* hazardous than chrome, but because they were not a particular list, like chrome is, they were considered more environmentally friendly when in reality they aren't necessarily. But basically, our role is, when someone develops something in a lab that they think can meet the goals that have to be met by chrome without having chrome in it, we go ahead and test it. We try to find places to implement it.

I: So is this a project where there an end user already? Or is this exploratory research that might have an application down the line?

C6: Oh, no, there would be an end user. And that end user would be Navy Army, Airforce, the aerospace industry. Commercial side, the automotive industry... Basically anything you could imagine that uses aluminum, probably besides aluminum cans.

I: Okay. Have you met with any of these people? I guess you've met some Army people.

C6: I've met army, navy, airforce -- and navy includes Marines. As well as some automotive and aerospace.

I: So they're encouraging it?

C6: Yeah, as a matter of fact, many of them are behind the research.

I: So what other labs do you work with.

C6: In reality, most of them have not been labs, they've been private companies that have started up through SBIRs getting into this area. In terms of labs, Brookhaven National Labs. In terms of universities, I talked to University of Cincinnati, University of South Carolina - I mean Southern California, big difference. And Notre Dame.

I: Wow. That's a pretty complex group? I guess it's pretty complicated when you have so many groups on a project.

C6: Well in reality what happens is, often times it's not a continuous line of communication. You only deal with these people for a short period of time. Either hearing that they've developed something and trying to get a sample of it, or seeing them at a conference or something like that. The organizations that we've

actually worked with through contracts, those are pretty quick. The communication is pretty good because we're dealing with them on a regular basis. Whereas the universities, it tends to be just here and there, just occasional communication. There's also a couple other large companies... We deal with them a lot, and both of those are very large chemical manufacturing companies. But again, since they already have products in the metal pretreatment industry, they certainly don't want to lose what they have, so they're also trying to develop and work on new conversion coating systems.

I: Do you think there's ever an instance that people are secretive about their developments?

C6: I've run into people... We've had to sign a number of non disclosure agreements. Usually people have a hard time with the concept that I don't care what's in your material, I just want to see if it works. And so usually we have a trust issue.

I: There's no form to sign that says, "I don't care"?

C6: Yeah, exactly. You know, they're willing to work with us but they have us sign something until the patent comes out. They're afraid we'll steal something. But the interesting thing is that they are also willing to be a little bit more free than they might normally be because there is such a large end user community. So if they can have their material qualify, they know there's a phenomenal payback. So in many cases they're a little bit more willing to work with us than if it was a niche product.

I: So I'm going to ask about the different methods you've used to let people know about the work that you're doing. Do you write articles? You go to conferences and stuff?

C6: Yeah, usually it's just presentations and conferences.

I: And you've done the SGM reports. And you've had military visits. Do you work with anyone at NJIT?

C6: No.

I: Here's an open-ended question. How do you think technology transfer is supposed to operate? How do you like the situation to be set up?

C6: Well let's see. I'm lazy and I seek instant gratification. So I'd love it if it just showed up somehow electronically. In reality, I believe that in cases like this, and even though chrome conversion is not high tech, it's wet chemistry. But I still think it should be taking advantage of the Web. I still think there should be - My ideal goal would be, there would be a centralized website that would have a database that would have all of the products that are available, as well as information on up-and-coming products. Basically, one stop shopping, so to speak. I understand that it will never be capable for it to be pushed on to me but at least if I had one place to go to find it, that'd be great. Because right now it's really hit and miss. If you happen to hear someone's working on something, and you get a hold of a phone number or something, you give them a call, then you find out. Otherwise you never hear about it until someone else is already testing it, and you're thinking about testing it. And by that point you've already allocated money to possibly do the same thing over. We've been able to ensure that we don't duplicate effort but it becomes very difficult to do that on a long-run basis.

I: Do you think any aspect of the technology transfer is different because it's a green project?

C6: *Yes.* Justifying it. Green products are typically not less expensive than their counterparts. They're usually more expensive. And the justifications have to become somewhat sketchy in justifying the cost that you're going to be moving to something. And what I mean by that is, you start having to look at a lot of different factors in order to start to develop a cost analysis that shows that your material would be cost effective. When in reality, what really needs to be done - and I'm not saying it's simple but it does need to be done - is a way of quantifying in dollars or whatever, what it means by worker exposure risk or environmental impact. In other words chrome we know is a carcinogen. We know it causes certain problems with the routinely exposed on line worker. But does that really mean in terms of dollars. If we

could establish to that, and show that there was a significant lower cost in terms of these alternatives, it *may* be a justification. That at least you could stand behind in saying you want to move to a different process. But in reality what it comes down to is, you end up coming up with a process that no one wants to stand behind.

I: And yet the military has to change whether they think it's a good investment or not.

C6: You know, when Heller wrote *Catch-22* he was way ahead of his time. Right now, if you talk to a program manager within the Department of Defense, they'll tell you they have to meet certain environmental objectives. They'll also tell you they have no money to do that, and on top of it, they have to prove that whatever they'd be moving to is a cost *benefit* to them. And so what you're being told is, you have to cut money, but you have to make this environmental impact which is not going to reduce your costs, it's actually going to increase them. And they get no where. They run into each other and they stop. And then the program manager gets to say, Well, I have other things which are more important like the lethality of my weapon system or making sure that the engine is designed right or operating right. Which are more important to mission objectives. So he puts that away. It's just not set up intelligently in order to let them achieve those goals.

I: Is there any way to set it up better?

C6: I don't know. Because unfortunately we have a situation... Well it exists all across the world. People say they don't have enough time to get their work done and they're already overburdened. Not enough people to do the jobs yet they're downsizing anyway. So maybe rightly so, maybe not, they don't necessarily believe they have enough time to get their job done. And these people are in positions to make decisions on whether or not things are implemented or purchased or not. So what happens is, the program manager, he's in a position to know all of the impacts of something. You know, everything from the technical, operational to the environmental, everything. But when he goes to present his boss, in order to be in a position to have the approval to make a change, he needs to water that down some so he can explain it to his boss in 15 minutes. Well, his boss has to be able to explain it to his boss in 5 minutes. And he has to explain it to his boss in 30 seconds. So by the time you get to the final end of the chain, you have a decision that has to be made on one piece of information, because that's all they believe they have time to look at. So what does it end up coming down to? It ends up coming down to a cost. In reality, that's what all decisions are made on. And personally, cost is a piss-poor value. But until people change their methodology, I don't think it's an easy problem to solve.

I: I'm going to quote you. Okay, here's a question. Do you yourself believe in the positive potential of your work in SGM to the outside world?

C6: No. And the reason again gets back to the fact that I don't think any of these things will be transitioned. Because they don't represent a significant cost decrease to the programs. Do I believe we will eventually identify alternatives that could be implemented and that would be great? Yes, I do. But it will be a *while* from now before those are cost effective, or mandated into existence by the EPA finally saying, You *cannot* have chrome, period. That kind of thing. Until one of those two things happen, whatever we come up with will just sit, and it will never be implemented. And that's because I've seen the way depots and other facilities operate. Unless they can get it across to their director in 25 seconds, This will be great, it's just not going to fly.

I: Do you have any other technology transfer experience to compare to this? How would you rate the SGM project? In helping you get your work done? Is there anything that would make you happier?

C6: Everything's been fine. Our project's been like in its own separate world. I just communicate people with who I have to, when I have to. But everything's been fine. As a whole, as an industry, there could be some changes like a central information depository but within the SGM project, it's fine.

I: Okay, one more question. I'm sure that a lot of people would understand just from looking at it that it will cost more. Why do you think they're funding this type of research if the potential for it to not be used

is so high? Do you think there might be a way to refine the process to bring the costs down? Do you think they have a long range plan in mind or are they just curious to see what results you get?

C6: Politics. It looks good. It's a way of saying, "We're trying to reduce worker exposure, and we're trying to become more environmentally friendly." And sadly enough, I think in some ways that's what a lot of DOD green money is. They're almost like PR dollars. They're able to say, "Hey, we spend x number of millions dollars a year on environmental issues." If you really look at the efficiency of those dollars, I don't think it'd be very good. Which goes both ways. A, it is a PR thing, it's definitely done partly for that reason. And it is done with good intentions. And the fact that it's research implies that there's gonna be a risk, research is not usually terribly efficient unless you come out with a big product. I think in this case, the material that we recommended, and the why it was selected to be investigated, shows that it will be cost effective. It may not be cheaper, but it will be the same cost. Which thereby implies that you have a rational decision for making a transfer. Which is, Hey, it doesn't cost more and it's safer. Which is easier to justify than "It's safer but it costs you five times." So I think that was the primary reason for us being involved in SGM in this particular area. I run about five or six projects, SGM being one of them. And many of them are looking at materials that are much more expensive. They're trying to show increase in performance or other types of things to overcome the fact that it is so much more expensive. In the SGM case we're looking at something that should be the same cost. So in this case, if the material proves out, I think the transition possibilities could be relatively good.

I: Well, that's all the questions I have. Thank you very much. I think it will be very useful.

C6: Thanks!

APPENDIX D

NJIT RESEARCHER INTERVIEWS

Interview with NJIT Researcher-Satisfied Group

November 16, 1999

R1=NJIT Researcher 1

I= Interviewer: Susan

I: First, could you give me a summary of your research for SGM?

R1: I'm involved in two projects. The first project is titled Life Cycle Assessment Environment. Basically it involves improving tools for ecological risk assessment. To achieve this, we initially conducted a preliminary ecological risk assessment looking at existing models. And based on this assessment, using a case study of looking at the effect of replacing electroplated, hexavalent chrome, with sputtered tantalum or some other coating, we tried to assess the impact of a green process, a potentially more green process. And from this we've identified the best parts of the models that we'd like to use. And in fact we've established somewhat of a collaboration with Argonne National Laboratory in using their framework and building upon that. Because they have some additional features that, down the road, we want to use. Like a transport code. The second one, is titled, X-Ray Absorbing Scattering. It goes along with the first project because we're looking at the properties. There are two parts to the project. Looking at the properties of the tantalum coating, the sputtered tantalum coating: its structure, both short and long-range structure. And we're also looking at its ability to act as a barrier in preventing the substrate from corroding. So we're doing a lot of controlled studies and looking at the gun barrel steel corrosion, versus tantalum corrosion or lack of. And once we understand the mechanisms or the rate in the corrosion process, we can model this and we can prevent this from occurring. So they're both really fun.

I: Just to make certain for me, You're working mostly with Argonne National Laboratories? Or is that just one project?

R1: That's just one project and it's a collaboration that we've initiated. We haven't relied a lot on each other yet.

I: Okay. It's just important for me to keep track of all the labs that are involved. So, for this type of research, is this something that you were working on before? Or did they contact you and ask you if you want to get involved. ... ****Phone**** I was just trying to get an idea, how did your involvement start?

R1: My involvement in this started because I was invited to a meeting where they were talking about using tantalum to replace hexavalent electroplated chrome. And I had worked in the electroplating industry for a couple of years, so from that perspective, that experience.. Sitting in the meeting M. asked if I would look into the environmental aspects of tantalum, which kind of broke off into a project on its own. So it was based on my experience, my background, and being in the right place at the right time.

I: So you have a scientific background but do you have a history of choosing green project?

R1: Yeah, I'm an environmental engineer.

I: Oh, sorry. (*I'd thought R1 was a mechanical engineer*) This is embarrassing. All right, so we're done with that question. So, do you know who the end user is going to be? Have you met someone who is going to take the information and use it?

R1: There was an in-process review meeting where people from the modeling group were there. And we've even gone out to Yuma Proving Ground. Yuma Proving Ground is an army installation out in Arizona where they're going to do the test firing of the gun barrel that has this new coating on it. So that is the first place we have to assess whether there's going to be an impact to the environment. Also, we had a first hand experience of how they assess corrosion in gun barrels where they have chrome. So yeah, we had meetings, you could say, with the people who are impacted by this work.

I: I'm interested in the Yuma Proving Ground. I'm just wondering, was that early on in the project? At what point were you invited to Yuma?

R1: It was a year and a half into the project.

I: Did that help you get a better understanding of what they wanted?

R1: Well, it gave us a really good understanding about the gun barrel. It was very exciting. It's an amazing facility. Also we needed a lot of information for our ecological risk assessment. Such as site characteristics, receptor information, animals. The best place to get it was at Yuma because they have such a history of environmental reports that have the data that we need there. And we went out there on a mission to collect that data and meet with the people who are working with gun barrels and looking at corrosion, as well as the environmental people. So it was a great - it was an important meeting, an important visit.

I: Aside from that meeting, there are different ways that knowledge or technology can be transferred from researchers to the users. I'm asking all the researchers the same questions so, Have you refereed a journal article on these topics?

R1: Yes.

I: Done the SGM monthly and annual reports?

R1: Yes.

I: Do you have a student working on a thesis?

R1: We had one student complete a thesis. E. completed his thesis for the ecological risk assessment work in January of 1999. So L. completed his masters in looking at the corrosion of the gun barrel in August of 1999. He's gone on to pursue a Phd in the project. P. is another master's student in materials science. She finished hers back in December of 1998. So we have three Phd students on the X-ray Absorbing scattering project, and we have two masters students on the ecological risk, and one Phd.

I: Wow. So they're all funded by this, or they're just working on it.

R1: Well, five of the six are funded.

I: And they've been presenting conference papers? Or you have been presenting conference papers?

R1: Actually tomorrow, two of them are going to the C-TECH conference in Philadelphia to present the work from the first and second stage of progress. And we're putting together right now two papers for journal for potential publication.

I: Aside from the Yuma trip, have you had other face to face meetings with army personnel or other labs? I have to ask everyone.

R1: Sure, we went to the Army lab in New York, Benet Labs, to meet and discuss what they're doing similar work with tantalum sputtering. That was within the first year of the project right now and they're trying to arrange another meeting at NJIT for that group.

I: And as for the relations you have on campus now with other professors and other researchers, did you know them before this project, or is it as a result of this that you came together to collaborate?

R1: As a result of this I learned about a lot more people, so it's been wonderful. And I should mention, I don't know if you've already talked with Dr. U.? I'm working with him.

I: Yep. Here's a question that's supposed to be your opinion as a researcher. How do you think the process of technology transfer is supposed to operate? And by technology transfer they mean knowledge or ideas. I know it's not the sort of thing you think about every day, but it's almost asking what you would like it to be. Say, in the terms of communication, timing, management.

R1: Well, beyond dissemination through going to appropriate conferences, and publishing in peer reviewed journals, I think it's important to have meetings. Hopefully if you have a product-- which in one case we hope to have one down the road -- to be working with these throughout the process. Though we haven't had meetings yet on any regular basis with CTC I think they have a group there in development of databases. Database management system to house as much data environmentally and process wise. There's a lot of potential we could learn by working with them and hopefully the interaction could help strengthen our work and they could learn more about what we're doing. I think it's just been timing. There's always something going on that it hasn't happened. But those are things that X has talked about that we're going to do in the future. In addition, I have to call Professor G. over here in Industrial Engineering because they're working on Life Cycle Assessment and down the road, it would be really great to integrate their work with our work.

I: He's not on the grant right now, no?

R1: No, but you know, you have to look beyond that. We're trying to look beyond that.

I: Oh yeah, sure. One other question. If you were to arrange any sort of person, would you have to go through X? Is that the person who initiates this? Or would you be able to just call a lab and say, Would you like to meet?

R1: Well actually it was more because X's schedule is so tight that it's probably best for him and anyone else who has crazy schedules at Picatinny to make sure everyone could attend. I'm here all the time. That's the primary reason X has to be involved with the dates. But for CTC we've been in phone conversation when they were doing the risk assessment to exchange information, exchange reports, talk about resources and references, so they've been very helpful and it's been good working with them.

I: So the way it's actually happening, as opposed to the ideal, you just have to face the reality that there are schedule differences and so forth. But otherwise there's no resistance or lack of response from any group?

R1: I haven't ... no.

I: Do you think the technology transfer is any different because it's a green project? Level of interest?

R1: Well, all my work is environmental so...

I: I think you're the only person I've talked to like that. I thought you were a mechanical engineer... That's why I was so surprised. Everyone says, I've never done anything like this before...

R1: To be honest with you, it's different. I've had funding from NSF and I give them reports. They look at the report and they look at the content but that's about as much interaction as I have from the funding agency. From Dupont, it's completely different. They want as much information as soon as I have it, so we can talk about it and so they can use it. With the Army is somewhere in between because we're not always keyed into the people who need it immediately or who are even working on similar problems. And plus, it's also an issue of schedules are so difficult. When I say Dupont, I'm always in interaction because there's one person I'm working with so we can always find a way to meet. But when you have large groups of people, like you said, it's a scheduling issue.

I: So your contacts are mostly people who are working on a team towards a research goal or is are they project managers? I'm trying to figure out the type of interaction. Is it sharing the research results, that sort of thing?

R1: Yes.

I: Okay, whereas the person at Dupont is not in that position, more like a grant manager?

R1: That's true, he's in that position, but he's also working with other people on similar projects so we share information, too.

I: Oh no, I'm not saying he wouldn't understand it or it's beyond him

R1: Oh no, he's intricately involved because it's part of his research, too.

I: Here's a question. What connection do you see between your research and the outside world? Do you think it will have a positive environmental impact, at this stage?

R1: Oh yeah, anything we learn will absolutely have a positive impact, whether it's good or bad. It's positive because we're learning something. Surprising - well, not surprisingly- there's not a lot known - there's a lot to learn about corrosion, a lot to learn about properties of the coating. And looking at ecological risk assessment, it's growing, and there has to be a greater understanding of the impacts to ecosystems. Because most of the emphasis has been on human health.

I: Maybe I've been misled by the other interviews but I thought you were the only environmental engineer that I've met so far. Do they rely on you for the environmental aspect? I've met physicists, mechanical engineers, they don't have as much experience in environmental projects..

R1: Well, maybe it's the people you talked to so far, because there's people in chemical engineering who are on SGM who have been doing environmental work for a long time.

I: I didn't mean it that way, I was wondering if your background is relied on in any way. Are you considered to be the expert on environmental issues?

R1 No. I think... No.

I: I'm trying to find out your role in the research, that's all.

R1: On a weekly basis, we get together as a group. I don't mean the whole SGM, it's the group for X ray absorbing work and the group for life cycle assessment. We have three students at least on each and one undergraduate. So they're large meetings between that and Professor K. and myself. I would guess that most groups have to operate in the same way so you can keep up with what you're doing, keep up with your students. Periodically we get together with Professor T. too.

I: Have you worked on another technology transfer experience that compares to SGM?

R1: I think you have to. When you say technology transfer I think of disseminating it through papers. If you don't get peers involved through submitting it to journals and people learning about what you're doing, then you're not transferring your knowledge. I think that's one aspect. I think the closest so far as working directly with someone who needs to benefit, that would be Dupont.

I: And you said there was one person involved. Is it important to have someone whose main job is to coordinate the activities? What is your preference?

R1: Here it's been ideal. I know X has probably had a lot of headaches. But it's been great working on a project, working with students and being able to do research. I think X is doing an outstanding job. I guess it's always great to work as much as you can with other people involved. I don't know if you ever get enough feedback, but that's something you try to do. People are all so busy. It's hard to do. There's one person at Dupont but when I go down there there's other people too.

I: Finally is there anything else you'd like to comment on: monthly reports, travel expenses, is funding adequate for the work you're supposed to produce?

R1: Well, we're spending it too fast. Some people don't spend it fast enough and we're spending it too fast. We have a lot of needs because we want to do some interesting experiments. I don't have any complaints about travel reimbursement. We went out to Yuma. It was extremely expensive. It was ridiculous, to fly to the southwestern point of Arizona, right at the border between Mexico and California in the summer, at the end of June, when you'd expect no travel. No one wants to go there in that kind of heat, and the tickets were outrageous. More expensive than going to Europe, which is something I'd prefer to do in the summer.

I: Maybe you can work in a trip somehow if you play that right.

R1: Now it would be a great time to take a visit. But anyways, as far as funding everything's been great. We're just spending it so fast because we have a lot of equipment needs.

I: Okay. That's all the questions I have. And I really do apologize, I was under the impression you were a mechanical engineer, so that's why I asked if you had a green background. If it seemed ridiculous, I'm sorry, sometimes I just lose track of things. But thank you for taking the time for the interview.

R1: Oh no, thank you, etc.

Interview with NJIT Researcher- Satisfied Group
Nov. 1, 1999

R2= *NJIT Researcher 2*

I= *Interviewer: Susan*

I: Just for the record could you tell me about the research you're developing for SGM?

R2: The research we're doing is to disassemble or break apart any kind of equipment or component which is used in the defense. In particular people are breaking these apart for several reasons: One is simply because they're there and they want to get rid of them. Secondly there are a lot of valuable materials in them. And thirdly there are a lot of explosive components which we need to get out and defuse in a secondary manner. So the question is how to do this efficiently. Obviously if it's just a couple of them you could just do it any way you wanted it doesn't matter. But once there are tons of them the question is how to do it efficiently. And that's what we're trying to do.

I: So is this the type of work you were working on before the army approached you or did you just do something related and then they asked you to do the project?

R2: We were doing quite closely work being funded from other sources, similar types of work. We were able to take a lot of that knowledge and quickly transition it for this particular application.

I: So do you strive to have a green component in your research? Or is that just something that has that application, not something you need to find in your career. Is it an important part of your research, a big motivation?

R2: It is an important part of our research and we are striving. At the first level we review the things which are already there. And the more green aspect would come when the some of the things we find that has the ability to build new ones. We would incorporate those, and in that sense those equipment would be greener than the ones we have now.

I: For this SGM project who do you think the end user is or will be?

It will be the arsenals and the people who design and build the new piece of equipment.

I: So you've already actually met with the people who will be the end user or are you just talking in broad terms right now?

R2: No we've actually met with them on a couple of occasions.

I: All right. Have they given you a lot of guidance or direction on what they want or have they sort of left it up to you to figure out?

R2: To a certain extent they have given some broader guidelines. But on the more specific level we have sort of fill in those gaps and, based on our experience, fleshed it out.

I: Here's a question about the ways you can express your ideas or teach people about how this is going to work. Various people have tried different methods. Have you referred a journal article?

R2: Yes.

I: Just for this SGM project?

R2: Correct.

I: And you've done the SGM monthly reports and annual reports.

R2: Correct.

I: Have you done a conference paper?

R2: Yes.

I: Do you have a graduate student doing a thesis?

R2: We had one graduate student who completed a thesis.

I: Have you had visits to CTC or Picatinny?

R2: We had both at Picatinny and Johnstown.

I: Have any of the army personnel come to visit NJIT?

R2: Not yet.

I: Here's a question that's just your opinion. How do you think technology is supposed to operate. In your role as a researcher, how do you think things should work?

R2: Well, ideally once you are in the process of ending the development of whatever tool you are doing if the industry partners would start to incorporate those at that time, that would sort of be the best case scenario. If you were able to available a software or other kind of tool which implemented your development, that would be even more powerful because you could get a larger number of people to incorporate it.

I: But in the ideal situation you don't have to push too hard to get your technology out there.

R2: Yes, people will come to you.

I: Has that happened in SGM?

R2: Not really in the sense that we are dealing with one end user, here the army. And obviously they have a lot of restrictions in which they operate. But we don't fit into that scenario.

I: Do you think this technology transfer project is any different because it is a green project? Do you think that makes it a special case or is it just a run of the mill, working for the army situation?

R2: I think technology programs with the green is always a special case because the project is being sold because it is green. As opposed to being more profitable or more productive. To a certain extent the specific problem that we are working with is we are luckier that they're going to have to do what they're going to do. We're just trying to help them do it in a more productive way.

I: So you see a connection between your research and the outside, the working world. It's going to have a positive impact.

R2: Yes.

I: Do you have any other tech transfer experiences that could compare to this. Maybe one that went better, one that went worse, or exactly the same. Is this a typical case?

R2: We've done a lot of things in product design, etc. and I guess many of them probably went better. We had industry partners with whom we were working with more closely.

I: Have you seen enough initiative or enthusiasm on the part of army contacts? How would you characterize them as environmentalists?

R2: They are certainly concerned about the environment and they are certainly concerned over what happens to these equipment. Simply because if they weren't there would be other ramifications for that. Most of our meetings have been structured and as we were more focused on deliverables, whether we were going along as planned.

I: Would it be helpful to have more informal contact?

R2: Possibly yeah, more informal contact.

I: Anything else you'd like to add? Some people had comments on the monthly reports... Everyone has their own preferred way of working.

R2: A couple of things unique to this project which we may or may not like are things like these monthly reports. The assumption here is that every month something occurred of a reportable fashion. Whereas the projects may have longer gestation times. And that could be one drawback. I know some projects have higher levels of specifications from the army, while some have less. I would say that ours was on the less side. Maybe if we had more, we could do some more things. But for us it has not really hindered us in the sense that we've been able to fill in the gaps and move ahead quite rapidly. Otherwise we've been pretty happy with the project.

I: Well, I think that covers all the topics.

R2: Excellent.

I: Thank you very much.

R2: You're welcome.

**Interview with NJIT Researcher- Dissatisfied Group
November 15, 1999**

R3= *NJIT Researcher 3*

I= *Interviewer: Susan*

I: For background, could you tell me about the research you're doing for SGM?

R3: Yeah, actually I'm involved with two projects. One project is what's called make primal scale project. We have to basically help in scaling in some of the processes that Army is considering. The part we're really going to be focussing on is the mixing of two different types of powders. And the other project is really actually a very big project that's headed by Professor Sosnowski. And I'm involved in a very small part of it. We are trying to figure out alternate ways of target production of tantulum targets.

I: Were you asked or sought out to work on these projects, or was this your field of work to start with?

R3: Actually the particle technology side, which is the first project, was in my field of work. And Professor J. was soliciting from different people various input, and I think he was asking people, what are your capabilities. So I basically just wrote him a page. I think things just sort of developed.

I: Do you try to incorporate a green concept in your research or is this just a coincidence for you?

R3: No, actually we are doing this -environmentally friendly techniques in coating work. We are very much into doing things without using liquids and solvents. So whatever technically that means. The army doesn't like this either, for one reason or another. So actually we were doing that. And in fact recently we even wrote a proposal to EPA and NSF jointly. So no, I think, we do it already in some of our work. We can't do it in everything.

I: How motivated are you to pursue environmental projects. Does it make the work more interesting to you?

R3: Yeah it does, but I think that it should still fall into the general things that I like and I'm able to do.

I: Who do you think the end user will be, or have you even met the end user?

R3: Actually yes, we have met who we think are the end users. But we're not totally clear if that is the person or the group of if there's going to be more. So it's not very clear. But yes, in each party we do have contacts with people we think are going to be the end user.

I: And they've been giving you direction, feedback?

R3: No, not as we would like. In some cases, it could be a communication problem on both parties. But in many cases.. I think the Army - We feel is happening... It's the one entity funding the project, another entity overseeing the project, and the end users are not made clear about what advantages they're going to get from all this. They'll keep doing what they're doing. This is something that is very frivolous in some cases to them. And I think that's a little bit an annoyance. Because we believe that we can help them, and it's probably because they don't think that this may end up with something directly. They don't even know exactly, oh okay, we hve to keep doing this, our priorities right now are this and next year we will talk to you. There needs to be a little better type of coordination type between the end user and the researcher. That I think is lacking now. It's difficult to blame anybody. I think it's just everybody is extremely busy on both sides.

I: Do you think it would be helpful if you had more regular contact? Do you think e-mails or phone calls, if they were more frequent, would help with this? Or is it really just a matter of people being in different locations and completely different jobs?

R3: I think if everybody had the same boss, then this would work. I don't think it has anything to do with whether it's e-mail or phone.

I: Or in the same kind of organization.

R3: Yeah, if everybody had clear agenda. That okay, this guy has to talk to this guy, and then the other guy also needs this person, then it's going to work. Otherwise it doesn't work. It's very easy for me to pick up the phone and call somebody else. But then that person has to follow up also. And he or she may have other priorities at that time. It's a management problem, I think. It's such a huge project and everybody has other huge projects. I think that might be it.

I: This is a question that's just your opinion. You can even answer it as a dream situation. Would it help to have one person at the host site whose only job --or main job-- was to make it easier for you to deliver this process? If they knew they had to move when you called them?

R3: Yeah, yeah, sure. Oh, yeah.

I: Now this a question I'm asking everyone. What do you think the outcome or deliverable will be for this project. The outcome would be a coating process?

R3: Yeah, actually, in the tantalum project we definitely believe we will have an answer yes or no. About whether there is an alternate possibility of producing these targets. Rather than buying very expensive prefabricated material that they are doing right now. So the answer will be yes or no, but they'll have to take it from there. But in the mixing, I think we will have an answer whether an environmentally friendly way is possible or not.

I: This is a question to find out What methods you've been using to communicate the technology or ideas you've had. Have you refereed a journal article on this topic? A professional conference paper?

R3: Yeah, we have some papers, but not on the tantalum project. It's too small to write anything about. But the other project, yes, we just had a presentation an AIChE meeting, last week I think it was. And we had our own symposium that we conduct.

I: And you've done the monthly and annual reports?

R3: Yeah

I: Has there been a graduate student writing a thesis?

R3: Yes, in the mixing project, we do have several grad students. They are unfortunately not all funded through SGM.

I: Have you had faculty visits to the host site?

R3: Yes

I: And they've come to NJIT?

R3: Yes, in the mixing project somebody had been to NJIT.

I: And you've been to the review meetings.

R3: Yes.

I: Now, in your opinion as a researcher, how do you think the process of technology transfer is supposed to operate? I know that's a very open ended question. But you're being asked to create something or develop something. It has to be handed over to someone else. They have to learn and adapt to be able to use this. So how do you think it can work?

R3: That's a difficult question to answer because I don't have a lot of experience with that. I would say that it could only work if there is a specific person whose job depends on making this work, translate into what they are doing there. Then I think everything kind of falls in place. Because then that person will communicate with us, and we will be very happy, when the project ended to continue talking to them, even visits to show them how it works. So I think it is really a matter of close coordination between the person responsible there and the person responsible here. In our projects, particularly the mixing project, we are in a little bit of a different ballgame compared to what I understand about the other projects. Because in many other cases, it is really existing research that we are to adapt and then the technology transfer is to be made. In our case we are breaking completely new ground. So we do not even know if this is going to work. So this is not a statement of pride, or anything, it's just a matter of fact. And fortunately or unfortunately our project is such that we don't know if it's going to work.

I: But even the knowledge counts as a technology. That to them is valuable.

R3: That is true. That's exactly what we'll be able to transfer to them, the answer of whether this is going to work or not. And if it works, how can they transfer it into their site. I mean, we are making some headway in the tech transfer. It's just that we still need a person there who really, really desperately is waiting for our results. And that's probably not the case yet. (joking)

I: Oh, okay. Do you think this process is any different because this is a green project? Do you think the army would react any differently if this were a different type of project?

R3: Probably not.

I: And yet you see the outcome of your research will have a positive effect on the outside world? I guess this is a question to see how you feel about your own research.

R3: Oh yeah, I think we are very happy doing this research. Just as an example, at that recent presentation at AIChE, we generated a lot of interest. A lot of people came and started asking questions and exchanged their cards and things like that. Some of them basically said, "Well, we don't think this going to work." And some of them of them said, "Looks like it's going to work, and it sounds like a very good idea." I think the outcome will be positive one way or another.

I: Just talking about the tantalum project – As a researcher, would you have needed to consider tantalum as a coating if this were not a green project? Is the cost of chromium so high? Would there be another factor that would induce this sort of research?

R3: It would (be considered). If it is clear, and I'm not from chemical engineering, but I do believe it is clear, this is a harmful way of doing this, then yes, I would definitely look into alternates. Whether it is tantalum or something else, it should be investigated. And even the way they are using tantalum, the sputtering. That needs to be investigated also, whether the army is interested or not. Whether the army is going to fund it or not. If I had a dream part of money, then yes, I would try and look into that.

I: Do you think this type of grant restricts you in your research? Are you free to go off on tangents?

R3: Luckily our project is exploratory in nature so it is not restricting too much. However we are worried for the results. Because we cannot afford to go on something. There is just not enough resources. This does help in some other ways. I still think it's a good project. The tantalum coating project is quite restrictive. But the mixing project is quite open ended.

I: Do you feel it is hard to juggle the two different projects? Don't worry, it's confidential.

R3: No, it's not that that I have two projects, but that I have a lot of other things also. It is very hard to keep up with the deadlines and keep everything moving for two projects. It is hard.

I: One more question here... Do you have any other technology transfer experience that could compare to the SGM project?

R3: I have very limited experience there in the sense that nothing has actually occurred. But a lot of companies have shown interest in some of the other things we are doing. And so we are in the technology. Transfer process but the experience is completely different. There, the initiative comes from somebody who is desperately looking for a solution. And he or she contacted us. Rather than we contacting them. Here it's like one agency is funding and we help three other parties. So it is quite different.

I: And I'm just trying to get an idea from researchers: Has the army been telling you about their policy for intellectual property?

R3: I haven't really heard much about that.

I: Is there anything else you would like to comment on? Monthly reports? Travel funds? Meetings? You can say whatever you want.

R3: I think the biggest complaint is that the funding is quite tight. And it turns out we are promising, at least in the mixing project, more than what the funding allows us to do. Particularly the second year. The first year seem relatively reasonable. The second year funding is too little. And part of the student funding is very little. And that really hurts, overall, productivity of the project. Other things, I'm not too unhappy about at all. They need monthly reports. Have to keep doing them. But actually, I think it's the money. It's just not enough for what we really do want to do.

I: As for the funding, can you tell me in a specific way? Is it for salaries or equipment or testing procedures?

R3: Yeah, actually more for the equipment and the students than just the salaries. Salaries also are very low. I think it's really difficult to solve this problem because you start with such an amount, and you started so many projects at one point in time. And then the money is cut. Then you either have to cut all the projects an equal amount. Or you have to cut some projects. So cutting one project is harder than cutting all the projects an equal amount. That has been really a problem. I don't know what I would have done differently if I had been running the show. Once the money is low, what can you do. That is very difficult to figure out. My needs are, the priorities are, the students, equipment, and then the salaries.

I: Well, that's all the questions. Thank you very much.

R3: Thank you, etc....

**Interview with NJIT Researcher- Mildly Concerned Group
October 27, 1999**

R4= NJIT Researcher 4

I= Interviewer: Susan

English is not his first language but I did not correct the grammar except in cases where it would otherwise be difficult to understand the statement. There were cases when I could not decipher a word even after repeated playbacks. I made a best guess.

I: Can you tell me about the research you're developing for the Sustainable Green Manufacturing project?

R4: Well, currently my project is on coating of metal particles with polymers using supercritical carbon dioxide as a solvent.

I: Was this something that you chose to do, and you've been doing this along? Or was this something they asked you to do?

R4: I did some research on supercritical fluids as possible replacements for organic solvents. Which is an environmental issue, though with emissions of certain compounds. So there was a significant overlap between my previous research. (There) was an environmental center here for this green manufacturing program.

I: We're just trying to get an idea. Have you had a lot of environmentally related research projects? Is it something you try to have in your career or is it just a coincidence in this case?

R4: Before here, I studied destruction of organic compounds. (Says a phrase or term that might not be English.) It was environmentally driven... What's wrong?

I: Uh, you just said something I didn't understand.

R4: It's a kind of electric discharge which is very efficient in destruction of small concentrations of organic compounds. So basically I would say I did environmentally oriented research during last six years and before I work on fundamental chemical kinetics. So I just partially shifted my interest to reflect environmental impact mainly because of centers around here, research centers which are focussed on environmental issues. Funding opportunities too.

I: Thinking about the research for SGM, could you tell me who you expect the end user to be?

R4: This project was funded by the army. Basically the research object is paratechnic formulations which contain metal powders. What I'm doing is possible technology of coating of small metal particles to prevent contacts between each other, let's say (keeping) oxidant and the metal from the environment. One possible consumer is U.S. Army with some extensions of coating other particles, not necessarily metal particles, using supercritical carbon dioxide as a solvent. So basically the main idea is (to) reduce usage of organic solvents. And second maybe was to get technology using supercritical fluids. Just because of the supercritical fluid properties which (are) different from the properties of common organic solvents. That's all I can say.

I: Okay. This is another open ended question. What do you think the outcome of SGM project will be? Here, it's a small project to start with, something requested by the army. In your own thoughts. How do you think it's going to turn out.

R4: My understanding, there are several maybe ten, fifteen different suggestions. They never formulated specific projects. They formulated something which is of interest to the army and simultaneously of environmental import. And I think those projects which are successful from the point of view of technology

will be developed further, irrespective of the army or for some other purposes. And some of them will just die. That's how I can see it. Actually, I'm not sure I understand the question.

I: Oh no, it's just... Some people say they're anticipating that it's something that it can be used in people's homes as well in the military applications. I don't know....

R4: Yes, I understand. But it's an unknown. In my case, if I find a way to make better coatings of small particles there could be different applications, not necessarily military. It's possible the solution will find some kind of other area. I don't know if technologies which are focussed on a Area. If there could be different applications, not necessarily military. It's possible, but militarily it would be more work and so on. It's usual when you develop something new, first of all it's difficult to predict where it's applicable and typically, if it goes, it goes in many areas. For example supercritical extraction found application in extraction of caffeine from coffee. And some other extraction process was just not practical. So it's very difficult to predict. Lets' say 30, 40 years ago when the process was developing. So as any research, successful applications can be found in different areas.

I: One thing they're trying to find out is the different ways that you've used to let the end user know about your technology. It the past year or so, have you refereed a journal article? Or published articles on it to let people know what your work is about?

R4: Well right now we are ready to submit a paper for some issue. Typically my research takes more than one year. Actually it's more like one and a half years. The whole cycle from data gathering to submission of paper. Definitely we're going to submit several papers. Probably two or three. Currently we have material, experimental data and some understanding, for one paper at least.

I: And are any students doing a thesis or anything related to this type of work?

R4: No. Currently we don't have (a) Phd program in chemistry. I don't have masters students. Mainly I deal with kind of post doc people, visiting scientists. I'm going to attract one masters student next semester in the spring. So it's just because we have shortage in our program.

I: And you've been doing the usual monthly reports, annual report?

R4: Oh yeah.

I: Have you had any chance to do face-to-face communications with Picatinny or CTC?

R4: You have two meetings and then it's going to certain other meetings with people specifically interested in this project or focussed on this project. Although there was some feedback. So typically what we did was report our results and there was some discussion. And soon probably within the next month we will have a meeting with some people from Picatinny who are specifically interested in this research project. So my understanding was the whole thing was organized.... They never told us. They told us, Here is a broad field, I would say, but it must be environmentally sound. Technologies which can be used militarily. All of this research is open. It's not classified. So we don't have anything secret here. At least I don't... Yeah, there have been some meetings and there will be meetings with more specific tasks.

I: Okay. In your own opinion, how do you think the technology transfer process is supposed to operate? Or how you would like it to operate? Are you comfortable with the way things have been going, or is there something you would like to change?

R4: Well, I would say, I can figure out --I can try to figure out how I can see it. If I see that there is some interesting process probably they would contact us. I would actually prefer to have more closer contacts. Some feedback, I would put it this way. A little bit more guidance in the directions. They never told us,

never told me where they have real needs in the project. So it's kind of (a) one way flow of information, almost one way flow. So I would say probably could be a little bit, I would prefer a little bit more feedback.

I: So the way it's really happening, they're just asking, "Send it to us," and that's it. That's basically the kind of contact that you have.

R4: I'm hoping next month (this) will change. X. is going to set up a meeting with some interested people. But up to (this) date, we just reported what we did. And they made their choice probably what to fund, what not to fund. But for myself I never get exact directions. Maybe it's positive, I don't know. I wouldn't say it's negative.

I: Oh no, it's just something you've noticed.

R4: Yeah yeah.

I: Do you think the technology transfer process is any different because it's a green project or a project in sustainability? Or even because it's a project that has to do with the army? Say you were doing this kind of work with a company, it might be an entirely different situation. Do think that because it's a green project that it's any different?

R4: I wouldn't comment too much because I don't have too much experience working in R&D for companies. What I do know, if I am working in R&D division of a company it would be almost on a daily basis, so it would be different. But working at a university, for a company directly, I don't have too much experience here. But if you have some positive technology it overrides and it belongs to the company. ... I don't know exactly what the arrangement is in this project. With all this technology transfer, intellectual property. I would assume, it belongs to the funding agency. But to what degree I don't know. So I would say that from what I see what right now I would conclude the technology transfer process is somewhat different but how much different I cannot tell. It's something new, it's less than two years old and I would probably anticipate that (if) ten percent or (even) less directions find practical application, it will already be successful. So in any applied research you never have 100% yield. So there are some projects which will work, some projects which won't work, but when we start we don't know.

I: But even 10% would have a good impact.

R4: Oh, ten percent, I pulled it out of blue.

I: Oh no, I don't mean in a numerical way. I mean, if you had even one of these applications succeed, say it reduced pollution or whatever, would you consider that to be a success?

R4: It depends on the scale. It depends on the scale of applicability. Sometimes inventions, of them are so important. So one out of thousand would be considered... It depends on the scale. On the funding involved. I can't tell.

I: I'm just trying to see how researchers gage their success. Because for some people, they could be very frustrated. They could say, "I've been working on this so many years and nothing came of it." But other people have patience to say, "That doesn't bother me. I need to reject some ideas and go on to others."

R4: Well it's a difficult situation I would say. Especially in applied research. Actually if you try something new, and you if you can say whether it's if it's going to work or not it's not research. It's already something known. You need research when you don't know the answer. If you don't know the answer there's always probability to have negative answer or positive answer. Out of applied of all applied research projects I don't know what yield should be considered successful. Definitely it's never 100% yield. SoI don't know. What is the question again?

I: You have to understand that researchers think a lot differently from other people. There are people in management who might not understand this. They'll say, we want 80% yield. I'm not saying that's it's something I'm going to find in this study, but that's part of what the question is asking, To see how researchers are thinking at this time to gage their attitudes. Let's say ten years from now, something from SGM was applied, that would great for the researcher, but someone else might wonder, how come only one idea worked?

R4: Yeah, But it should be realized that if you have an idea and you are sure it's going to work. Like 99% sure, then you don't go for research money. Then you go for other funding agencies. Like small biz innovation and so on. Or just patent it if you are sure it's going to we. So we are doing research. The idea was, lets' use carbon dioxide to dissolve polymers. There are a bunch of questions right away. What is the solubility. What are the properties of polymer films which are going to be produced, with that kind of solid. Whatever. If I knew all the answers. , there is no need to do research. There is no need to spend this time and this money. The problem is, if you have some ideas. If you consider chances, as pretty good it's going to work but you don't know all answers, that's why you need research money. To check all answers for possible questions. There's always probabilities of you just didn't think about something and you have ... negative result. There is a different between when you do research or give already a product. Let's imagine there is already some technology and we are just slightly improving it. We are developing new technology there is big difference. That is why we do research. If you have invention in your mind, just patent it. There are a lot of examples in history of people just patenting something. Why bother? For example... I know for example something which works and was patented. But there were so many ways to go around. So people who patented didn't get anything. It's not what we do. We do research. It's not he same as "make an invention." It's still possible to invent some technology. But before this technology works, it should be investigated how it works.

I: So someone could look at the results you get and be a step ahead. And if they're given the assignment to perfect the process. You've laid the groundwork?

R4: Exactly, exactly.

I: You don't plan on doing that sort of thing, developing your own patent -- unless something good comes up?

R4: I even don't know what the arrangements are.

I: Would you like to know?

R4: It's always interesting to know. Maybe some other people around know. I would assume that because we got funding from a specific agency, to some significant extent our result belongs to the agency. To what extent I don't know. Obviously there are limitations from NJIT which extend intellectually property transport to some other agencies. I just don't know. It would be interesting to find out.

I: And the final question – though you can say anything else you feel like adding - Do you have any other technology transfer experiences? Anything to compare to the SGM project?

R4: No, I don't. I don't have anything. Actually I came from more fundamental end of the research project. So my previous research was basically fundamental research. During last six years I did research which is more applied and I found extremely interesting.

I: So was that other experience in the US?

R4: I came to NJIT six years ago. I did research in chemical kinetics... Mainly fundamental thermochemistry. I did other research which could possibly be applied but always on the fundamental end.

So when I came here, I shifted 60% of my research to applied. I did plasma treatment of VOCs and supercritical carbon dioxide. All those projects have significant fundamental component. But they are driven by environmental need. And that experience was very interesting. You can think about different things, and why we are doing that, what is important, what is not so important, which is different.

I: But your main motivation is studying in your field? And not necessarily working for environmental project. Or is it equal, now that you've had the experience? If you were told, from now on, you're just going to do these environmental research projects, would that bother you? Or would you like to go back to fundamental research?

R4: I would like to have around 50-50 distribution. And I have around 50-50 distribution. I have funding some other funding sources, from American Chemical Association where I can continue doing my fundamental chemical kinetics. I have several other funding sources. I have additional research. Research on supercritical fluids is just part of my research currently. But as I said, I find it very interesting because motivation, whole approach is different, that's for sure. We don't think about ... We still have fundamental components. But for example, in my case, the case of my project. *****(telephone rings)***** For example, from the point of view of fundamental, it would be more interested in how the process goes, what the properties (are). From the point of view of applied project, they mainly (are) interested in final properties. So what you investigate is, What kind of film, how (does) it improve resistance to some chemicals and so on. So it's kind of (a) shift. If I did the same project from 100% fundamental view, my approach would be different. That's all.

I: Anything else you'd like to add? Anything you'd felt about the project?

R4: I dunno. Monthly report sometimes... Research doesn't go like that. Every month you have to. But it's no big deal. They don't require too much writing. Maybe a little bit more feedback. Encourage this, discourage this. Direct. But that's all.

I: Okay. Well, thank you very much. These are very important things for them to know. That's kind of the purpose of the study. They need to know these things for the future, anyway.

R4: Okay, all right, thank you...etc...

**Interview with NJIT Researcher- Satisfied Group
October 27, 1999**

R5= NJIT Researcher 5

I=Interviewer: Susan

At R5's request, this interview took place during his dinner break. There is background noise on the tape but the conversation is clearly audible.

I: First question: Just for the record, could you talk about the research you're developing for the sustainable green manufacturing project. What is your task that you've been assigned?

R5: The task is to look at some of the new chemicals, new highly energetic chemicals used as explosives by the army, which are being in the experimental stage and to green up the process of making them. That is, to design a chemical process for making explosives that is free of hazardous waste, hazardous solvents, pollutants, etc.

I: Is this something you were already working on or something they approached you to do?

R5: We had been working before the army approached us on one in organic reactions, pharmaceutical reactions, in water, which is a very innovative thing because most organic reactions are run in solvents like carbon tetrachloride - a very toxic chemical. So we were trying - had some success - in replacing some bromination methods and running them in water.

I: Just get an idea, does a lot of your research have green concepts, or is this a first time thing?

R5: My collaborator, G., and I have been doing research for several years on pollution control. Not process change which is SGM, but on end of pipe treatment, on removing of air pollution, NOX and SOX, which produce acid rain. We devised a new way, and have patented it - a new chemical, --(or rather) an old chemical that has a new use, namely, destroying nitric oxide.

I: So in this case for your SGM technology, I guess the user will be in the army or a contractor, but can you give a specific case of how it will be used? The question is, who do you think the user will be either or say, in the army or in a commercial venture? Who would the consumer of the technology be?

R5: The work we're doing is not designed to be specifically used by the army. The army may want to use it in producing some of their new explosives, like tinase. The army may want to use our results. We're trying to come up with a totally new way of making tinase which is shorter, less costly and less wasteful in terms of pollutants and waste chemicals. But the principles that we're developing, the principles for sustainable green manufacturing, are principles which could go way beyond the army and can be used by the whole chemical processing industry. Wherever batch processes are prevalent.

I: Now, We're just trying to get an idea of how you've been letting the outside world know about the technology you're developing. For instance, through formal channels, have you referred a journal article on this topic?

R5: As a matter of fact, -- we published a paper on green brominations in water. And his name, we alternate on publications. So a journal article was sent to him to referee of some Indian chemists who was doing brominations in water, so we are in the process of refereeing an article on green chemistry. We are in the process of referring a paper on green chemistry.

I: You've done the basic SGM things, the monthly reports, annual reports.

R5: Oh yeah.

I: You have a student working on his Phd. in this area?

R5: Yes, Mr. Vincent Palumbo, he's going for a Phd in chemistry at Rutgers. He's a Rutgers graduate student. I am one of five NJIT chemists who is on the graduate faculty at Rutgers. He's working on a new way of making explosives.

I: Okay, and through informal channels: Have you had a chance for face-to-face meetings visits at CTC or Picatinny? Has the faculty gone there, or have their personnel come to NJIT at all?

R5: They came at NJIT I think once or twice. We visited Picatinny a couple times. And we made a trip to Johnstown, where CTC is, twice.

I: Was that helpful or just get to meet them briefly? It wasn't that meaningful, or did you have a good chance to talk?

R5: On a scale of one to ten it was about five or six. Some things didn't have much meaning for us but we had a good interaction with Y., who is very interested in our work.

I: Okay. This is a question that's just your opinion. How do you think the technology transfer process is supposed to operate? You are the researcher and that's your role in the technology transfer. You're sending it off to the end user who is going to apply your research. Do you think the lines of communication should be more frequent? Are you happy with the way it's been going so far?

R5: Well, I think our technology transfer has been mainly with Picatinny. There was a problem in the beginning. The failure of communication may be our fault. We had the impression that they were interested in looking at certain explosives that had been used for years. It turns out - It was a while. It took a little while but then we realized they were interested in totally new explosives. To recertify old explosives for new processes would be too expensive. But that took a little while.

I: So in this SGM case, it has not been ideal. On a scale of one to ten you would give it a five or six?

R5: In the beginning it was five or six. Now it is eight or nine. Now it has become very clear what the army wants. It does not want a particular solution for a particular chemical. The army wants general guidelines. Which would be good for future chemicals.

I: Did they tell you that or did you have to guess about it.

R5: We talked about it. Or they talked to X. and X. talked to us.

I: Do you think the tech transfer process is this any different because it is a green project? Do you think the greenness made the project a little different?

R5: No, it's chemistry. We're changing a process.

I: Okay, and yet the impact on the outside world or the working world will be a green effect. Is that a goal of yours? Do you have an environmental leaning in your work because of that, or is that just something where you're saying it's chemistry, and it has this application? (*background noise*)

R5: Could you repeat that?

I: In your motivation to do this kind of work, do you have a desire to improve the environment? Or is this just an application of chemistry? Does it matter to you if its green or not?

R5: Oh, it makes a difference. The fact that we developed a new chemical, which had a new use in curbing air pollution - It wasn't exciting because it was a new use of something, but the very idea that we could do something that could help the environment... That makes the work much more meaningful.

I: Okay. And finally. Do you have any technology transfer experience that can compare to this one. Some other in the past, did it go better, worse the same? Is this a predictable kind of situation that you're in?

R5: The only other project was the air pollution which has an industrial advisory board. There we ran into a problem in technology transfer. We were developing a new technology and companies were looking at our work, and deciding they liked it didn't like it, not on the basis of whether the work was good enough, but on the basis, frankly, of their prior prejudices. Like, our chemical's an organic chemical. So most companies said, "Oh, we don't want to use an organic chemical." Even though our thing is better and cleaner. So we ran into some problem with companies that are rather set in their ways. I guess this is a case- I'm sure other people have experienced. But in the case of the army, it's worked out very well.

I: So they actually are motivated to change. I know they've been mandated to change. I guess when I speak to army people I'll find out more of their motivations.

R5: Oh, they're motivated to change. It's not just a question of clean chemistry but also the cost. They're motivated to keep down the cost.

I: Mm hmm. Is there anything else you'd like to ask at this time? That pretty much covers the questions, but if you have any ideas of how your work could be better received, anything you've wanted and haven't gotten it?

R5: No... I'd say, we have to do monthly reports. Organic chemistry's very hard. At the end of August, we're working on a chemical reaction, making a new tinase. End of the next month, we're still working on it. Organic synthesis take months and months and months. We would prefer to have bimonthly reports. Does that sound right?

I: Sure, sure, every two months.

R5: Yeah, bimonthly reports. That would take a little pressure off.

I: Sure. Well. Thank you. These are all great comments and thank you very much.

**Interview with NJIT Researcher-Satisfied Group
November 9, 1999**

R6= *NJIT Researcher 6*

I= *Interviewer: Susan*

I: Just for the record, in your own words, can you describe the research you're developing for SGM?

R6: Yes, we're trying to develop a general procedure to be able to look at processes very early in the research cycle that has potential for developing new explosives and propellants that could be manufactured green. You could make them in various ways and obviously the idea is that as we start looking at the way we synthesize these materials, we're wondering, what questions do we ask? How do we develop it? Because very often in this kind of work, whatever you do in the laboratory, all you do is you make it bigger, and that becomes the plan, but it's exactly the same steps, and that's a very bad way to do it. You have different goals when you do research. The first goal is to make the product that you need, regardless of what it takes. So if you're using hazardous solvents, or it's very explosive, you'll use a glove box, you'll protect yourself with shields, you'll use masks, and you'll make it. Because you have to learn it's properties and if it is indeed an explosive or propellant or has the properties that you really want. But ultimately, to manufacture this, it's definitely not the way you want to do it. You want to manufacture it, then you have to put a different hat on and say let's think can we do this in a way that's it's not hazardous to our neighbors, it doesn't effect the environment, and usually the figure of merit, the way you look at it is, you say, How much else do I emit per pound of product. In green manufacturing there's an acronym or something you will use. The ideal process is a P.O.P. Products Only Process. Because nothing else gets made except for your product. That's the ideal but that's uh... you don't do that very often. But that's how you have to think about it. So once you've through brute force you've made the product, you know it's possible to make it, you know what its properties are, then you have to go back and think, How do I begin to do this in a clean way, or ultimately how do I do it in a P.O.P. fashion? And we are in that mode right now.

I: So the Army approached you, or this was something you brought to them? I know in general they tried to match up NJIT researchers with people who were suitable for the project. How did you go about that early negotiation when you were showing them what you could do, or your ideas?

R6: I have talked to the Army and have been there and they've been here, but initially it went through Dan Watts. I wrote a proposal - This is jointly with Dr. O. in Chemistry - See, that's the other thing, we're a team in the sense that I'm a chemical engineer and he's a chemist, so he'll figure the fundamental chemistry and I'll think up the applications, the minimizing cost, the minimizing pollution and so on. And so that's how we work -- And we wrote a proposal to Dr. X. and said, that's what we're proposing to do. But we did similar kinds of things with the National Science Foundation before that. And it went through and then we talked to Bob Goldberg with the Army. In fact it looks right now that we're going to be applying for a patent because it is rather novel. And this is something that I think is very very important in green manufacturing. In the process of making it green and more friendly, you also sometimes come up with ideas that make the synthesis even better. And in our case we have developed a synthesis that's better than anything available in the literature. This doesn't always apply but there are times that by being forced to think in a certain way that's different, out of the box ****phone call****

I: You were talking about the different process, or a different synthesis...

R6: What I think is that the discipline that you need in terms of sustainable green manufacturing has the potential for improving the process not necessarily for green reasons, but just for chemical reasons. You're forced to think in so many different ways, that the little light goes off and you says, Oh wait a minute, we could also do it this way. If you're doing it the straight and narrow, this is a synthesis, we're going by brute force to make a synthesis, you're not necessarily forced to try to do anything unusual because you'll do it the

most direct way. And usually the most direct way is the best way. But in this case, if you can't do it the most direct way, and you think about this... That's how we're trained as scientists, to do it the most direct way anyway. Now we have another um- What should I call it? - another restriction on the way we do it. Obviously there are restrictions of temperature and materials and so on anyway. This is just another restriction for doing it. If you take that restriction into account on many occasions you'll find that that restriction helps you think of it in such a way that it improves the whole thing.

I: Do you try to have a green concept in all your projects or just when it's required, really? Is it something that's required of you as a researcher?

R6: Oh, most definitely. I have been involved in the environmental movement and in my research for my whole career. Started out in the nuclear business and then from then on.

I: Okay. Well, that's good to know. So, just thinking about this synthesis that you're developing. Obviously the army will be interested, but do you think it has wider applications?

R6: It has very wide scientific applications.

I: Not just the explosive part.

R6: No, no, it's the synthesis. We have to make what's called a ring that's uh... The bonds are very tight and the net effect is that these kinds of molecules are also very important in pharmaceutical industry and other places. And we're doing it - because of this approach that we're taking - in such an unusual way, that's why we're thinking we want to go for a patent. It's such a new way of doing it, it's never been tried before. We're delighted that we'll be able to publish this and possibly patent this. But it has very very wide applications.

I: That's great... But in this case the deliverable for SGM will be a process specifically for the explosives.

R6: Yes. It's going to make the same- it's going to make tinase. It's going to make the same explosive but the way we're making it, it could make many many other compounds of importance.

I: Okay. This is just a question they're asking all the researchers. to ask them what methods they've used for transferring the information in the research they've done. So

- Have you referred a journal article on this topic?

R6: No.

- I: You've done the monthly and annual reports for SGM...

R6: Yes

- I: Okay. Everyone's done those...Have you done a professional conference paper or is that something for the future?

R6: That's, um, we have not done that either. In many respects we're not even trying to do it. Because we need - The process has been very slow. We went for about six months without a student. Now finally -the person I just spoke with on the phone was the doctoral student that's working on it. He was a doctoral student at Rutgers. His advisor retired. So he had to find another advisor and he decided he wanted to work with us. It took him a little bit of time to catch on and he was very instrumental, a real important participant in terms of new development. It helps to have someone who hasn't come up through the ranks and learned the synthesis the way we did. All of a sudden he could ask some fresh questions. So he has been instrumental. It's taken him a little longer than I would have expected to develop this synthesis. There

are no show-stoppers so far, it's working. And that becomes an intellectual property question. If we think that it's potentially going to be patentable we can't really present it or discuss it until it is (patented). But I did present it and discuss it and the Army was extremely pleased at the meeting in Johnstown.

- I: That was the question I was going to ask you - I guess you've visited with the clients, or whatever you want to call them, and they've visited here. Just trying to get an idea of how much contact there's been.

R6: Yes.

I: Now here's a question that's just your opinion as a researcher, how do you think process of technology transfer is supposed to operate? I know it's not the sort of question you think about it every day. But just assuming you're doing the work, someone's giving you the assignment...How would you like it to go from there. In terms of just about anything, like the amount of time, the freedom you're allowed to have....

R6: There's some good things and bad things about working with this particular contract. In most things you do in academic life, you work on grants. This is a contract. So this has very specific deliverables, very specific ideas of what your travel funds are or what you can do with your money. It's all defined. Most of the stuff you do with academic grants, the person who wins the grant or gets the grant has complete say about this. Even the school can't say very much to you about it. So of course the researcher prefers having a grant. If I don't have enough money for my other little pet project, you don't over do it, but I will find ways of meeting all the objectives of my grant and still putting some more of the money in a project I feel is related but not necessarily one that I wrote into the grant proposal. I'm free to go off on a tangent if it's relevant. In this case we really are not free to go off on a tangent. And the worst thing of all is that the school is not overly generous on our travel funds, for example. And the net effect is that if I have a grant and I feel I need to go to a national meeting, I will do so. There's no questions about this. Over here I really can't.

I: So in SGM, I guess you could say, the way it's actually happening, you're under more restrictions, more supervision.

R6: I'm not under more *supervision*-

I: Okay, I shouldn't say that...

R6: I'm working in a different mode than is usual in academic mode. And it's not a mode that gives the researcher the freedom to explore as much as in a grant mode.

I: So if you could change SGM do you think you would you ask for a little more chance to...

R6: There's a deadline in both cases but the deliverables in a grant while the deliverables do not change in a contract. I shouldn't say that though. I could petition to change. If I were to have discovered a new explosive and I wrote to the Army and said, "Wow, you ought to see what I just discovered," They'd say, "Absolutely, let's rewrite this and let you follow this thing." But there's a procedure I'd have to go through with the Army. While with the grant, it's not quite that formal. If I think that what I'm going to do is going to accomplish the goals of the grant, I could decide to do that myself. I could inform my monitor before the fact, after the fact, in between, it doesn't really matter. But it's much easier for me to go to NSF and say, I've gone off on a tangent here because it was warranted, and Wow, I've succeeded. Or I could do the same thing and say, I went off on a tangent because of this, this and this. I failed miserably, I'm going back to the old procedure. Either way, I make the decision when its appropriate. With the army you can't do that. You've got to follow the course that you've laid out. And only if you really feel that you have something different, so you want to change something, then you have to go through the red tape of changing it before you do so.

I: So in the aspect that anything you create has to be given to someone else, either through education or training, how much do you think, in your role as researcher, is required of you to do that?

R6: That's a common thing. That you always must do. You know, the tree in the forest. If a tree falls in the forest and no one's there, you don't know it happened. If you're a researcher and you don't disseminate what you're doing, positive or negative, then you haven't done it. So it doesn't matter if it's a contract or a grant, you must disseminate it

I: Has the army been pretty good, willing to accept your ideas?

R6: In certain respects it's much better to work for the army or the D.O.D. than practically for any other department. less restrictive in terms of intellectual property. They say, All we're interested in is ways of making this explosive cleaner. Their goals are very clear. Whether you patent it, or whether you publish it, We don't care. We want the product. We want the product to be available. We don't even care if we own it, we just want it to be available. That's very very generous compared to everyone else who kind of says, well before you publish it, we must see it. You know, that kind of thing.

I: Do you think this project is any different because it's a green project or one in sustainability? Do you think that changes any aspect of it?

R6: No, not really. I teach this, I do all my research regardless of who funds it in this general area. I'm talking about myself.

I: This is a question that is pretty open ended. What connection do you see between your SGM research and the outside world.. I know that's kind of a Miss America question, but it depends on the researcher. I'm asking everyone the same questions. In your case you've pretty much answered it already.... Okay, we'll skip that one...

I: Do you have any tech transfer experiences that could compare to this one. Maybe better, about the same, worse....

R6: You have to understand what my background is. I'm in a second career here. I worked for Exxon pretty much my whole career and retired from Exxon. I was in charge of the Environmental and Energy area. The whole area. Other were managers working for me. And that was my job. Whatever we did we had to find ways for Exxon to make money out of it. So tech transfer is foremost in my mind.

I: Okay. Do you have anything else you'd like to bring up? Some people commented on monthly reports, travel? Anything you think they should know about?

R6: In industry I had monthly reports. They're a pain in the neck, I hated them. They're a necessarily evil. You have to put yourself in the customer's shoes. If I was the project manager for the army I would insist on monthly reports. And the monthly reports serve a purpose for me too. I have them on disk, I have them on my computer. They give me a progress of what's going and what we're thinking of. Are we maintaining the direction, are we maintaining the momentum? So I think they're useful in both places. It's just that they always come at the wrong time. Just like you came and I had five telephone calls. Just when the monthly reports are due I have ten other things that are due. All of a sudden I feel a tremendous pressure. But I think it's necessary and I wouldn't like to see them go away. I think they're good.

I: That makes you very unique among the people I've interviewed, because most of them do not have both experiences, being a manager and being the researcher. Some of them have spent their lives on one side, having someone monitoring them.

R6: Uh huh.

I: That's pretty interesting...Well, I think I've run out of questions. It's been really great talking to you and I appreciate it.

R6: Thank you.

**Interview with NJIT Researcher-Dissatisfied Group
November 24, 1999**

R7= NJIT Researcher 7

I= Interviewer: Susan

I: Once again, just for background, could you summarize the research that you're doing for SGM?

R7: We were suggested, or it was suggested to us, that some of the membrane separation techniques that we had developed could be tested at various DOD facilities. And these membrane separation techniques were meant for removing and recovering and controlling the amount of emissions of VOCs in airstreams, or for VOCs in waterstreams, or heavy metals that are being discharged in water, or any other type of pollutant. But these three that I talked about - VOC removal from air, water, the heavy metal removal from water - were our primary concerns. We've been developing a number of technologies here, and they are appropriate for demonstration at a DOD site. And if the demonstration is successful, I think there could be interest involving large scale commercial devices for controlling these emissions, both in air and water. We went for the project to Johnstown. We had developed contact with them and we made presentations about technology. We provided them with hand outs. We visited their various facilities and they were going to make an effort to find out where site demonstrations could be done, where such streams were available, releasing pollutants to the air or water. *Nothing* happened though from that side. They were not able to do anything for whatever reason. They did not get back to us. And so it was decided, maybe we ought to contact people at a *different* site. And this site happens to be Tobyhanna, again in Pennsylvania. The other one was at Johnstown with the CTC people. And this time it's a DOD site at Tobyhanna. After considerable effort when Nelson Colon of Picatinny Arsenal was able to finally get the contacts going, we visited Tobyhanna and we talked with some of the people, described some of our technologies, and they said they would definitely look into it. We again sent them by e-mail as well as in print description of our technologies. After considerable delay we were told near the middle to third quarter of last year- yeah, I think it was essentially near the end of 1998--that Yeah, they're looking into it, they have been able to locate the environmental people and they forwarded the stuff to them. And so we waited and we waited. But finally we were told near the beginning of this year, the environmental people are too busy with reconfiguration, reengineering at Tobyhanna. They just could not spare any time even though we thought we had possibilities there. We had identified some streams which had some VOC emissions. So then we pointed this out to the people who were organizing the program and managing the program. And after some inquiries they thought that Radford, Virginia would be another appropriate site. And we kept on wondering when we were going to go down to Radford, Virginia to locate the actual streams where such demonstrations could be done. *No* such offer was forthcoming. And so then I had to point out the people that technically trained personnel who going to help me carry out this project are not going to be available for long. And when this final statement was put out, I have been informed just three weeks back or four weeks back that Picatinny is willing to have the demonstration. Now we could have had the demonstration at Picatinny to start with! I think that the authorities who are involved in this are probably overcommitted and probably not interested in this particular project. And I find it somewhat disturbing that literally one and half years have gone through and even *more* probably, and we are unable to deliver anything. And I don't think I will be able to deliver anything unless this is implemented right away. *So I want a site at Picatinny selected right away.* A particular site and a stream and I want to get on with it with the personnel for as long as they're going to be here.

I: Well, one question I have is that it seems that out of all the projects, yours was the most advanced and deliverable early on in the project.

R7: Yes.

I: And many of the other people are doing fundamental or exploratory research. If they reach a point where they have something to deliver and they have this kind of problem, do you have any recommendation for

how they can deal with it? Or do you think the only way to deal with it is to tell them, If you don't want it, forget it.

R7: I think at the DOD level they must identify champions. People who are accountable for this particular project. And they must have appropriate time and resources available to monitor such a thing or pursue such a thing. I personally think something like that happened. The person who was put in charge either had overcommitments, or had no interest, or were not capable. *Or ...there's an alternate possibility...DOD facilities where they wanted to do the exploration, threw in a lot of roadblocks because DOD is having a lot of restructuring.*

I: So did you have research colleagues at other labs, at army labs? Or were they just going to take your idea and try to apply it there. Were there other people working on this problem at any other sites?

R7: We have had experiments on related projects at other facilities. For example, we had a similar project where we did a small demonstration of the technology at Robins Airforce Base in Georgia, Macon Georgia. We've *done* that. These things can be done if people are interested. And we think the demonstration is useful. Another project under another sort of contract, we did some work with EPA and then EPA is doing some of the demonstration at another campus. I have a feeling that that was a DOD site also, but I am not sure. So I think these things can be done provided we have the right personnel, they have the time, they have the right interest, and DOD facilities are appropriately cooperative.

I: So it's not really enough to hand over a blueprint of ideas to them? You really think you need the technically trained personnel to teach them how to use it and explain it? For instance you were saying that some of the people on your staff were going to be leaving. Do you think that is going to be a serious problem if they say, two years from now, Oh, now we want it. Do you think it's going to be too late.

R7: Oh, yeah. Yeah. We can always find people. We can always find people. But their capabilities are going to be very different. The particular person that I'm worried about is extremely capable. He has managed at least two or three other demonstrations at other sites. And he has a lot of background, he's a senior research engineer. And graduate students are not as knowledgeable right away unless are they are working *in that specific project with those techniques*. They will need to learn a few things. On the other hand, you may have minimum time available because it's a production facility. And they will say, well, "We are going to make it available for you at such and such time. You'll have to run it and do it very quickly." And then we'll have to contact appropriate people, get appropriate analytical resources there, and appropriate equipment, assemble it quickly and do it. I think regular students *can* do it, but they need very, very experienced guides to do it. Since I'm not going to be there at the site round the clock. It's physically impossible for me since I have so many other projects. The presence of experienced personnel is very important.

I: Now just getting back to some of the questions I have to ask you... In your career, do you have other cases where green concepts were incorporated into your research? Is this a streak that's running through your work or is this one of the few projects? How would you characterize your work?

R7: We had a project just completed at Novartis, a pharmaceutical corporation, where we are concerned the VOCs, you know the solvents that are going out in airstreams. And the solvents would be recycled back into the reactor. So that's green, that's green manufacturing. Because you're not allowing anything to go out and it's going into the process which emitted it. So that is certainly green manufacturing.

I: But do these innovations come about because you're aiming to change a process to control the pollution, or is it something that is branching out of a fundamental research plan, and then you notice it has a green application?

R7: In this particular case there were concerns about four things. Namely, the VOCs in airstreams, low as well as high levels; VOCs in waterstreams, and heavy metals in waterstreams. So we knew this when I

started some of this research. And we developed the research technologies to actually take care of these problems. Now *how* this particular technique is going to be applied to a given manufacturing situation, will depend very much on the technology with which we're going to interact. Very much. It depends on the site, it depends on the manufacturing process, and it depends on the nature of the technology. And then we'll have to adapt our technology to it. But generally in these cases we developed these things knowing fully well that there are general problems of solvent emission or heavy metal emission or water that is polluted. Sometimes you develop other technologies and you find an application, expected or unexpected in these areas. In this case, this is not true.

I: So you would be happiest if you had a chance to apply it to a specific site, rather than just telling them that you could do it. Just knowing that you have the ability isn't enough for you, you'd rather see it in place.

R7: Yes.

I: I have to ask about written reports. Have you referred a journal article on this topic?

R7: On this topic, oh yeah, quite a few.

I: And you've done the SGM monthly reports, annual reports.

R7: Yes.

I: Do you have any graduate students working on their thesis in this area?

R7: In my case we have a problem. If we do not have any site, if we are not putting up any set up, we cannot have graduate students working on it. So at the very beginning we were putting graduate students in it. But the graduate students had no work to do. So we immediately stopped that activity. We said, "Until a site is selected, graduate students cannot do anything." And graduate students require a very defined time frame. They cannot just float around, on the lookout for a problem that's going to come a year from now, or six months from now, or a year and a half from now. There is much more order in life. So I think these things have to be implemented with experienced research engineers.

I: So you've had plenty of face to face communication at Picatinny and all these different DOD sites. Have they come to NJIT at any point? Have army personnel been here?

R7: Some of them have been here.

I: And do they say things to you like --

R7:- They never have any time to interact with us individuals, no.

I: So they don't even tell you little stories like " Oh, yes, we're interested," and then they don't get back to you. It's truly a matter that it's inaccessible to start with.

R7: Well, whether they are accessible or inaccessible, the whole point is, they haven't done anything. They haven't allowed us to do anything.

I: Before you gave your opinion that technology transfer works best when there are champions to support the work that's being developed. Maybe you could say as a description, if they want to know what sort of person they need. If you were hiring such a person, what kind of background would you like them to have? Do they need more of a management understanding, or a scientific training?

R7: A certain amount of scientific training is essential. A certain amount of management perspective or capabilities is also essential. But the whole point is obligation. They have to have *some* sense of responsibility towards the program. I think that is critical.

I: Otherwise, they probably shouldn't bother having a program, because it's not going to work. That's something I've been hearing. Without someone to respond to you, what's the point of all the funding in the first place?

R7: Yes.

I: Lemme see... Now do you think the process of technology transfer is any different because this is a green project? It's just your opinion.

R7: The process of technology different is somewhat more difficult in the sense that the person or the facility where you are transferring the process, must be very interested in it. See, normal technology transfer processes, there may be a market pull. A market will say, yeah, you do that, you can sell the product in the marketplace. In this case, that's not necessarily so. You are preventing pollution. You are reducing the amount of pollution. But whether that helps you to sell the product better in the marketplace, it's not known.

I: So do you think that the answer to that is to have more legislation or some other incentive? Like a country like Germany has a law requiring companies to be environmentally efficient.

R7: Yeah, I think legislation is very important, and the German laws are ideal. Sometimes they're overly strict because there may not be any technology but I think this is an on-going process. Anyway, you articulate a requirement and then possibly technology *can* be developed to take that of that requirement. So regulations are important. It's also important to develop a cadre of people who are committed to it. I think generally this is a slow process. That's what we are seeing. A few are interested and some projects get much more attention than others. So I think, you know, there is that part of it. I'm sure there is much more interest in a green *bullet*. (joking)

I: Unfortunately maybe. One question that is also your opinion, and I think I even know the answer, but, do you see a positive connection between your SGM research and the outside world or the working world. Do you yourself believe it has -

R7: --Utility?

I: Yes.

R7: Oh, no question. In my case, if I can do the demonstration I can then use that demonstration to convince a lot of other people, "Look at these results." For example the demonstration we had at Novartes, and we are slowly going outside with the results. People are very very interested. And they are going to be having tests at their own facilities to find out how these are doing. And once these tests are very successful they will then be building a big facility.

I: So it's just a matter of prodding people into action.

R7: All changes go through, you know, the zig zag route. This is in the nature of the process, we have to persist.

I: And finally, do you have any technology transfer experience that could compare to the SGM experience? You probably had a case that went much better than this where people were more responsive.

R7: Technology transfer in chemicals and their life processes, is always demanding. Unless the product is going to immediately give you thirty, forty, fifty percent return on the investment. That's very important. If it is giving fifty, sixty percent return on the investment, even *then* you may have a problem because capital has gone somewhere else. To Internet start-up companies, you know, where you have 200% rate of return the moment you issue your shares. So this is always a problem but I'm sure there would be capital, we just have to persist.

I: Would you like to comment on any aspects of the project such as funding for travel, monthly reports, anything like that.

R7: No, I think the procedures they're developing in those areas, they're reasonable. They're reasonable.

I: Well, that's all I needed to find out. Thank you once again for doing this twice. I really appreciate it.

R7: Hmm mm..*etc.*

**Interview with NJIT Researcher-Satisfied Group
November 12, 1999**

R8= *NJIT Researcher 8*

I = *Interviewer: Susan*

I: Just for background, could you describe the research that you're doing for SGM?

R8: In this research we are involved in things that are related to multi life cycle design and design for disassembly, demanufacturing. That means many products, life is over, what do you do after that? If there's any product, once its useful life is over, there are basically two things you can do. Either you can dump it in a landfill or you can reuse. So in order to reuse we have to disassemble the product because everything is made by assembling several components together. Whatever the product is, whether it's a military product or a general product, they are all assembled by putting together different components. So there are two things we can do. You can either unscrew, unfasten and separate the things, and see what are useful. And reuse them. Or you can destructively damage the things and reuse the materials. It's not possible sometimes, or it's not even economical to disassemble and unfasten in a manner that we protect the product. Some of the things are already damaged. So we have to see, what is important? There are certain things we can damage. Like the plastics can be remelted. Or there is some kind of useful components which could be reused. So that is basically demanufacturing.

I So the goal is to reuse a certain percentage of the product, like a minimum of 50%, or just better than what they have now.

R8: Yes. I am more into the mechanical aspects of this. See, we have, if you look at all the books here on machine design, they all deal with designing new things. How do you put together new components and new devices? But none of them deal with, What do you do after their life is over? So even not only "life is over." Sometimes you have to take things apart because of serviceability, because of maintenance or because of modification. Particularly in the military products, mechanically things don't change, but controls, electronics, software changes. So you may need to take apart something in order to introduce the latest controls and other computer type features.

I: Is this a way of working or thinking that you've pursued in other studies in your career? Or is this something you started to do for the Army project?

R8: Good question. You see, this is something you should believe in. It's not a purely scientific thing. It's not like a project where you're writing and developing equations and mathematical formulas. Here's it something in which you have to be conscious about the environment. It's more of a general project because there are many things involved. There are things relating to costing. Second, there are environmental issues related to rules and regulations. And there are hazardous materials in this. Sometimes materials which would be hazardous if you take them apart. And I have fortunately one or two students who are very dedicated to these issues. and take this project very seriously. So there are many aspects to this. We are trying to concentrate more and more on the mechanical aspects. But there are numerous issues to be considered in this project. And you have to believe in this to do it.

I: Just for the record, I'm trying to find out if this was your own design philosophy. Is this something you pursued? Or just a coincidence that it came up in SGM?

R8: I have been involved in mechanical design, designing of devices, designing of various things, design theory. That's what I've been teaching for the past 18 years. And some of the issues we have already considered before in some aspects in relation to environmental issues and design. When this project came along it was a nice fit and we could use some of the design concepts we have already developed. But you can say, the design philosophy, some of it we have developed before we could use. But the applications,

these are newer problems. It was an interesting fit. It does interests us and it's something that will be a very important. Issue in the next few years.

I: Do you know who the end user will be? Have you met people who have been telling you what they want out of the end product, or is it an abstract assignment you've been given.

R8: No, we have met some of the end users through various seminars all at NJIT. There was one earlier this year when the people from Navy were here and we made a presentation, we looked at this. Some of the things we are developing are very generic in nature and they could be applied to different products. So we are looking at specific results now which could be applied.

I: Just because you mentioned the conferences, I'd like to ask about the different ways of passing the information on to the end user. Have you referred a journal article on this topic?

R8: Yes, we had a paper presented earlier this year at an IEEE conference in Boston where we specifically discussed the issues regarding the fastening of various things for disassembly. We had another paper submitted for publication in an international journal which deals with disassembly - guideline of specifications for the fasteners. Because fasteners are the key element holding components together. And we have another paper... so we have three or four other publications either done or currently involved.

I: Done the monthly, annual reports?

R8: Yes

I: Professional conference? I guess the IEEE was a conference.

R8: Yes.

I: I was going to ask about your doctoral students. They're doing their thesis on this topic?

R8: Yes.

I: You've had face to face meetings - been to the in process review meetings?

R8: Yes.

I: Military visits? You mentioned that, I'm just checking it off on the list. Okay, I got it now. Now, this questions is just supposed to be your opinion as a researcher. How is technology transfer supposed to happen?

R8: Well I think... We have to work jointly. We have to continuously keep people in industry who are going to be the users of our design processes, methods, procedures, products, whatever. And they should continuously give us feed back and review. And it's a constant exchange of info between us and them. I am dealing with a fastener comp trying to tell them what are more suitable for disassembly and green manufacturing and so it's a constant dialogue between them and us.

I: Is that how it's happening or how you'd like it to be? Some professors had aspects that they wanted to change. Others were happy. Was there sufficient feedback, etc.

R8: You can never be satisfied in research. You can always hope for better. It's a long term project. You cannot get results overnight. I assume we will continuously attract.. and once the results are checked by the army people, they will show more and more interest in the project.

I: Do you think the process of technology transfer is any different because this is a green product? Do you think it effects the army's level of interest?

R8: Naturally it will be slightly different because we are dealing here with the army. When you deal with companies there is a different objective, they have profit making goals. We are dealing with IBM and we work in a more commercial manner. With the army it's not that easy to just go in and walk into their offices. And we have to work through proper channels of communications.

I: In your own opinion, do you see a positive relation between SGM and the outside world or working world? Do you believe in the positive benefits?

R8: Oh yes. Because we have limited natural resources. And particularly working in an academic environment, where we deal with students, I always try to work on projects that also interest the students. And many of these students are very interested in protecting the environment. And I think more and more legislation is coming which will make it a necessity for companies to take back the products. And with the army, I think the other problem is that a very large percentage of systems are never really used unless there is warfare or something and so, What do you do after ten years? Because they may become obsolete. Not everything becomes obsolete in a system. The only thing that becomes obsolete is probably the computer controls or other devices. But the mechanical structures may still be useable. There are certain things which are still useable. There are other things in army projects which have certain components which are very dangerous, hazardous. Explosives, mines. Although I'm not working the mines and all that. But I read about how to take apart the fuse and all that. It's just a big amount of budget on these devices and naturally more and more problems are arising the more you do with them. So there will be more and more need for our research.

I: Can you compare this to another technology transfer experience? The army requiring more formal channels of communication. Anything went much better or worse? How would you rate it?

R8: The main thing different, number one, there are a lot of people involved in this project. And I'm working with two fact members in my group. And I think it's a huge team, there are several groups. We have a very communications with Dr. X. with whom we meet, two of us, other group member. And sometimes we meet like the whole group, I don't know fifteen, twenty people. So it is slightly different because we have to go through proper channels in dealing with their requirements and basically in communicating with them. Whereas with the companies it is a different thing. I mean, we have mostly projects. I have an individual project. I deal with a com and I'm the only one. I deal with only one person in the co and I know who to contact. So it's slightly different. We have to plan ahead and go. And also, the army ... normally the contractor out there work. They don't do everything alone. So there are many agencies involved. But we are trying to do fundamental work, generic work, which could be used in many situations.

I: Anything you'd like to comment on about monthly reports, whether you get what you want when you need it, just how things are going that you'd like to change...

R8: I think it's going fine and I wish there were slightly more resources in doing physical work in which we have more expenses (*I think he means Funds*) to buy something. We need new computers, we need new devices. Everything involves money. There is one way you could have the research by paying through your salary, your students' time. But there are other aspects that are not directly in my control but I wish I could expand our work.

I: Do you think , if you were allowed to diverge a bit, go off on a tangent, would that help? Because they are only asking for one deliverable. Are you allowed enough freedom as a researcher?

R8: What we have is adequate. But in research there are no limits, there are no boundaries. I think it is like we are picking up, what do you call that, from an ocean, you know?

I: Pebbles, shells?

R8: Shells, so there are a million things you could do.

I: Okay, so I guess you have to limit it.

R8: Yeah. But. Anyway. Thank you for your time.

I: Yeah, I guess that wraps it up. Thank you very much, *etc.*

**Interview with NJIT Researcher-Satisfied Group
October 28, 1999**

R9= NJIT Researcher 9

I= Interviewer: Susan

The interviewer is not a native speaker of English. Unless it was necessary to understand the statement, I did not alter the grammar when transcribing the interview.

I: Okay, just for the record could you tell me about the research you're developing for SGM?

R9: We are working on a process of coating of steel with another metal, which is tantalum in this case. That protective coating has to have certain properties. It's actually inside the gun barrels. So it has to withstand very extreme conditions of high pressure, temperature, and friction and so on. And it is related to sustainable green manufacturing because tantalum metal is supposed to replace chromium, which is environmentally very unfriendly. The present process which uses chromium produces a lot of chemical waste, which eventually ends up in the environment and has to be taken care of very carefully. And so it's like two pronged, in a way, results, one is technological advancement and the second is the environmental solution for an existing problem.

I: So is this something you were working on (before) or is this something that the Army requested you to do?

R9: Actually there was a particular need indicated by the Army when we started the project we looked - - The idea was to look around, how we can possibly help, interface with the Army need. And NJIT, when you look at various people doing different things, my expertise was in what we call thin film deposition or this process of depositing layers of materials on other materials and it just fit this particular need. Of course, things had to be advanced, modified, the laboratory transformed for this particular need. New equipment - but the basic knowledge was here, essentially.

I: And do you try to have a green aspect to your research or is this something that just as a coincidence, this thin film property...

R9: A what aspect?

I: A green or environmentally friendly aspect to your research, is that something you strive to have in your work?

R9: In very general sense, that's one of the needs. I work mostly with semiconductor industry which is also part of industry today: essentially conscious of environmental hazards. My expertise wasn't in environment. But simply, I think it's a very interdisciplinary problem. Just being interested in environment doesn't solve necessarily the problem, you need experts in various fields to contribute whatever needs to be done.

I: Just thinking about your SGM work here, who do expect the end user to be? Have you already met them?

R9: Yes actually, in this case, we have pretty close relations with Army laboratory that already actually started work on this problem before we entered into it. That laboratory is in Watervliet, NY, in upstate NY near Albany. Benet Laboratory, that is the name of the Army development unit, whatever. And they actually have a manufacturing facility. And the idea was that we could perhaps solve certain problems that would help them to run the production of these units that they want to make. Actually that army unit is more geared towards manufacturing the final product. It has some research capabilities. But they

approached the problem by, for example, coating with tantalum large objects so that their time between trying something new and getting final answer was long and costly. So our approach is to make a scale-down model of the same process and provide quicker turn around and test the process, maybe test some parameters and feed information to them, what they could do and by discussing with them which things could scale to their environment..

I: So the outcome of your project here will not be an actual item but a model that they can apply to their work.

R9: It's actually process development and there are certain things that are - -eventually have to be tried on a full-size unit. But many parameters like, for example, the type of metal that is being used which is the same but there is perhaps at the interface we could use another material in between steel and tantalum that would be the same thing on the model and on the large object. Or some process parameters there are certain gasses used in this process that help some other parameters and so on. So generally it's in research common thing that you're doing things in laboratory environment and then you have to transfer it to full scale industrial production, so we are used to these adjustments. Not necessarily one-to-one but you can learn a lot quicker usually and we can also focus on more fundamental aspects of the process.

I: So, so far the Army has been pretty receptive to the ideas that you bring up, there's no resistance or doubt?

R9: No, in fact, we had good relations right in the beginning. They appreciated some of our contributions and they tried our suggestions. We also interfaced with the Army Research Laboratory which is in Maryland. Which is not part of that unit I mentioned before. But they do general research on materials and processes and they were receptive to collaborating with us because this research involves not only- Say we prepare some samples of materials, now they hve to be tested in various ways, and the diagnostic equipment is quite costly and we don't have everything. So the Army research lab would do certain tests or invite us to use their equipment, for example, and the results then would be transferred to the unit I mentioned before.

I: So basically if at any moment you needed to just call someone, you have a name, you have a contact. I was just trying to get an idea of the informality or the kind of contact you have. Is it very formal where you have to introduce yourself every time or is it a good working relationship?

R9: Actually there is a team of about ten people and we met right in the beginning the key player. The leader of this group and other people who do the actual work, and we made several trips there. And we are also applying to invite them here to NJIT so the meetings as for the army usually have to formally approved or arranged but a positive point, things are pretty informal. If we take a trip, it takes maybe three hours or so drive, then usually meeting and lunch together, wrap up and three hours there.

I: And talking about more formal ways of letting people know about the process, have you had a chance to write a paper for a conference, maybe refereed a journal article?

R9: We are getting to this point. We haven't done this yet and we want to include also our collaborators there. There is the issue of, they may have more formal requirements as far as what's publishable, who does what, so we are aware of this and will be talking to them. But we have also formal meetings, in Johnstown there is a group that manages this project, and we have meetings there. Earlier this year we had a large meeting in which we presented our results in a more formal way, oral presentations. We had also a visit at NJIT, people from Johnstown, some people from the army, who visited actually our laboratory and then we gave them some report in a written form. So it's not like a conference paper where everybody comes to the conference but it is the interested group that got this information.

I: So here's a question that's supposed to be just your opinion. How do you think technology transfer is supposed to operate?

R9: Well, it may be a little different with the army than in general, with industry for example. But there are common elements. [With] the army [there] might be certain propriety or more classified aspects of some research. Which I don't think we had this kind of problem in this project. But obviously it's certain things they want to keep for themselves. After I said that I realize that industry has sometimes the same concerns. The companies who advance certain products don't necessarily want to spread it out. So we operate on the fringes of this proprietary knowledge. We are as a university interested in broader knowledge that is disseminated throughout [by an] international conference, for example, or publication. But sometimes --this may be something new for industry in recent years where we work with more applied research-- There are issues of what we call intellectual property. And possibly patents that come out of this research, and once the work is published it is actually common knowledge. So in this case we have to negotiate with companies for the proprietary rights to the knowledge. But essentially we prefer to be quite open about it and there is the tradition of a university of disseminating knowledge for everybody.

I: So in the case of SGM you have to find a balance between being an academic and researcher and realizing that the interest of the partner is someone is someone who wants to keep a lower profile. Is that how you would say the situation is for SGM?

R9: I think in this project we haven't run into this problem yet, but we are aware of this and will be in communication with our partners there, so if we want to publish something we send written paper and we will ask, Is this all right with you that we do this?

I: Or even just thinking of it in terms of developing a process for an end user: Do you think so far the transfer - even if it's a transfer of ideas - has it been going smoothly? You don't have any complaints about Army contacts?

R9: No, no, I think the Army is some tendency to use civilian technology and use whatever army developed in wider industry. So no, I didn't have problems.

I: Do think anything about this project has been different because it is a green project? Or it really wouldn't make a difference.

R9: I don't think the green aspect is any different. If anything it might deflect some of the proprietary or secretive issues because we are all interest in environment, and if there is a particular process that is working for the army, a spin-off might be for larger industry, too. So in that sense it's not different

I: So you see the work you are doing here as having a potentially positive aspect on the outside world, the regular working world? Some projects are very narrow in scope and I guess yours has wider applicability?

R9: We do hope so, of course.

I: Of course. And finally, do you have any technology transfer experience that could compare to the SGM experience? Was there another project you worked on?

R9: Each project is maybe a little different but most of the work here at the university was published, that was the typical way of transferring information. Although some projects with industry there was also direct contact. I think that question would be answered differently by different faculty depending on what project they had. I had some interaction with industrial consortium, Sementek makes semiconductors in industry and had more direct, it was quite similar actually, more contact with a more narrow group of people. Where you passed the most recent information or the latest data, but at the same time the data were also published, later, but the people directly involved were interested in what you did last week or recently.

I: So there's been a lot of feedback?

R9: Yeah to have quick feedback to the people that you know are interested. Even though later on when the time comes to write a paper, this would be... So there are similarities.

I: Do you think it is a characteristic of the people you work with in the Army? Is it their desire or is it just something you can expect that the Army is going to take an interest in your work. Do you take it for granted or is it something unusual?

R9: I think it comes from the fact that the work is useful to them, and they'll be interested. And always among researches, if they have some kind of interest, they often strike some kind of good relations. Of course there may situation of competition, like two groups. It could also be also at universities working on same things, there is sort of Who is first, is quite common. But in this case the problem is, frankly, quite broad and difficult, so nobody has all solutions. It's not like one thing you can do and solve the problems. So in a way, every bit helps and they are looking for input. If we succeed, in a way they succeed too, so I think that's part of it.

I: Do you think it will be difficult, economically, to change the process. Will they have to get a lot of new equipment?

R9: They started already on this route. There is two issues. One is to show, is it possible? The other, is it economical? I think this is often very issue with environmental projects. We know today the replacement for some processes that are very environmentally unfriendly ... But they are just too costly to apply. It would be unrealistic to expect. So this is tied together. I think in engineering price is one of the technical parameters. You can plate things with gold and they will not corrode, you have solved corrosion problem! (Joking)

I: Gold plated guns...

R9: Anything! Cars, for example. Gold plated cars will not rust. But it is not acceptable solution. So it is always together. Of course for wider technology too. We had quite impressive computers 30 years ago but there were few in town. Now everybody has one on their desk top, so that is what changes the world, the accessibility. You don't know, right? From the beginning, how it will turn out.

I: So you know already, they want to save money along the process and have less waste, but ultimately the cost of implementing the process is a consideration.

R9: Yes, but at the same time. Always introduction of a new process has a price threshold. The initial cost.. What often works in environmental issues is the initially hidden cost of environmental damage is becoming more visible. In terms of regulation, the cost of cleanup which is being passed onto the perpetrators, or even getting rid of something. They have to do something with it. Even if the whole process is cheaper, all the associated task might eventually shift the balance towards more expensive but cleaner process.

I: So they have to think long-term.

R9: They are pretty good about this. They are told to do that.

I: Anything you would like to add? Any opinions about monthly reports? It's going to be all confidential, but comments will be passed on.

R9: So far we have been quite comfortable with the away things have been done. We didn't have them on our backs all the time, we passed on information and got a good response. So I don't have any negative comments. And we are hoping that it will help them and at the same time help us. It brings something to NJIT, definitely, in the form of experience for our students and ourselves too. It also builds our equipment base because we have to buy thing that officially belong to the government but we can use some

instrumentation and experiment with these processes might be useful overall with our research capabilities in the future.

I: So you do have doctoral students, undergrads or masters working on this?

R9: It changes semester to semester as they come and go but I try to involve also undergraduates in small aspects. Also in this case there are a number of people involved at NJIT and the nature of my segment of the project is such that I collaborate with X and Y . Samples created in my laboratory are being used for their assessment of some corrosion properties. And it creates a network at NJIT that is also helpful.

I: All right. Well, that's all it for now. Thanks very much.

R9: All right. Thank you.

Interview with NJIT Researcher- Satisfied Group
November 12, 1999

R10=*NJIT Researcher 10*

I= *Interviewer: Susan*

I: For background could you tell me about the research you're doing for SGM?

R10: Actually we're working on two different levels. On one level we're trying to understand atomic scale processes. - - Actually there are two components to this project. One component is the calculation component. One component is actually making films and coating the gun barrel. That component is not part of this group. We're doing the calculation aspect of that. That's M. Have you talked to M yet? All right, so you're familiar with that. . . . So one of the issues we're trying to solve from a fundamental level, is to understand how when tantalum is applied to steel, what are the important adhesion properties that you can enhance? For example, if you put down tantalum on steel, which the army is interested in doing, many of the times during the process, the tantalum does not adhere. It comes off. The reason why tantalum is replacing the steel is because chromium is toxic in its hexavalent form. And so tantalum, they think, is a good replacement for chromium. And actually, in terms of toxicity it probably is. The issues are, how would you get it on the steel uniformly, in a way that can apply on an industrial scale; and also, figuring out what the mechanisms are involved for depositing it and adhering it. So we've applied two different kinds of techniques. One is in-lab methods. For example, X-ray diffraction, fluorescence, let's see, what else did we do, ESEM, typical laboratory tools which give you both properties of the materials. In addition to that we've developed new techniques based on cyclotron radiation experiments. The last week and a half ago, those students went to Brookhaven National Laboratory to do experiments. Let me show you this. . . (gets a book to show me data, etc.) Brookhaven National Laboratory is located on Long Island which is about eighty miles from here, and this facility has a cyclotron source. This cyclotron source enables us to do many different kinds of experiments. Not only the in-lab ones but also new novel ones. Such as a technique called EXCESS and also measurements.

I: So NJIT already had this relationship with Brookhaven, or is it a result of working with the army?

R10: Oh no, a few of us here have been independently doing work in the area. And essentially we applied or extended the techniques that can be used over there to this project. Because it provides new insight that is not available on site (at NJIT). . . . I can describe it to you anyway. Essentially what you have is a circular ring. You have electrons going that way. If you have electrons are orbiting a circle they release radiation. That's why - I don't know if I can go off on a tangent - That's why, if you had an atom. . . Remember the Bohr's model of the atom?

I: Sure.

R10: The reason that model is not correct, is because if you confine electron to move around the nucleus, in a circle, it will radiate energy and just collapse into the nucleus. And the nucleus would not exist anymore because all the atoms would just collapse like that. But actually they move around in, like, fuzzy shaped orbits. If you're good at setting up that kind of configuration, you can actually use the radiation that's coming from the electrons they're emitting as they're going around in a circle and use them in experiments. In a laboratory what you do is you have a target, electrons hit the target, and the target fluoresces because you excite the atoms on the target. Here you take advantage of the fact that the electrons are moving in a circle and that has very interesting properties. If the electrons are moving at a very low velocity, then the radiation pattern looks like a pattern from, I guess, an antenna. I mean, an antenna that's vertical. In fact, if you look at any antenna anywhere around here, you'll notice they have a vertical wire, because radiation from a vertical wire is going to perpendicular to it. If you take that antenna and move it to high velocities, the pattern doesn't look like that. It will look quite different. What happens is if you look tangential to that ring, then the radiation pattern becomes highly focussed. It's almost like a laser. So you have a source of radiation covers a range of between ten to the minus two to ten to the fifth electron volts. That means you

can do optical studies or you can hard x-ray studies. And there's no other system that tunable to the entire range, it's unique. So if you want to study structure of atoms, which is on this energy scale, you have essentially no choice but to go over there and do it. So that's one of the advantages of what we're doing. Now, why do you want to do this?

I: Oh, well, I don't mind. You can explain your work any way you want. What I'm trying to get at here, is ask you, is this research you're doing now - is this something you before in other research? Do you try to incorporate a green concept in your other research?

R10: In other research? In terms of waste management?

I: Or any sort of ... You do physics so I guess you could do any kind of environmental topic. I guess it's trying to gauge how environmentally motivated you are.

R10: Oh yeah, actually, I have other types of collaborations. I'm a physicist so I develop methods and models for doing fundamental science. But I also do environmental science work in addition to the green manufacturing work. For example, I studied what happens when you have heavy metals such as chromium and other kinds of metal oxides, on clays. What mechanisms are involved? Do you have strong binding of metals to the sites? Do you have leaching? There's a whole idea called "speciation". Where you need to find exactly what chemical species form, for example, if you have lead spilled on the soil. Is it going to form some insoluble solid, or is it going to form some species that's going to migrate away. And again you can use these various techniques to get at that. That's the only environmental component I've had in my other projects. The other projects I'm working on are essentially things like superconductivity things like magnetic materials. But it's not clear to me how to include a green aspect in those.

I: Sure, some things are too abstract.

R10: Okay, yeah. - - I still haven't told you what we're going to do with radiation yet in terms of the SGM project. So one of the problems with tantalum is that it has this beta phase. It's beta phase is brittle. And when you try to replace chromium, chromium is an incredible metal. It is easily deposited. There's a chemical process for putting it down. And if you're going to replace it you're going to have to find something at least as hard, in terms of scratch resistance and so on. And in many experiments, when you deposit tantalum, you can just take it and flick it off. So it's totally useless in terms of a gun barrel, or if you coat a jeep or any other steel substrate. So we're trying to understand exactly, when you deposit tantalum on a steel surface, what are the mechanisms. I have a student right now, in addition to this, who is trying to understand the thermodynamics of the growth of tantalum. And to get at those kinds of fundamental pieces of information, you need to have atomic level description. So from Brookhaven, we get structural measurement essentially. When you sputter tantalum here, at NJIT, what are those parameters of your system that you sputter with, what phases of tantalum form? What are the parameters that generate the right phases? So it's kind of a cycle here. They mix films and then we characterize and pinpoint the parameters. At some point in this loop we have to pin down what parameters give you the alpha phase, which is the real one you need to get a hold of. That's sort of the core.

I: Okay. Well um, I guess I'm asking questions of all the researchers, so if it doesn't apply to you exactly.. Do you know the end user will be or what sort of products it will be applied to?

R10: Yeah. In our case, we're interfacing with Watervliet, which is a laboratory, an army laboratory, that's actually also making films in various geometries. And so our transfer will be a transfer, essentially, of information in the form of very detail reports about the conditions under which tantalum would form the best film. That's the main output. There's on other thing that's important in our group. We're also looking at steel substrate and also tantalum under aggressive attack. If you had steel coated with tantalum coating or even chromium out in the field, you want to know under what conditions it would start to corrode. So we set up two experiments, one in a solution of ammonium fluoride, which is one of the most severe,

aggressive, corrosive environments for tantalum. And also high temperature gas phase experiments to see, under high temperature, what kind of corrosion would occur. So on one level, you're characterizing the materials. On another level you're aggressively corroding them and then characterizing them. So that information should be useful, directly, for the Army.

I: Okay. Since you're talking about the information transfer, I'm just going to ask you what channels you've used to do that. You've done the SGM monthly reports, annual reports?

R10: Yeah, last year we wrote a large report on the mechanisms and methods for corrosion protection. In addition a thesis was published. I don't have it here. As student, Praba, wrote a thesis, detailing a lot of the information I just mentioned to you. We published a lot of stuff on the web. However, you just can't upload it and have everybody looking at it because, you know...

I: It is the army, after all.

R10: Yes, after all.

I: They might want to take a first look at it.

R10: Yeah!

I: Now let's see, have you referred a journal article on this topic?

R10: We haven't referred any journal articles yet, but we are in the process of doing that. One of the problems is, in addition to the detailed background that's required there's not... The thing about tantalum is, there's a lot of information out there, but it's disjointed. One of the first things to do is to put together a serious report about beta tantalum. That's actually still going on. I mean, the journal's been stuck in Bell Labs' internal documents and we are finally taking it out. And just recently we just finished a whole phase of experiments at Brookhaven. So right now we're in the process of analyzing data and writing up reports. So by the end of the year we should have at least one really thorough peer review journal article.

I: As for professional conference papers, is that another thing that's being delayed for now?

R10: Professional conference papers? You mean presentations at conferences?

I: Yeah, a little different from the presentations at Watervliet. A general conference.

R10: What we do is, once you have an article written up, then you present that work. That's natural. That's the way we do things.

I: Oh. Okay, and you've had Watervliet visit NJIT? And back and forth?

R10: Yes, we actually took a trip up there once.

I: Okay, here's a question you can answer in your opinion as a researcher, how do you think the process of technology transfer is supposed to operate?.

R10: I think it should not be something rigid. You should be communicating so frequently that it should be transparent. That's my opinion.

I: Is that how it actually happens in SGM?

R10: Within the project at NJIT?

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