

METRO ENVIRONMENTAL: THE IMPACT OF TRAINING HVAC TECHNICIANS  
USING THE SIGHTPROS-VIRTECHS SYSTEM FOR REMOTE,  
WIRELESS, INTERNET VIDEO ASSISTANCE

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This qualitative study explored the overall impact of training HVAC technicians using the SightPros-VirTechs system for remote, wireless, internet video assistance at a small HVAC company, Metro Environmental. John Thomason, the president/co-owner developed a website and a new SightPros communication tool that allows wireless, one-on-one, just-in-time, high-quality, video-monitored instructions between an expert at one site and a technician at another site.

Metro Environmental successfully used the SightPros-VirTechs system to train a new apprentice remotely. The apprentice and expert changed their normal and routine physical activities because the expert worked remotely and the apprentice worked on-site. Within just a few months, the apprentice proved competent enough to go to customer accounts without more experienced technicians nearby. The technicians express excitement about the SightPros communication tool as a way to contact remote experts whenever needed. The customer and business contacts also give good reviews and suggest other benefits. The expert permanently captures the communications so the company can use the saved video for many applications, especially training. The dissertation provides a list of recommendations to trainers/educators for similar applications.

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## LIST OF TRADEMARKED PRODUCT NAMES

Trademarked Name	Trademarks of:
Adobe® Photoshop® CS3 graphic software (2005)	Adobe Systems Incorporated, <a href="http://www.photoshop.com">http://www.photoshop.com</a>
Air Conditioning Contractors of America® (ACCA®) association services	Air Conditioning Contractors of America, <a href="http://www.acca.org">http://www.acca.org</a>
Armaflex insulation	Listed owner: Armstrong World Industries, Inc., <a href="http://www.armstrong.com">http://www.armstrong.com</a> New owner as of 2000: Armacell LLC, <a href="http://www.armaflex.com">http://www.armaflex.com</a>
AT&T® telecommunication equipment, services, etc.	AT&T Intellectual Property II, L.P., <a href="http://www.att.com">http://www.att.com</a>
Camtasia® and/or Camtasia Studio® screen recorder software	TechSmith Corporation, <a href="http://www.techsmith.com">http://www.techsmith.com</a>
Cingular® telecommunication equipment, services, etc.	AT&T Mobility II, LLC, <a href="http://www.wireless.att.com/about/cingular-history.jsp">http://www.wireless.att.com/about/cingular-history.jsp</a>
CyberLink® PowerCinema® NE for Everio software (2006, Version 1.0)	CyberLink Corporation, <a href="http://www.cyberlink.com">http://www.cyberlink.com</a>
D-Link® network camera	D-Link Systems, Inc., <a href="http://www.dlink.com">http://www.dlink.com</a>
Dell® Inspiron® laptop computer	Dell Computer Corporation, <a href="http://www.dell.com">http://www.dell.com</a>
Direct Connect® cell phones	S-N Merger Corporation, <a href="http://www2.sprint.com/mr/aboutsprint.do">http://www2.sprint.com/mr/aboutsprint.do</a>
Dragon® NaturallySpeaking® speech recognition software (2006, Version 9.0)	Nuance Communications, Inc., <a href="http://www.nuance.com">http://www.nuance.com</a>
ENERGY STAR compliant products and services	Environmental Protection Agency, <a href="http://www.epa.gov">http://www.epa.gov</a>
Freon® refrigerant	E. I. du Pont de Nemours and Company, <a href="http://www.dupont.com">http://www.dupont.com</a>

JVC® Everio® hard disk camcorder	Victory Company of Japan, Limited, <a href="http://www.jvc.com">http://www.jvc.com</a>
MAPSCO® maps	MAPSCO, Inc., <a href="http://www.mapsco.com">http://www.mapsco.com</a>
Microsoft® features, products, software, and/or services.	Microsoft Corporation, <a href="http://www.microsoft.com">http://www.microsoft.com</a>
Microsoft Office® system products (1997, 2000, 2003, XP, 2007)	Microsoft Corporation, <a href="http://www.microsoft.com">http://www.microsoft.com</a>
Microsoft PowerPoint® presentation software (1997, 2000, 2003, XP, 2007)	Microsoft Corporation, <a href="http://www.microsoft.com">http://www.microsoft.com</a>
Microsoft Windows® operating system software (1997, 2000, 2003, XP, 2007)	Microsoft Corporation, <a href="http://www.microsoft.com">http://www.microsoft.com</a>
My Book® Essential 500 GB external hard drive	Western Digital Technologies, Inc., <a href="http://www.westerndigital.com">http://www.westerndigital.com</a>
Nextel® telecommunications services	S-N Merger Corporation, <a href="http://www2.sprint.com/mr/aboutsprint.do">http://www2.sprint.com/mr/aboutsprint.do</a>
North American Technician Excellence® (NATE®) testing and certification	Air-Conditioning, Heating, and Refrigeration Institute, <a href="http://www.ahrinet.org">http://www.ahrinet.org</a> and/or North American Technician Excellence, <a href="http://www.natex.org">http://www.natex.org</a>
Panasonic® RR-US450 IC recorder	Panasonic Corporation, <a href="http://www.panasonic.com">http://www.panasonic.com</a>
Puron® refrigerant	Carrier Corporation, <a href="http://www.carrier.com">http://www.carrier.com</a>
RFM® wireless components	RF Monolithics, Inc., <a href="http://www.rfm.com">http://www.rfm.com</a>
Sil-Fos® solder	Handy & Harman Corporation, <a href="http://www.silfos.com">http://www.silfos.com</a>
Sprint® telecommunications services, products, etc.	Sprint Communications Company, <a href="http://www.sprint.com">http://www.sprint.com</a>
Trane® HVAC systems	Trane, Inc., <a href="http://www.trane.com">http://www.trane.com</a>
Transana™ qualitative analysis software for video and audio data, Version 2.21 (Woods & Fassnacht, 2007)	The Board of Regents of the University of Wisconsin System: <a href="http://www.transana.org">http://www.transana.org</a>

United States Postal Service® (USPS®)  
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<http://www.usps.com>

Wi-Fi® wireless local area networking  
products

Wi-Fi Alliance, <http://www.wi-fi.org>

Xerox® paper, services, copiers, and fax  
machines

Xerox Corporation, <http://www.xerox.com>

Yahoo!® Messenger instant messages

Yahoo!, Inc., <http://m.www.yahoo.com>

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## CHAPTER 1

### INTRODUCTION

#### General Introduction

I recently completed a study at a HVAC (heating, ventilation, and air conditioning) company. I researched the impact of training technicians using a system for remote, wireless, Internet video assistance.

I present an introduction to my study in this chapter; a review of related literature in Chapter 2; an explanation of my methods and procedures in Chapter 3; a description of my findings from the study in Chapter 4; and my discussions, conclusions, and recommendations in Chapter 5. I include multiple appendices that provide additional relevant and detailed information regarding the study. I finalize this dissertation with my bibliography.

In this chapter, I start with an introduction to my dissertation and to Chapter 1. Next, I present the contextual background for this study. Afterwards, I discuss the significance of the study. Then, I describe the purpose of this study which includes my major research questions. Subsequently, I follow that with a list of guiding research questions that I have used to explore the major research questions in more detail. After that, I state the delimitations of this study and define certain terms related to this study. Finally, I finish this chapter with a brief summary.

## Background

In this section, I present the contextual background for this dissertation. I address four areas: (a) an overview of the current state of distance learning and wireless computer technology, (b) a summary of my background, (c) a brief portrayal of the HVAC expert that I used, and (d) a synopsis of the HVAC business that I studied.

### *Current State of Distance Learning and Wireless Computer Technology*

Training has changed dramatically for many industries as computer and technology capabilities have expanded in the workplace. Moore and Kearsley (1996), in discussing learning environments, stated: “Many stories are told about distant learners on battlefields, in submarines, in lighthouses, and in prisons” (p. 12). In some employment sectors, like flying and military combat, virtual technology puts a trainee in life-like scenarios where training via computer simulations removes the actual consequences of risky and/or potentially expensive situations. In other situations, instructors enhance distance learning via collaborative virtual environments (CVEs) and computer supported collaborative work (CSCW) (Redfern and Naughton, 2002).

Nolan (1996) noted that job training plays a more dominant role in company success than ever before. He predicted a growing need to adapt to new information and to acquire knowledge and skills due to the ever-increasing rate of technological changes. Further, he indicated that the boundaries between learning and work have diminished with less emphasis on off-the-job training and more emphasis on integrating training and learning on the job. His future job training scenario suggests computerized



electronic performance support systems that give workers immediate access to information and learning while they perform their jobs.

Wong et al. (2007) projected that as technology grows more complex, the expertise needed to operate and repair it may prove essential but scarce in many organizations. They suggested that an expert utilize information technologies to assist a novice in a remote location when that novice needs specialized knowledge. They recommended that "it can be faster and cheaper to provide technical support over the phone than to travel to a customer's site to fix a problem directly" (p. 261).

Today, wireless technology continues to expand dramatically in the marketplace and in the classrooms. It may influence training and apprenticeships by encouraging improvements in some of the current instructional techniques and practices. It may impact knowledge management in education or business by changing the ratio of expert or trainer to apprentices and students. Educators and trainers may benefit from practical recommendations for instructional improvements relative to wireless video technology.

In this dissertation, I report on the impact of using wireless computer technology within apprenticeship training at one small business, a HVAC company. More specifically, I examine the impact of a system that uses a portable, wireless audio/visual communication tool (similar to Webcam technology) to connect a local technician to other technicians or to various industry experts via the Internet even when the technicians or the experts work in remote locations. Their system utilizes a concept

called just-in-time training (when training occurs as a specific need arises) and a concept called leveraged expertise (when an expert assists one or more people and/or locations concurrently about different situations).

Instructors may benefit by successfully adapting to the new environments caused by rapidly changing technologies. The system at this HVAC provider suggests an emergent pattern. With this dissertation, I present both the positive and negative impacts of wireless communications on instructional practice as I describe this new instructional environment within an apprenticeship framework. I then provide my recommendations for improving instructional support of similar programs as wireless technology and the Information Age drive some of these instructional changes.

#### *Researcher Background*

God blessed me with some natural talents, an inquisitive mind, and some luck. All of these played a role within my research for this dissertation.

My educational credentials emphasize some of my skills and interests. I earned a bachelor's degree in physics with a minor in math. As electives for that degree, I also studied psychology, sociology, statistics, and photography. I earned a master's degree in computer education and cognitive systems which also included courses on hardware, software, learning theory, and psychology. This dissertation now completes the requirements for my Ph.D. in applied technology and performance improvement (ATPI) with a minor in applied anthropology. (The ATPI name provides a new name for an older program of study at my university. I completed all of my coursework under the previous

program in the applied technology, training and development department. That name changed in the fall of 2005 to ATPI. I mention this change because I like the training and development emphasis in the older name.) For my Ph.D. degree, I also studied educational statistics, technical writing, and some additional topics in computer education.

My work credentials also highlight various skills and interests. I worked for 2 years (in my first full-time job) as a summertime activities counselor and later as a housemother in a Christian children's home. That experience provided me with a strong ethical foundation for this research. Next, I spent 2 years compiling, graphing, and analyzing quantitative Air Force balloon and weather pattern data for the Schellenger Research Lab at UTEP (University of Texas at El Paso). For approximately 4 years I worked in computer processing, operations, and programming in both the banking industry and a small construction-supply business. Afterwards, I spent 19 years with the Xerox Corporation on various XEROX® copier and fax service and development teams where I learned to service, to teach, and to publish documents for the operation and servicing of their machines. My experiences with Xerox Corporation include 2 years as a field service technician, 2 years as a branch expert and trainer, 3 years as an international trainer, and 12 years as a technical writer producing operator handbooks, service manuals and service training. As a branch expert and trainer, I used quantitative data to analyze individual, team, and branch performance. After Xerox Corporation, I spent another 2 years gaining knowledge and experiences in the marketing department

at RF Monolithics, Inc. creating and updating the marketing manual and materials for their RFM<sup>®</sup> wireless components. Then, I decided to pursue graduate studies in which I also gained over 10 years of skills in teaching undergraduates at 2 state universities by training computer education and communications theories as well as various computer applications like Microsoft<sup>®</sup> Windows<sup>®</sup> operating system software (Versions 1997, 2000, 2003, XP, & 2007), Microsoft Office<sup>®</sup> system products (Versions 1997, 2000, 2003, XP, & 2007), and Adobe<sup>®</sup> Photoshop<sup>®</sup> graphic software (Versions 6.0, 7.0, CS, CS2, & CS3).

This dissertation includes both qualitative and quantitative components. It expands on several small classroom studies where I also used grounded research, ethnography, and collaborative techniques:

- A pilot study in 2003 at the same HVAC business that I used in this study. It met the requirements of a classroom assignment for an educational research (EDER) course at UNT (University of North Texas). (See Appendix A for the final report.)
- Two studies as part of classroom assignments in anthropology (ANTH) courses at UNT. One of these assignments included research at the same HVAC business in 2004. (See Appendix B for the final report.)

In July 2000, I needed service on a furnace at my home. Having had previous experience on servicing Xerox copier and fax machines, I easily fixed everything myself except the burned-out fan motor. When I contacted the HVAC business to discuss a replacement part, I talked directly with the president/co-owner. When he learned that I

had received a master's degree in computer education and cognitive systems; I studied at that time for my doctorate in applied technology, training and development; and I used applications for the Internet and streaming video, we began a series of discussions regarding his use of computers in his business. The president/co-owner seemed impressed with my previous experience as an expert with Xerox Corporation where I helped field technicians diagnose and repair complicated machine problems as well as trained them on various product lines. Overall, the president/co-owner supplied the needed fan motor while I gained an intriguing business contact.

In September 2002 (about 2 years after the motor problem), I used the same HVAC business to replace my HVAC system due to its 25 years of built-up rust and corrosion. Because we didn't want the system to fail during a crisis or inclement weather, my husband and I decided to update the system at a convenient time, before it failed, and while the weather cooperated. As we huddled in a warm house the next winter, we felt glad that our family didn't have to worry about the furnace going out of service due to old parts. After we compared our electricity and heating bills to prior years, it seemed obvious that our decision resulted in a money-saving replacement, too, due to the more efficient system.

After the HVAC system replacement, I asked that same HVAC business if they would let me do a study on their training philosophy, concepts and processes. After discussing the study with my major professor, she suggested that I also take another qualitative course (EDER 6285: Qualitative Data Analysis) to refresh/reinforce my

qualitative analysis skills. In conjunction with that course, I did my first pilot study on that HVAC business during the spring semester of 2003.

In the spring semester of 2004, I took an anthropology course (ANTH 5910: Language and Culture) and used that same HVAC business to gather information regarding their communications and culture. During that semester, my instructor (C. Wasson) and I assisted/advised them when they applied for a National Institute of Standards and Technology (NIST) grant for their training processes. Regretfully, the grant application proved unsuccessful because we had based the application on processes rather than an actual hardware design as sought by NIST.

Between June and September 2004, I also assisted that same HVAC business part-time in their offices, to help when one of their office managers went out on medical leave. They installed and used a new business management software tool. This daily exposure gave me additional insight into their overall business operations.

In May 2007, my family used the same HVAC business to repair a condenser problem under the warranty on our new system. My husband initiated the service call and monitored the repair. I personally had no direct contact with their personnel during this service call.

In July 2007, the president/co-owner of the same HVAC business contacted me to discuss his progress on patents and some pending negotiations for a new communication tool. The president/co-owner again expressed an interest in having me do research on their training.

*John Thomason and Metro Environmental*

John Thomason works as the president and co-owner of a HVAC company located in the Dallas/Fort-Worth Metroplex, Metro Environmental Services Company, Inc. (I refer to it as Metro Environmental throughout this dissertation; <http://www.BuyTrane.com>). He and his wife own the HVAC business that I have studied since 2000.

John Thomason obtained certification as a HVAC technician with certification by both the state of Texas and by the North American Technician Excellence® (NATE®, <http://www.natex.org/>) testing and certification. The HVAC industry considers him as an expert and a good businessperson.

As a company owner, John Thomason cannot afford risky investments, but he believes in computer and wireless technology. His business expanded when he set up a Web site (<http://www.BuyTrane.com>) which contained various customer information pages, including an online quote system. His technicians have used wireless technology for years to communicate between each other and back to the home office. He maintains his company on the leading edge of technology applications for his business.

John Thomason has actively worked in the HVAC industry. He sat on the board of the Texas Air Conditioning Contractors Association (TACCA, <http://www.tacca.org/>). He maintains membership in the Air Conditioning Contractors of America® (ACCA®, <http://www.acca.org/>) association, the largest professional association of HVAC contractors in the nation. From 2002-2003, John Thomason sat on the board of the

north Texas chapter of ACCA (<http://www.acca-ntx.org/>) and wrote a monthly newsletter column regarding the use of computers and computer applications in their industry. Also, he has authored articles in other leading industry magazines such as the *Contractor* magazine (<http://contractormag.com/>).

*SightPros, VirTechs, and Metro Environmental*

The HVAC industry considers John Thomason as an innovator in their industry. In the late 1990's, he developed his first concepts and processes for virtual technicians (U.S. Patent No. 6,317,039, 2001) that he referred to as VirTechs through 2007. He then incorporated those concepts and processes into his current SightPros business. I now suggest that the concepts, processes, and businesses he developed actually constitute a business and training system that I call the SightPros-VirTechs system. The system utilizes Internet connections to link multiple, dispatched, field technicians with an in-office expert using various configurations of a portable, wireless audio/visual communication tool to establish best-in-the-industry, two-way synchronous information. He designed the system to make his apprentices billable sooner and to maintain his experienced personnel longer. John Thomason still uses this system with updated technologies and processes to leverage both his workforce and training.

John Thomason tested a portable, wireless audio/visual communication configuration with his technicians in April 2003. Between 2003 and this study, John Thomason (sometimes on his own and sometimes with my help) has completed multiple pilot tests of the SightPros-VirTechs system using various portable, wireless audio/visual



communication configurations. During one pilot test on a communication configuration utilizing laptop computers, Metro Environmental determined that the laptop computers available then would not stand up to the harsh physical conditions and the Texas summer heat at many of their job sites. He later applied for and received another patent (U.S. Patent No. 6,690,273, 2004) for a portable, wireless audio/visual communication device, the SightPros communication tool, which addressed many design issues that we discovered in his initial trials. He also updated his communication configuration to utilize more recent telecommunication standards.

During my pilot studies, I reported that the technicians at Metro Environmental frequently met at the office for group training sessions as needed. Additionally, one-on-one technical training occurred on the jobs sites as situations arose.

Traditionally, Metro Environmental apprentices have traveled with experienced technicians until they have learned the trade. Technicians have taken routine calls independently only after years of training and job-site experiences. On major jobs, everyone has worked in teams. They have used cell phones with the Direct Connect<sup>®</sup> features (Direct Connect operates similar to two-way radios.) and/or telephones to communicate between team members and back to the office.

From my pilot studies, I noted that apprentices learned parts identification, replacement procedures, troubleshooting, and tool use. They learned proper billing procedures and customer management skills. They studied for specialized licenses.

In discussions with John Thomason and in my pilot study observations, I discovered that personnel throughout the HVAC industry have been very fluid in their employment status. The number of personnel and/or technicians required at a company at any time has fluctuated due to employee skills, seasonal requirements and business work loads. This has caused frequent movement of personnel between competing companies. For example, in spring 2003, Metro Environmental had eight technicians; three were apprentices at various stages of learning. The ages of the technicians varied between 22 and 45 years. I ranked the social-class status of the technicians as blue collar and low-to-middle income. All technicians were male. Two participants were Hispanic; the rest were Caucasian. By the spring of 2004, Metro Environmental had four technicians; the one apprentice now had three years of experience. The ages of the technicians varied between 23 and 40 years of age. I still ranked the social-class status of the technicians as still blue collar and low-to-middle income. All technicians were male. All participants were Caucasian.

At various stages, Metro Environmental has utilized various hardware and software configurations in their application of the SightPros-VirTechs system: cell phones; cell phone cameras; personal and/or laptop computers; instant messaging; chat; virtual meetings; Webcams; wearable cameras, network cameras; wireless, streaming audio/visual Internet connections; call management, and inventory software; etc. Throughout, the various hardware and software configurations have incorporated two-way synchronous (real time) information. Metro Environmental has used the

system to link and train dispatched field technicians at a customer location with an expert in the home office and/or a remote expert at another field location.

Metro Environmental operated as the only business using the SightPros-VirTechs system with its leveraged expertise and just-in-time training as defined by their patents. John Thomason has wanted to license the system and/or his SightPros communication tools to other businesses. As part of his plans to market to and to inform potential customers and/or business contacts about the SightPros-VirTechs system and communication tools, John Thomason registered several Web sites beginning in 2000. Moreover, he included information directly related to the VirTechs or SightPros-VirTechs system when he wrote various published articles for several trade publications. He wants to eventually write a book about his company and their successes and/or failures with the process, the training, and the communication tools in the SightPros-VirTechs system.

John Thomason has felt that other companies would sign on once wireless video technologies advanced sufficiently. The HVAC industry in specific and other similar industries have had a significant shortage of skilled labor. John Thomason predicted that he could use the SightPros-VirTechs system to increase the lifetime productivity of his field personnel while lowering the overall cost to his company. He has felt that the system would be well received by other companies in the HVAC industry and by other dispatched service industries if his system proved that it might increase productivity

while maintaining costs. Finally technology improvements have made the system and the communication tools feasible for others to use.

The SightPros-VirTechs system incorporates a unique application of wireless technology that has had little substantial research. It has potential for a significant impact on training associated with dispatched service environments.

#### Significance of the Study

The Bureau of Labor Statistics (2003b) projected that general maintenance and repair workers, electricians, and first-line supervisors/managers of construction trades, mechanics, installers, and repairers would be occupations that would have large numerical increases in the United States workforce between 2000 and 2010 for their long-term on-the-job training category (training lasting more than 12 months). They predicted almost 2 million people would be required for both replacement needs and growth for just the installation, maintenance, and repair category - a 12.5% increase. From discussions with John Thomason, I realized that wireless video technology will force changes in current instructional practice for these industries. The potential instructional innovations and opportunities suggested by that interaction initially inspired me to this study.

Visual information remains a key component of the communications interface between the expert and the technicians with the SightPros-VirTechs system. According to Gergle, Kraut, and Fussell (2006) regarding collaborative work:

Many researchers hypothesize that visual information plays a central role in coordinating collaborative work. . . . Recently, researchers have shifted their focus to the use of video and visual information in support of dynamic information about the tasks, objects and events that serve collaboration in a visual environment (Kraut et al., 2003; Monk & Watts, 2000; Nardi et al., 1993; Whittaker et al., 1993; Whittaker & O'Conaill, 1997). This approach has identified a range of conditions under which visual information is valuable. For example, viewing a partner's actions facilitates monitoring of comprehension and enables efficient object reference (Daly-Jones et al., 1998); changing the amount of available visual information impacts information gathering and recovery from ambiguous help requests (Karsenty, 1999); and varying the field of view a remote helper has of a co-worker's environment influences performance and shapes communication patterns in directed physical tasks (Fussell et al., 2003a). (p. 2)

The two pilot studies that I conducted in spring 2003 and spring 2004 at Metro

Environmental revealed potential instructional opportunities and/or concerns:

- Wireless video required expensive devices.
- Wireless Webcams saved travel time and payroll expenses. For unanticipated problems, the apprentices used them to communicate with their remote expert. This saved the expert travel time. It gave the apprentice hands-on experience.
- HVAC technicians worked in a harsh environment but offset it with a strong sense of teamwork and camaraderie. A congenial atmosphere encouraged a strong community of practice for the technicians. Wireless technology could impact these interrelationships.
- For some situations, privacy remained an issue. Using technology, management could monitor technicians closely. This proved both a benefit

and a concern. In the pilot studies, the technicians and sales personnel typically sought permission from customers before using video technology in a customer location.

- An experienced technician who developed a physical disability such as a back or knee problem might still provide value by becoming a remote expert. Using the SightPros-VirTechs system and SightPros communication tool, a technician who became physically disabled due to work injuries, health problems, and/or age might sit in an office location or even in their own homes and direct less experienced technicians. Therefore, their expertise remained valuable to them since they no longer had to negotiate the physical barriers of customer locations.
- Job security could be at risk. After my first pilot study, management fired one technician for cause when the technician misused his wireless telephone to make personal long-distance calls. Consequently, management lost trust that the technician would respect an even more expensive personal computer with Internet capabilities.
- Language barriers and other communication difficulties could create a problem. After my first pilot study, management dismissed one installation assistant because he spoke and/or understood only a few English words. This occurred after they fired their only bilingual technician for cause. Metro Environmental had no other personnel left who could negotiate successfully

the language barrier. Moreover, they felt slightly overstaffed for the seasonal workload.

Educators and trainers face a new variety of situations due to wireless technologies. In schools and businesses, they have begun to experience some of the following scenarios:

- "RJC video" (2003) reported on a classroom situation that created an international controversy when the situation reached a public forum. A student captured an instructor's picture as the instructor berated a foreign student and then captured another image of the instructor tearing up the foreign student's paperwork. To make matters worse, the picture taker captured the pictures via a camera phone then posted them on the Internet for everyone to see.
- During the spring of 2003, a local classroom teacher used live-streaming video to bring field relevancy to the classroom. The teacher discussed job skills with a class and other peers while communicating via live video directly with a field HVAC technician.
- Permission to use live and/or captured video in research presents additional challenges since the technicians, management, business owners, customers, technical instructors, and/or experts might perceive conflicting values and/or risks. For instance, workers might feel either secure or intimidated if managers,

peers and/or customers assist and/or monitor them with professional security cams on a regular basis.

Wireless technologies have expanded rapidly. Security network cameras, Webcams, and cell phone cameras have invaded the privacy of homes and businesses throughout society. This has impacted teaching and learning. Due to my research study, I can now discuss the new SightPros-VirTechs system and the SightPros communication tool in field situations with its faster video connections and flexible viewing angles and zoom. I hope that the information I present in this dissertation will help to inform workers, instructors, businesses, and customers of new instructional recommendations as wireless technology and the Information Age continue to drive these and many other instructional changes.

This study suggests significant findings for other areas. Frequently, various news organizations have reported on families going without heat or power for weeks at a time due to weather related instances such as freezes, heat spells, tornadoes, flooding, and major fires. In times of crisis, contractors often have traveled from across the country to assist the victims because of a shortage of local qualified technicians. Coordinating job site needs with visiting in-field technicians always has challenged emergency personnel.

One online article discussed the crisis conditions and the impact of severe weather in the Carolinas in December 2002:



(In) the race to restore power to nearly 1.8 million people in the ice-coated Carolinas . . . repair workers who have poured in from across the South were working against the clock and the ice. . . . Frustrated utilities . . . acknowledged most customers won't have power back until . . . exactly a week after the ice storm began. . . . Ten thousand utility workers . . . Jean Voss hung yards of felt to isolate her living room . . . and spent Thursday night huddled with her elderly parents under a pile of blankets in front of a set of gas logs. (Associated Press, 2002, ¶s 1-3, 5, 7, & 14)

In another similar online news report that discussed two recent winters in

Kansas, Lucy, Harrington, and Fischbach (2002), noted:

Electricians help restore power to 387,000 homes. . . . 300 out-of-state utility crews from 12 different states helped. . . . The utility crews worked 16-hour shifts. Nearly 150,000 people still were without power 48 hours after the start of the ice storm. As of . . . Feb. 5, 90% of . . . customers were back on line. Restoration efforts . . . [will] continue through . . . Feb. 8. . . . About 350,000 customers were without electricity during the worst part. (Fast Facts section, ¶s 1-4 & 6)

The ice storm of 1996 . . . also left many homes without power for several days . . . the entire storm recovery effort cost \$5.8 million in 1996, while the cleanup for this year's storm could cost the city from \$15 million to \$20 million. (Backup Power section, ¶s 3 & 5)

420,000 homes (were) without power in Kansas City . . . the worst ice storm in Kansas City's history. (Powering Homes section, ¶s 1-2 & 3)

In the first few days of the ice storm, freezing rain coated the streets of Kansas City, transformers blew and entire neighborhoods turned pitch black. . . . By Feb. 5, a full week after the ice-storm started, tens of thousands of area homes still remained without power . . . desperate attempts to restore power led to too much crossover work between contractors and utility workers. Both utility people and utility subcontractors are performing work that they normally don't do. (On the Scene section, ¶s 4 & 7)

Thomason (1999) noted that skilled labor ranked as the most pressing issue that has limited growth for the HVAC industry. The Bureau of Labor Statistics, U. S.

Department of Labor (2003a) noted that: "heating, air-conditioning, and refrigeration

mechanics and installers held about 243,000 jobs in 2000; approximately one third of these worked for cooling and heating contractors." (Employment section, ¶1) The report noted expectations for skilled labor in the HVAC industry to increase 21-35% which seemed faster than the average for all occupations through the year 2010 (Job Outlook section). The Construction Labor Research Council (1998) noted that the industry has had a shortage of skilled labor and has had difficulty retaining the skilled labor already in the industry.

Employees in the HVAC industry typically get trained and some get licensed. The Bureau of Labor Statistics (2003a) noted the need for training and licensing for the HVAC technicians:

Because of the increasing sophistication of heating, air-conditioning, and refrigeration systems, employers prefer to hire those with technical school or apprenticeship training. A sizable number of mechanics and installers, however, still learn the trade informally on the job. (Training, Other Qualifications, and Advancement section, ¶ 1)

Formal apprenticeship programs normally last 3 to 5 years and combines on-the-job training with classroom instruction. (Training, Other Qualifications, and Advancement section, ¶ 3)

Those who acquire their skills on the job usually begin by assisting experienced technicians. They may begin performing simple tasks such as carrying materials, insulating refrigerant lines, or cleaning furnaces. In time, they move on to more difficult tasks, such as cutting and soldering pipes and sheet metal and checking electrical and electronic circuit. (Training, Other Qualifications, and Advancement section, ¶ 4)

All technicians who purchase or work with refrigerants must be certified in their proper handling. To become certified to purchase and handle refrigerants, technicians must pass a written examination specific to the type of work in which they specialize. The three possible areas of certification are: Type I—servicing small appliances, Type II—high pressure refrigerants, and Type III—low pressure refrigerants. Exams are administered by organizations approved by the U.S. Environmental

Protection Agency, such as trade schools, unions, contractor associations, or building groups. (Training, Other Qualifications, and Advancement section, ¶ 6)

The industry recently announced the adoption of one standard for certification of experienced technicians: the Air-Conditioning Excellence program, which is offered through North American Technician Excellence, Inc. (NATE). (Training, Other Qualifications, and Advancement section, ¶ 7)

Working conditions for the HVAC industry demands friendly, strong, able-bodied technicians willing to work long hours. The Bureau of Labor Statistics (2003a) noted that technicians deal directly with aggravated customers. The Bureau of Labor Statistics also noted that technicians must be in good enough physical condition to lift and move heavy equipment. Their workspaces involve awkward, cramped, and/or high places. Hazards to the technicians include electrical shock (from the high voltage lines), burns (from welding and furnaces), muscle strains, and other injuries (from handling heavy equipment). They need safety equipment because handling refrigerants can cause skin damage, frostbite, inhalation hazards, or blindness. The Bureau of Labor Statistics also noted that most of the current laborers in HVAC work over 40 hour weeks. They often work in the evening or on weekends and/or remain on call during those time frames.

Even when they remain physically fit, skilled workers don't always continue working in the field. The Bureau of Labor Statistics (2003a) noted:

Advancement usually takes the form of higher wages. Some technicians, however, may advance to positions as supervisor or service manager. Others may move into areas such as sales and marketing. Still others may become building superintendents, cost estimators, or, with the necessary certification, teachers. Those with sufficient money and managerial skill

can open their own contracting business. (Training, Other Qualifications, and Advancement section, ¶ 8)

Approximately 1 of every 5 mechanics and installers was self-employed. (Employment, ¶ 1)

The HVAC industry needs more skilled laborers. The shortage occurs partially from the current methods used for training apprentices. Site training takes approximately one expert for every two or three apprentices (Construction Labor Research Council, 2002). Training requires extensive time expenditures since apprentices usually take 3-5 years to complete it. Both the Construction Cost Effectiveness Task Force (1997) and the Construction Labor Research Council (1998) have reported labor shortages already. The Bureau of Labor Statistics (2003b, Labor Force section, ¶1) projected the civilian labor force to increase by 12 percent over the period 2000-10.

The labor shortages suggest several concerns that may impact our future. How much longer will customers have to wait if service providers cannot hire enough skilled/trained technicians to service equipment? How much higher will the costs rise due to increased competition for the already understaffed service industries? Can the industry afford to wait 3-5 years to certify apprentices as fully-qualified service technicians?

Wireless technology offers a potential solution to improve the training ratio and shorten apprenticeship training. John Thomason answers the national labor shortage in skilled HVAC service technicians with the SightPros-VirTechs system. He hopes to use it

to make his apprentices more productive and billable at an earlier point in their career. He also hopes to maintain and advance his older experienced personnel who often leave the field in their late thirties and early forties due to the physical demands in the HVAC service environment. John Thomason has remained open to any study of his SightPros-VirTechs system to help document the potential benefits or pitfalls from an independent perspective. He believes that many of the other HVAC businesses will also benefit from his SightPros-VirTechs system. John Thomason feels that the HVAC industry and other industries will find it very important that we document the processes and then publish the findings.

The HVAC industry competes with many dispatched service environments for the same personnel. If the SightPros-VirTechs system can provide a feasible alternative to the skilled labor shortage for John Thomason and the HVAC industry, the processes might also help to alleviate the shortages for many other dispatched service environments like appliance repair, utilities, etc.

Dispatched service businesses have an ongoing demand to get homes and offices functioning properly again. They need to quickly dispatch service technicians to areas, especially in times of crisis. The ability to communicate wirelessly on battery-powered, portable, wireless audio/visual communication tools back to a central command post and connect with an expert on an as-needed basis with visual information as a supplement to normal audio and textual information may prove to be an extremely valuable resource.

Many technicians start their training in career and technical education (CTE) courses (previously known as vocational education). Educators and instructors need to quickly identify and update instructional requirements as new computer and/or wireless technologies launch. Recommendations stemming from leading edge innovators like Metro Environmental potentially improve instructional practice.

#### Purpose of the Study

The purpose of my study has been to investigate the SightPros-VirTechs system and to analyze its business impact. The system addresses training and/or assistance via wireless Internet video from job site apprentices and/or technicians to a remote expert. To investigate and analyze the system, I have explored the following research questions:

- Can the SightPros-VirTechs system as used by Metro Environmental demonstrate that its concepts of just-in-time training and leveraged expertise effectively expand the capabilities of their HVAC workforce?
- Can the SightPros-VirTechs system expand the workforce capabilities in other HVAC companies and/or other service-dispatched industries to positively impact the skilled labor shortages?
- Does the SightPros-VirTechs system generate additional impacts that might influence adoption of the system in other companies or industries?

As part of my investigation of the SightPros-VirTechs system, I have studied the personnel and environment surrounding Metro Environmental. I have documented the business context with both narrative description and statistical data.

As part of my analysis of the business impact, I have compared an apprentice technician who uses the SightPros-VirTechs system frequently with other technicians who use the system occasionally. Also, I have compared this study with my two pilot studies. I have analyzed the business context to determine the impact from the system and its concepts to Metro Environmental and potentially to other businesses and industries.

### Guiding Research Questions

To help me investigate and analyze the SightPros-VirTechs system as used by Metro Environmental, I also have developed some detailed research questions as an initial, overall guide. My guiding research questions have included:

1. What constitutes training in the SightPros-VirTechs system?
  - a. How does the SightPros-VirTechs system incorporate just-in-time training?
  - b. How does the SightPros-VirTechs system incorporate leveraged expertise?
  - c. What hardware does SightPros-VirTechs system require or suggest?
  - d. What software does SightPros-VirTechs system require or suggest?
  - e. What network connections does SightPros-VirTechs system require or suggest?
2. How does Metro Environmental use the SightPros-VirTechs system to train their personnel?

- a. What training needs has Metro Environmental identified?
  - b. Who uses the Metro Environmental training and in what capacity?
  - c. What target population(s) does John Thomason suggest for the SightPros-VirTechs system?
  - d. What other training does Metro Environmental use to supplement the SightPros-VirTechs system?
  - e. What training pages has Metro Environmental incorporated on their Web site and who has access to them?
  - f. What major manufacturers, if any, provide input or links through the Metro Environmental Web site training pages?
  - g. Does Metro Environmental have any statistical data regarding the Metro Environmental training?
  - h. What computer audio/visual data does Metro Environmental have available regarding their training?
  - i. How does the SightPros-VirTechs system impact the Metro Environmental hiring practices?
3. How do the training practices in the SightPros-VirTechs system differ from traditional HVAC training practices?
    - a. What system did Metro Environmental use prior to the SightPros-VirTechs system?



- b. How do the training practices in the SightPros-VirTechs system compare to how other companies train?
  - c. How do the training practices in the SightPros-VirTechs system compare to expert systems that other companies offer?
  - d. How do the timeframes for training compare between the SightPros-VirTechs system and other types of industry training?
  - e. How do on-site timeframes compare for training with the SightPros-VirTechs system and traditionally trained service technicians?
4. How do people perceive training with the SightPros-VirTechs system?
- a. How do Metro Environmental personnel (co-owners, officers, managers, staff, and technicians) perceive training within the SightPros-VirTechs system?
  - b. How do Metro Environmental customers and/or contacts perceive training within the SightPros-VirTechs system?
  - c. How does the HVAC industry report perception of comparable training by others?
  - d. How do other industries report perception of comparable training?
5. How does wireless training impact the business culture, the personal culture and/or communities of practice (Lave & Wenger, 1991) at Metro Environmental?

- a. What did the culture look like before Metro Environmental launched the SightPros-VirTechs system?
  - b. What adaptations, if any, seem evident in the culture as the SightPros-VirTechs system becomes fully implemented?
  - c. What resistance to change if any appeared within Metro Environmental and within the HVAC industry?
  - d. Who acted as the change agents within Metro Environmental and within the HVAC industry?
  - e. How does the current technician turnover at Metro Environmental compare to previous turnover?
6. What opportunities exist when companies use wireless technologies in training?
- a. What can companies use to measure training successes: call duration, call backs, satisfaction surveys, skill levels, etc.?
  - b. Do the training practices in the SightPros-VirTechs system yield practical knowledge that the technicians retain?
  - c. Can wireless technology shorten the current 3-5 years apprenticeships?
  - d. Do the training practices in the SightPros-VirTechs system yield leveraged expertise?

- e. Can wireless technology improve the current training ratio of one journeyman, master workman, or expert to two apprentices or assistants?
  - f. Can the training practices in the SightPros-VirTechs system successfully provide just-in-time training?
  - g. Can wireless technology enhance learning by delivering lessons wherever and whenever needed?
  - h. What opportunities exist for underutilized employees such as recent graduates, older populations, minority populations, females, and physically challenged individuals?
7. What obstacles exist when companies use wireless technologies in training?
- a. What competition exists for training with wireless technologies like the SightPros-VirTechs system?
  - b. What management issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - c. What customer issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - d. What employee issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - e. What personnel issues (unions, government, etc.) arise for training with wireless technologies like the SightPros-VirTechs system?

- f. What patent/copyright issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - g. What issues in the HVAC industry arise for training with wireless technologies like the SightPros-VirTechs system?
  - h. What privacy issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - i. What ethical issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - j. What, if any, insurance issues arise for training with wireless technologies like the SightPros-VirTechs system?
  - k. Do the training practices in the SightPros-VirTechs system fit within the licensing requirements for the industry?
  - l. What, if any, legal issues arise for training with wireless technologies like the SightPros-VirTechs system?
8. How may wireless technology impact instructional requirements for apprentices?

#### Delimitations

I have limited this study to Metro Environmental in Lewisville, Texas. I chose this group because they are the only company using the SightPros-VirTechs system and the SightPros communication tools. Moreover, one of the co-owners, John Thomason, holds the only patents for it. Several times since 2003, John Thomason has negotiated with

various investors for the general use of his SightPros-VirTechs system and mass production of new communication tools. However, those negotiations have not impacted this study. Nonetheless, this study may provide additional input for any ongoing negotiations.

I have limited this study to the specific employees, customers, and professional associates, vendors, or other contacts who expressed willingness to participate in this study. I required each person who participated in this study to complete a consent form prior to participation. John Thomason and I gave each participant the opportunity to withdraw consent at any point in the study without repercussions.

I have limited this study to the hardware and software currently available to the SightPros-VirTechs system. The communications industry has forecasted the launch for the next technological generation of wireless communications in this region to occur in April 2008 (just after the planned completion of this study). I expect that the next generation will further enhance the speed and reliability of remote wireless communications.

I have limited this study to the time frames available to me and also to those available to Metro Environmental because of the cyclical nature of their work. According to J. A. Thomason (personal communications, November 12, 2002), the busiest schedule for the technicians usually occurs from April through June in preparation for the hot summers in Texas. Metro Environmental typically hires new service technicians during the winter so that his company can meet the demands of the spring rush. Limited

availability of their personnel and/or training occurs during specific timeframes, particularly the spring rush, due to their varying work loads and schedules.

Clark (1984, 1993), in reviewing numerous studies over several decades, noted that previous studies by many researchers have shown that the training media (such as books, chalkboards, films, computers, etc.) doesn't seem to impact the effectiveness of the training. Therefore, even though wireless Internet technologies were new and exciting training media, I did not design this study as an analysis of the effectiveness of this media. However, the media and training practices at Metro Environmental utilize the concept that I call just-in-time training as well as the concept that John Thomason calls leveraged expertise. In this dissertation, I simply examine and describe the impact of those two concepts in the SightPros-VirTechs system.

#### Definition of Terms

The following definitions specify my intent for some terms that I use throughout this dissertation. I present them here to clarify or suggest my concept of the term or definition, not specifically to limit myself to that definition.

*ACCA* (Air Conditioning Contractors of America, <http://www.acca.org/>): The largest association of HVAC contractors in the nation.

*Adaptive*: "Able to . . . change so that one's behavior, attitudes, etc. will conform to new or changed circumstances" (Webster's New World Dictionary, 1957, p. 16).

*Cognitive psychology*: "The study of how people perceive, learn, remember, and think about information" (Sternberg, 1996, p. 499).

*Cognitive maps (mental imagery):* "Mental representation of the physical environment, particularly in regard to spatial relationships among objects in the environment" (Sternberg, 1996, p. 499).

*Collaborative:* "Tending to . . . work together, especially in reference to literary, artistic, or scientific work" (Webster's New World Dictionary, 1957, p. 286). In terms of research work, the researcher and the participants work together to achieve desired results rather than the researcher simply studying the participants. In terms of the service industry, the service technician works with a helper/expert to achieve desired results rather than the technician simply working with past knowledge and/or documentation.

*Culture:* "An integrated system of shared ideas, behavior, and artifacts characteristic of a group" (Jordan, 1999, p. 19). Most organizations have a web of interacting cultures. Ideal culture describes the way things should happen; Real culture describes the way things actually happen. Participants often divulge ideal rather than real behavior during an interview. Researchers usually discover real behavior during participant observation (Jordan, 1995).

*Diachronic:* Looking at how things came to be or can become (Kemmis & McTaggart, 2000).

*Ethnographic decision model (EDM):* "Qualitative, causal analyses that predict behavioral choices under specific circumstances. Visually they appear as decision trees,

flowcharts, and nested if-then statements that link criteria to behavior of interest" (Denzin & Lincoln, 1994, p. 287).

*Grounding*: The establishment of common ground. Sources of common ground include common group membership, linguistic co-presence, and physical co-presence (Clark and Marshall, 1981). Conversational grounding refers to the use of common ground as a starting point and then acceptance of new information through verification of understanding by all parties in a conversation. Shared visual space can enhance the conversational grounding process (Fussell, Setlock, & Kraut, 2003).

*Grounded theory*: A qualitative method used to generate theory and to ground that theory in actual data. It presents interpretation based on systematically carried out inquiry (Strauss & Corbin, 1998).

*Holistic view*: Looking at all factors inside and outside of a group that might affect a group under study (Jordan, 1999).

*HVAC*: Heating, ventilation, and air conditioning.

*Iterative*: "Repetitious; repeating" (Webster's New World Dictionary, 1957, p.779).

*Just-in-time information presentation*: Presenting instructional information when a specific learning need arises. This can be general information before performing a task or specific task information while the learner performs a task (Paas, Gerven & Tabbers, 2005, p. 348).



*Leveraged expertise:* An ability to extend the experience and knowledge of an individual to multiples of individuals in real-time (Thomason, 2002).

*Mental maps/mental models:* "An internal representations of information . . . or . . . "knowledge representation" (Sternberg, 1996, p.504). Visually, these show similarities among items (concepts).

*Metacognition:* "The ability of an individual to think about and to consider carefully the person's own processes of thought, particularly in regard to trying to strengthen cognitive abilities" (Sternberg, 1996, p. 504).

*NATE* (North American Technician Excellence, <http://www.natex.org/>): An agency that certifies the qualifications of HVAC technicians.

*North Texas ACCA* (<http://www.acca-ntx.org/>): Local chapter of ACCA which includes the Dallas/Fort-Worth Metroplex members.

*Personnel:* Any owner, manager, and other employee who works at a company.

*Real-time:* Observing an event as it occurs and/or communicating with someone without delay (Thomason, 2002).

*Reflective reporting:* "In a qualitative research report, a process in which the researcher relies primarily on intuition and judgment in order to portray or evaluate the phenomena being studied" (Gall, Borg, Gall, 1996, p. 768).

*Reflexive:* "In qualitative research, the researcher focuses on himself or herself as a constructor and interpreter of the social reality being studied" (Gall, Borg, Gall, 1996, p. 768). A participatory action researcher sees the relationship between the objective

(externally given) and the subjective (internally understood and interpreted) environments. Changing objective conditions changes the interpretation of a situation which then changes how people act. When people change their actions, they get understood and interpreted differently by others so then the others react differently. A "dynamic process of reflection and self-reflection gives human action in history its dynamic, fluid and reflexive character" (Kemmis & McTaggart, 2000, p. 578).

*Schemata*: Cognitive simplifications/organizations of concepts (Sternberg, 1996, p. 504), to help humans make sense of complex information.

*SightPros-VirTechs system*: A business and training system using patented (U.S. Patent No. 6,317,039, 2001 and U.S. Patent No. 6,690,273, 2004) concepts, processes, and portable, wireless audio/visual communication tools and the related Web site. The system essentially uses wireless Internet audio/video connections to relay two-way synchronous information that simultaneously links one or more field apprentices and/or service technicians (John Thomason's example of the processes showed 6 technicians) with one or more remote experts on an as needed basis for training and/or assistance.

*Spring rush*: April through June when the number of service calls rise dramatically in preparation for the hot summer (J. Thomason personal communication, April 21, 2003).

*Structural analysis*: "The process of examining qualitative data to identify patterns that are inherent features of discourse, text, events, or other phenomena" (Gall, Borg, Gall, 1996, p. 771).

*Synchronic*: Looking at how things are (Kemmis and McTaggart, 2000).

*Synchronous*: "Happening at the same time; occurring together" (Webster's New World Dictionary, 1957, p. 1478).

*TACCA* (Texas Air Conditioning Contractors Association, <http://www.tacca.org/>):  
A state division of ACCA.

*Taxonomy*: "The science of classification; laws and principles covering the classifying of objects" (Webster's New World Dictionary, 1957, p. 1494). Visually, they can look like organization charts.

*Thick descriptions*: Qualitative descriptions giving many details so the reader gets a better understanding of events, rituals, or customs (Geertz, C., 1973; Schwandt, 2001, p. 255). Schwandt (2001) further defines it as: "to thickly describe social action is actually to begin to interpret it by recording the circumstances, meanings, intentions, strategies, motivations, and so on that characterize a particular episode. It is this interpretive characteristic of description rather than detail per se that makes it thick" (p255).

*Triangulation*: "Used in all types of qualitative traditions, refers to the process of using multiple data collection methods, data sources, analysts, or theories to check the validity of the findings" (Leedy, 1997).

*Youth apprenticeships*: Non-traditional apprenticeships that link high school education, postsecondary education, and work experience for students as young as 16 years of age (Howard, 1996).

Workforce: The labor pool in a single company or industry. All personnel available for work (<http://en.wikipedia.org/wiki/Workforce>, 2007). Although this term generally implies manual laborers and excludes the employers or management, I use this term to incorporate all Metro Environmental personnel including the owners and management since they are also a vital part of the work teams.

### Summary

Wireless computer technologies might dramatically change on-the-job technical assistance and apprenticeship training. The purpose of my study has been to investigate the SightPros-VirTechs system and to analyze its business impact. The system addresses training and/or assistance via wireless Internet video from job site apprentices and/or technicians to a remote expert. This dissertation investigates the system as it applies to HVAC technicians at Metro Environmental and potentially to other companies or industries.

In this dissertation, I present the introduction to my study in Chapter 1; a review of related literature in Chapter 2; an explanation of my methods and procedures in Chapter 3; a description of my findings from the study in Chapter 4; and my discussions, conclusions, and recommendations in Chapter 5. I include multiple appendices that provide additional relevant and detailed information regarding the study. I finalize this dissertation with my bibliography.

In various chapters, I compare this study with my earlier pilot studies at Metro Environmental (see Appendix A and Appendix B) and with my past work experiences.

From the collected data, I analyze whether the SightPros-VirTechs system at Metro Environmental can demonstrate that their just-in-time training and leveraged expertise concepts effectively expand the capabilities of their workforce. I explore how the concepts may have a positive impact on the skilled labor shortage throughout the HVAC industry and/or all service dispatched industries. I discuss additional impacts that might influence adoption elsewhere. I list my recommendations for successfully using wireless Internet media in other teaching and/or training environments.

In final summation of this chapter, I started with an introduction to my dissertation and this chapter. Next, I presented the relevant contextual background for this study. Afterwards, I discussed the significance of the study. Then, I described the purpose of this study which included my major research questions. Subsequently, I followed that with a list of guiding research questions that I have used to explore the major research questions in more detail. After that I stated the delimitations of this study and defined certain terms related to this study. Finally, I finished the chapter with a brief summary.

## CHAPTER 2

### REVIEW OF THE RELATED LITERATURE

#### Chapter Introduction

I recently completed a study at Metro Environmental, a HVAC (heating, ventilation, and air conditioning) company. I researched the impact of training technicians using their SightPros-VirTechs system for remote, wireless, Internet video assistance.

In this chapter, I present important literature related to my study. First, I review the purpose of this study which includes my major research questions. Then, I offer a general introduction to the literature topics. Next, I provide a synopsis of each relevant topic. Finally, I finish the chapter with a general review of the related literature and how that literature impacts this study.

#### Purpose of the Study

The purpose of my study has been to investigate the SightPros-VirTechs system and to analyze its business impact. The system addresses training and/or assistance via wireless Internet video from job site apprentices and/or technicians to a remote expert. To investigate and analyze the system, I have explored the following research questions:

- Can the SightPros-VirTechs system as used by Metro Environmental demonstrate that its concepts of just-in-time training and leveraged expertise effectively expand the capabilities of their HVAC workforce?
- Can the SightPros-VirTechs system expand the workforce capabilities in other HVAC companies and/or other service-dispatched industries to positively impact the skilled labor shortages?
- Does the SightPros-VirTechs system generate additional impacts that might influence adoption of the system in other companies or industries?

As part of my investigation of the SightPros-VirTechs system, I have studied the personnel and environment surrounding Metro Environmental. I have documented the business context with both narrative description and statistical data.

As part of my analysis of the business impact, I have compared an apprentice technician who uses the SightPros-VirTechs system frequently with other technicians who use the system occasionally. Also, I have compared this study with my two pilot studies. I have analyzed the business context to determine the impact from the system and its concepts to Metro Environmental and potentially to other businesses and industries.

#### Introduction to the Relevant Literature

I considered both quantitative methods and qualitative methods for my study of Metro Environmental. From my statistics courses, I knew that the type of research design that I selected for my study impacted the recommended depth and breadth of

the literature search, the specific procedures used for the study, and the way that I reported it. Therefore, I investigated various research models for specific design recommendations relevant to this study. I present details of the research design investigation in the next chapter. For this chapter, I simply want to note that I selected both quantitative and qualitative methods but with major emphasis on the qualitative methodology.

Due to the number of relevant areas to this study and the emphasis on the qualitative methodologies, I chose to concentrate on the breadth of the research rather than the depth of the research since the following qualitative authors recommended breadth. Strauss and Corbin (1998) noted that for grounded research, the research should be driven by concepts that actually emerge while doing field research rather than from exhaustive research prior to field entry since the researcher could not possibly predetermine which concepts would actually emerge as salient. In discussing applied ethnography, Chambers (2000) noted that little prior knowledge actually yielded more productive data. Consequently, for my review of the related literature, I studied many relevant areas with a broad stroke rather than concentrating on one or two critical areas and researching them exhaustively. Yin (1993) noted that researchers used case study research appropriately when they studied a phenomenon from a broader perspective.

The most significant and relevant area of my research on training apprentices with the SightPros-VirTechs system included the literature about remote collaboration on physical tasks. Ou, Oh, Yang, and Fussell (2005) noted, "Because the expertise



required for a task may not always be present at the worksite, there is growing demand for technologies to support remote collaboration on physical tasks" (p. 231). Since 1996, multiple researchers at Carnegie Mellon University studied remote helpers instructing workers in building and/or repair of various complex devices (bicycles, on-screen puzzles, circuit breadboards, Lego arrangements, etc.) using shared visual information and collaborative communications. The research in this area stirred my interest in computer-supported collaborative work (CSCW) and the conversational patterns noted during those collaborative physical tasks. I summarize many of those studies and several similar studies in this chapter.

Another area of interest related to the SightPros-VirTechs system included findings from miscellaneous studies on experts/masters versus novices/apprentices. For instance, I wondered what behavior and/or speech patterns might differentiate experts/masters from novices/apprentices on various tasks. The SightPros-VirTechs system has relied on the transfer of knowledge between experts and apprentices. I wondered what key factors might influence this knowledge transfer.

To fully understand the significance of any information gathered at Metro Environmental or recommendations developed from that data, I looked for any historical analysis of the HVAC industry. That data helped me understand the impact of the SightPros-VirTechs system in the HVAC businesses as well as in other service industries.

To determine if the studies on remote collaboration on physical tasks could help with the design of a more successful training scenario for the SightPros-VirTechs system, I researched job training in general and apprenticeship training in specific. Additionally, I reviewed significant finding from distance learning using the Internet.

Due to my extensive training and educational background, I knew that adult learning had some unique characteristics that differentiated it from learning by children. I reviewed the literature on several factors of specific interest in adult learning. I hoped to discover additional areas of opportunity in or risk to this study with a broad understanding of the literature in those areas.

My past experience included training in a corporate environment and teaching in a university environment. I wondered if there were other considerations directly related to training in a small-business environment such as Metro Environmental. For instance, would I find unique characteristics that I would not find in a large corporation? Due to the potential collaborative nature of the Metro Environmental study, I also hoped to suggest realistic improvements to their training. Therefore, I reviewed the literature on training in a small-business environment.

Finally for my literature research in the area of training, I reviewed studies on silent curriculum in both education and training. I looked for the potential impact of both explicit and implicit curriculum on achieving successful instructional outcomes.

I wondered how a small business like Metro Environmental might improve management of their knowledge base. I briefly reviewed knowledge management literature to help with my overall understanding of areas to observe or recommend.

Several additional areas of my literature research related to anticipated changes in the Metro Environmental culture with the implementation of the SightPros-VirTechs system. To identify changes at Metro Environmental, I needed to observe the current work culture and compare it to the past culture that I found there and to the overall HVAC industry. General systems theory (Bertalanffy, 1968) suggested that the SightPros-VirTechs system might impact everyone and everything within Metro Environmental - not just the service technicians. Any of the communities of practice (Lave & Wenger, 1991) at Metro Environmental in 2007 could see significant stressors and change.

In the rest of this chapter I present a synopsis of the most relevant findings from my reviews of the current literature in all of those areas. I also explain why I felt that each of those might be relevant to this study.

#### Remote Collaboration on Physical Tasks

Multiple studies since 1996 researched remote collaboration on physical tasks. Literature suggested that Individuals sometimes lost important information in mediated conversations. Bly (2003) noted:

"Talking about things" moves the focus of collaborative activity from conversations that are primarily about concepts and abstractions to conversations in which objects play a central role. Much as gaze, gesture, and body language tell us something about a speaker's meaning in

conversation, visual actions are even more a part of the shared environment when we are talking about objects.

Of particular concern in minimizing the loss of shared context and shared experience . . . is the issue of common 'grounding' or shared knowledge and understanding, perhaps the most important factor in collaboration and, therefore, in mediated conversations. (p. 182)

During my first pilot study at Metro Environmental, I brought a copy of the bicycle study by Kraut, Miller, and Siegel (1996) to the attention of John Thomason, the president/co-owner of Metro Environmental. In subsequent email communications with both Kraut and Fussell in 2003, they both provided links to their articles and other recommended readings. The studies cited in their links looked at various video-mediated communications to determine how to improve the communications to achieve similar results to those achieved in side-by-side communications. I discussed many of these articles with the president/co-owner of Metro Environmental as part of the two pilot studies and as part of this study.

In the first of a series of bicycle studies Kraut et al. (1996) compared the effectiveness of using technology for remote assistance during physical repair of bicycles. The researchers studied multiple instances of an unskilled worker being instructed by an expert as the worker adjusted bicycle settings. The researchers noted difficulties in that participants sometimes did not understand the terminology or instructions and needed clarifications. Results showed quicker and more accurate repairs when they had a remote expert help them. They noted that when the worker and expert utilized video connections, they used more proactive help and less explicit

coordination. They found that "collaboration with a remote expert substantially improves a less skilled person's ability to perform maintenance and repair tasks" (p. 64).

Kraut et al. (1996) also tested several configurations of audio and video connections from head-mounted cameras. The worker's camera typically focused on the work area. They captured poor camera angles and poor close-up views. Delays occurred from video updates when the worker moved frequently. Nonetheless, the expert usually kept track of the worker's actions. Their preliminary findings indicated that media type did not make a difference in the number of tasks completed, the average time per task, or the success of repairs, but the conversations varied relevant to the media. The researchers found that the collaborators changed the descriptions of the physical state of objects and the amount of proactive instruction according to the technology that they used. The collaborators gave fewer descriptions and more proactive training when they had a visual image of the work environment. "Experts used the shared visual space . . . for assessing the worker's readiness to receive help as well as for inferring what help the worker needed. . . . The experts also referred to and pointed to drawings in the repair manual" (p. 64). Nonetheless, the researchers found that collaboration by language alone proved successful and also found that "while collaborators did take advantage of a shared visual space provided by a video camera, the display itself was not sufficient to substitute for real co-presence" (p. 65). They recommended "a camera with a wide field of view, an intelligent camera controller that could keep a predefined object in view, or the expert's control of the camera" (p. 66).

Kraut, Gergle, and Fussell (2002) studied pairs of students (one expert and one helper) as they manipulated colored squares on a computer screen to create a specified pattern. The researchers found that the pairs performed better when they had a shared view of a common work area. With complex tasks, pairs worked more efficiently in shared space. Conversations adapted to the shared visual space - the visual common ground. Delayed visuals degraded the conversations and performance. They found that even a three second delay negated the improvement in active visual space, but did not have much impact for static visual space. For less complex tasks they noted that audio only proved sufficient. They noted that their "stylized tasks" had both positive and negative limitations. They concluded that:

Shared visual space is essential for complex collaborative visual problem solving because it facilitates the ability of the pairs to maintain awareness of the task state, helps them to reduce errors and ambiguities when the environment is visually complex, and facilitates grounding and communication by allowing the use of efficient messages and a method for monitoring comprehension. (p. 40)

Kraut, Fussell, and Siegel (2003) studied a helper and a worker doing bicycle repairs with head mounted video. They used both professional bicycle experts and newly trained "experts" to help various novices worker. They compared side-by-side with head-mounted video and with audio only conditions. They found that visual information helped to maintain task awareness and improved conversational efficiency. They found that for physical tasks workers performed most efficiently with a co-present helper. They found that if the worker had a remote helper to assist with the repairs, the

worker yielded better performance than if the worker worked alone. They felt that with the mediated visuals they may not have captured the most important visual elements and/or only a partial view of the repair scene. The view depended on the worker's head position. Workers had to purposefully manipulate the cameras to bring objects into joint view. They preferred a wide field of view that showed task objects and the overall environment.

Fussell, Setlock, and Kraut (2003), in research with robotic assembly tasks, found significant differences in camera images over audio-only communications but they still were not as good as side-by-side repairs. They stated:

Our results clearly demonstrate the value of shared visual space for collaboration on physical tasks. As in previous studies . . . pairs worked best when they were side-by-side: they performed the task faster, rated their interactions as better and communicated most efficiently. Pairs worked least well in the audio-only condition. . . . A scene-oriented camera showing a wide-angle view of the workspace provided significant benefit over audio-only communications. (pp. 519-20)

Again, the researchers did not recommend head-mounted cameras as those cameras reduced overall effectiveness.

In a study about remote collaboration for recreating on-screen jigsaw puzzle designs, Gergle, Kraut, and Fussell (2004a) also found that shared visual space improved the efficiency of shared communications for both comprehension and actions. They recommended that "for high-level task planning it may be useful to have a wider view of the work area, while for grounding communications it may be more useful to have focused views" (p. 495). They also suggested that "developing ways of providing

awareness of others' views can enable efficient grounding and is crucial to the development of successful applications for remote collaboration on physical tasks" (p. 495).

Ou et al. (2005) studied pairs of students (one expert and one helper) as they manipulated colored squares on a computer screen to create a specified jigsaw pattern. They used an eye-tracking device to determine focus of attention. They used a speech recognition system to study speech patterns. They set a goal to understand when and why helpers changed their gaze to different areas of the screen. They researched this to understand collaboration and for future design of automated video systems for remote collaboration. Their preliminary analysis showed the helpers looked at the pieces bay when describing a piece and at the workspace when describing where the piece should go. They also noted that the helper stayed at the bay longer when the pieces were hard to describe but over time looked there less frequently. They noted that this fit with the communications model for grounding in that the helpers sought visual evidence of understanding unless they felt confidence that the expert understood. Their preliminary findings showed that gaze pattern varied as a function of the instructional phase and that automatic camera switching could work. They suggested that systems that added the ability to point and gesture provided additional value to the collaborations on physical tasks.

Ou, Shi, Wong, Fussell, and Yang (2006) used a breadboard assembly to study focus of attention when a helper assisted two novices that used a multimedia based



system. The workers both had circuit assembly experience and the helper had background knowledge. Workers had to assemble different circuits as quickly and accurately as possible. They used word recognition and worker activity recognition to create predictions for the focus of attention. They created an algorithm where they analyzed and predicted workers focus of attention approximately 80% of the time.

Rangan, Birnholtz, and Balakrishnan (2007) attempted to automate camera movements related to the worker's dominant hand position. They established that the hand location reasonably predicted camera focal point in some situations. However, they cautioned that while full automation of camera control might be possible in theory, manual override remained essential in actual applications due to the "adaptive nature of humans" (p. 1185). Moreover, they cautioned that hand location would be less accurate in situations where multiple simultaneous activities occurred or if activity in one area depended on information from another area.

Wong et al. (2007) studied one expert working with two helpers that did remote physical tasks. They studied two scenarios: one expert assisted two helpers both doing identical tasks and one expert assisted two helpers doing different tasks. They found significant differences in the results. The first scenario proceeded similar to previous studies with one expert and one helper where speech patterns predicted gaze location. However, when the helpers did different tasks, results showed additional confusion in communications, different speech patterns, and competition for the expert's attention since neither helper had the expert's undivided attention.

Zuiderent, Winthereik, and Berg (2003) in the introduction to an article about distributed doctors noted:

In fields as varied as airplane design, banking, and medicine, there is an increasing interest in computer-mediated communication (CMC). Various parts of an airplane may be developed in remote locations and still need to fit the larger design, or a medical specialist may assist an operation carried out in a different location by "virtually being there." The promise of such distributed communication is that it is possible to redesign existing work practices to procedures in which there is no need for the physical co-location of all actors and in which the quality of the product being delivered will be maintained or even improved. (p. 172)

Video has worked to provide critical data even in local situations. Nardi et al. noted that nurses monitored video feeds from surgery to anticipate the instruments and supplies that the surgeon would need which resulted in less conversation.

Since my first pilot study, John Thomason at Metro Environmental has used those research findings that also aligned with his own testing experiences to modify and enhance his original SightPros-VirTechs system and portable, wireless audio/visual communication configurations. He has spoken to investors that envisioned using the SightPros-VirTechs system to wirelessly connect field employees at disaster sites, such as chemical spills, with a retired expert in a remote or even foreign location. The medical field and elsewhere has used streaming video successfully. The SightPros communication tool added the wireless capabilities. Those wireless capabilities have offered streaming video to truly remote field locations. Since our preliminary discussions for this study, Thomason and I have anticipated the incorporation of additional design features into the SightPros-VirTechs system and the SightPros

communication tools as a result of this study and/or as a result of the recent studies on remote collaboration of physical tasks.

#### Expert or Master Technician versus Apprentice or Novice Technician

Dreyfus and Dreyfus (1986) presented a skill levels model. The skill levels flowed along a continuum from novice to expert:

- Novice – Novices needed to gain a broad understanding of a skill. They practiced the skill using learned rules. They had little understanding of specific context differences.
- Advanced Beginner – An advanced beginner had more practice than the novice and began to understand the problems enough to generate a few situational rules.
- Competent – A competent individual had a deeper understanding of the problems, but could become overwhelmed to the point that they could not discern the most important aspects of the problems. They sometimes got into situations where they had to break the “rules” they were taught.
- Proficient – A proficient individual had significant knowledge domain. They solved problems on two levels: intuitive through pattern recognition and deductive through an analytical, speculative strategy.
- Expert – An expert had both depth and breadth in the knowledge domain. Their problem solving skills demonstrated maturity and practice. Their knowledge often appeared highly individual, idiosyncratic, and intuitive. They

got in their zone. Experts at this level might lack awareness of how they solved a problem or could not explain it to others.

Sternberg (1996) suggested that when anyone categorized the skill level of a person that the results would depend on the specific task. Sternberg discussed these differences and how they related to intelligence as follows:

Each of us faces tasks and situations with which we have varying levels of experience, ranging from a completely novel task, with which we have no previous experience, to a completely familiar task, with which we have vast, extensive experience. As a task becomes increasingly familiar, many aspects of the task may become automatic, requiring little conscious effort for determining what step to take next and how to implement that next step. A novel task makes demands on intelligence different from those of a task for which automatic procedures have been developed.

According to the triarchic theory, relatively novel tasks – such as visiting a foreign country, mastering a new subject, or acquiring a foreign language – demand more of a person’s intelligence. On the other hand, a completely unfamiliar task may demand so much of the person as to be overwhelming. (p. 480)

Other researchers suggested other differentiations in the cognitive skills of experts and novices. Taylor (1998) stated that “the proper organization of declarative knowledge is the first step on the road to expertise” (p. 13). Jennings (2001) noted that graphics were beneficial for experts but hindered the performance of a novice for declarative knowledge assessments. However, Jennings noted that graphics enhanced performance for both groups with items that assessed procedural knowledge. Jennings also noted that both static and interactive graphics seemed to aid working memory since they resulted in reduced completion times for those items.

Brehm (1966) theorized that people have a psychological resistance to persuasion in reactance to their impeded ability to make independent decisions. With this in mind, Weaver (1999) analyzed why experts tended to resist advice given by another expert or by a computerized expert system. Weaver felt that resistance would be different due to two factors: (a) the traits of the person obtaining the advice and (b) whether the advice came from a computerized expert system or a human expert. The results indicated otherwise. However, Weaver also concluded that subtle threat statements helped the experts utilize the expert advice notwithstanding the source.

Argall (2002) in an on-line discussion forum on knowledge management noted some reasons why experts might resist sharing their knowledge and how to solve the issue:

One reason why people hoard knowledge is because it makes them important and a valuable asset to a company. They are reluctant to share the information because it reduces their power and importance within the company. Although they receive compensation for their consulting work, they do not receive rewards directly tied to sharing their knowledge. Unless experts feel that they are compensated for their knowledge, they will always be reluctant to share it. This is where the performance evaluation criteria come into play. If you want to be promoted, you must share your knowledge. (¶ 4)

Argall continued the discussion by talking about how some subject-matter experts shared some of their knowledge by writing articles or whitepapers but still held back some of the detailed information so that the reader had to contact the expert for additional information and advice.

The traditional training scenario for the SightPros-VirTechs system has used an expert or master technician training multiple apprentices or novices. During the pilot studies at Metro Environmental, John Thomason had not yet developed the portable, wireless audio/visual communication configuration sufficiently and the telecommunication providers had not yet advanced the Internet communications capabilities sufficiently to provide the level of training needed to effectively relay visual information between the novice and the expert. This study examined the training practices in the SightPros-VirTechs system with the faster communications speeds available in 2007 and early 2008. For this study I investigated:

- The characteristics and the incentives for the expert at Metro Environmental to share his knowledge.
- The amount of knowledge that the expert(s) actually shared. For example, did they use troubleshooting as a "thinking out loud" scenario or simply as a presentation of task procedures?
- The information that the president/co-owner of Metro Environmental still shared with the HVAC industry. If he held back information, then why did he do that? During the pilot studies, the president/co-owner shared various articles with me that he had written for his industry to share his knowledge.
- The ways that the technicians and the expert(s) effectively dealt with the graphical display of the SightPros communication tools.

- The resistance, if any, to the expert's advice shown by the technicians and how they demonstrated this resistance.

### The HVAC Industry

The Bureau of Labor Statistics (2003a) at the U. S. Department of Labor noted that the work environment for the HVAC technician: (a) Required lifting and moving heavy equipment, (b) felt physically uncomfortable, (c) included possible dangers, (d) involved frequent overtime or irregular hours, (e) demanded continuous training and licensing, (f) interfaced directly with the public and possibly aggravated customers, and (g) needed certification if working with refrigerants.

In addition, the Bureau of Labor Statistics (2003a) noted that many employees still learned through informal, on-the-job training. But, equipment had grown so sophisticated that employers preferred to hire technicians who had either attended technical school or received previous apprenticeship training. Training came from a variety of organizations and affiliations. Typically it took from 3 to 5 years to complete most formal apprenticeship training programs. As technicians increased their skill levels, their wages rose. Advancement opportunities included supervisory or management positions, crossover positions such as sales and marketing, teaching, small business ownership, etc.

The Bureau of Labor Statistics (2003a) predicted that the number of mechanics and installers employed for heating, air-conditioning, and refrigeration work by the year 2010 would increase approximately 21 to 35 percent from the 243,000 workers in the

year 2000. They noted that this increase occurred faster than the average for all occupations.

The description provided by the U. S. Department of Labor regarding the HVAC industry very accurately portrayed the environment that I noted at Metro Environmental during the pilot studies. Another area that I have examined throughout this study has been whether the SightPros-VirTechs system has impacted the length of time needed for training or has improved the number of technicians in the field that one expert could train effectively at one time.

### Training

In this section, I address training from several perspectives. Training refers to business instruction and improvements. Education refers to schooling. I reviewed literature from both training and education perspectives. I looked at job training, apprenticeship training, distance learning via the Internet, adult learning, training in a small business environment, and then silent curriculum.

#### *Job Training*

Nolan (1996) noted that training and on-the-job learning helped to facilitate change and allowed trainees to learn new skills. He noted that vocational training and apprenticeship training were the forerunners to job training. He portrayed the OJT (on-the-job training) scenario as an experienced employee teaching the newer employee specific knowledge and skills. Wehrenberg (1987) estimated that 60% of all training occurred informally on the job.



Nolan (1996) indicated that OJT seemed better suited for performance-based tasks and simple skills than for knowledge-based tasks and more complex skills. Nolan classified three methods used for this training:

- Structured OJT: The learner followed a set of structured or planned activities to learn the skills and knowledge.
- Unstructured OJT: The learner followed another employee around and picked up information in a trial and error fashion. The experienced employee saw the learner as a hindrance to them as they attempted to get their own job accomplished.
- Job Instruction Training: The learner followed an orderly, disciplined, systematic approach presented as procedures by the instructor. The instructors used this most frequently for motor skills training.

In my 2003 and 2004 pilot studies at Metro Environmental, they presented training for the technicians and staff as ongoing on an "as needed" basis and mostly for performance-based tasks. They used all three methods noted by Nolan (1996). For this study, I anticipated that implementation of the training scenario with the SightPros-VirTechs system would have the most direct impact on Nolan's unstructured OJT.

#### *Apprenticeship Training*

Nolan (1996) noted that apprenticeship training for skilled crafts and trades were probably the earliest documented training methods. He distinguished apprenticeship training as allowing the apprentice to become skilled in one of many areas instead of

learning specific tasks within one job. Nolan suggested 4 to 7 years as the typical apprenticeship “contract for training” made between the employers and the worker. He declared that during that contract time the apprentice would make only about half the salary of a skilled craftsperson/journeyman in exchange for the learning experiences. The craftsperson provided shop instruction but supplemented it with formal classroom instruction at a technical school. Nolan also noted that in some instances automation and changing technology made some apprenticeships obsolete by the time the apprentice completed training. However, he also stated that a good apprenticeship program proved itself as an excellent way to acquire highly complex skills and that apprenticeship training had many useful years ahead.

Howard (1996) tied apprenticeship training to the beginnings of family life where parents taught their children the basic craft skills they later used to make a living. As life got more complex, children were indentured to non-family craftsmen. He noted records from ancient Egypt, Greece, and Rome linked to apprenticeships.

Howard (1996) emphasized that history showed all apprentices were not equal – some provided better journeyman pay, learning difficulty, and basic start-up costs. Since the mid 1980s, “youth apprenticeships” (non-traditional apprenticeships that link high school education, postsecondary education, and work experience) starting at the age of 16 provided an alternative to formal schooling and provided a nationally recognized certificate at the end of the apprenticeship.

Howard (1996) noted that over 800 occupations had registered apprentice programs but over half of the apprentices worked in construction. Potential apprentices must qualify for, apply to, and be selected by the specific apprenticeship program of interest. Either a state agency or by the U.S. Department of Labor oversaw the apprentice programs. Labor unions (as a natural fit) actively created, implemented, and monitored various apprenticeship programs. Howard also stated that:

Apprenticeship programs create competent, versatile workers who have developed skills that are in demand by industry. Apprentices learn to work with different kinds of people in an actual working situation and become familiar with a company's organization and operation. Apprenticeship programs offer efficient ways to learn skills and assess performance in a planned and organized manner, and they result in advantages for both employer and employee. (p. 805)

From my pilot studies in 2003 and 2004 at Metro Environmental, I observed that about half of their service technicians included apprentices - some with little experience and some with extensive experience. John Thomason had a goal for the SightPros-VirTechs system to utilize lower-wage workers with lower-skill levels in tasks that might normally require a worker with higher skills by teaming them with a remote expert instead of an on-site expert. The SightPros-VirTechs system incorporated technology as a training tool and/or performance support system even for the more experienced technicians, but the main cost justification came from the demand of constant and ongoing training for the apprentices.

### *Distance Learning via the Internet*

My literature review showed that distance learning has displayed some unique characteristics when researchers have compared it to classroom and/or one-on-one training. Moore and Kearsley (1996) (in discussing distance education but applicable to distance training) noted that the technology utilized in distance education seemed to challenge many educators even when they used the same technology to search for information or used it for entertainment. The messages carried by the technology simply replaced their use of face-to-face lectures, discussions, and blackboards but this use of technology seemed to make it feel new and different to educators, trainers, and/or students.

As in all education, it is important for distant learners to have sufficient interaction with their instructors to allow an appropriate degree of exchange of ideas and information. . . . Ideally, a distance education course also provides an opportunity for students to interact with each other both synchronously by teleconferences, as they would in a traditional classroom setting, and asynchronously via computer bulletin boards and mailing lists. . . . Sometimes include face to face meetings to provide group interaction when designers determine that such interaction is necessary. (pp. 10-11)

Later in their discussion on distance education, Moore and Kearsley (1996) noted the challenges of the learning environment and dealing with distractions and interruptions:

In any distance education organization, a great deal of attention must be given to the nature of the learning environment. Students may study course materials and may interact with instructors in their workplaces, at home, in a classroom, at a learning center, or even when they travel. . . . Learning in such places . . . presents some real challenges because such

settings are subject to many kinds of distractions and interruptions that make learning difficult. . . . Most designers believe that courses should be organized into short, self-contained segments with frequent summaries and overviews. Some emphasize the need to link academic content to real-life work, community and home issues that will help student integrate their study with everyday problems, so that instead of being distractions, these become part of their learning. (pp. 12-13)

Mosher (2000) mentioned several additional issues involving time that directly related to online learning:

- Students needed time to learn how to learn in new learning environments.
- Designers needed to consider possible revisions to some of the approaches used by the early adopters once the masses adopted e-learning.
- Instructors required better needs assessments and learning-style assessment tools to ensure that they placed students into the correct learning methodology.
- Learning took time so even on-line training would not guarantee that employers would save time and money when employees trained. Students still needed dedicated time to learn.

In the pilot studies at Metro Environmental, technicians learned in their weekly meeting to correctly use laptop computers for various communication and paperwork activities. Some of the students adapted to the training easily and then communicated effectively with the home office; other technicians were more reticent and hesitated more with its use. For this study, I anticipated that synchronous Internet communications with the visuals from the SightPros communication tool would assist

the learners by providing the necessary interactions to help make the learning more effective. I also anticipated that the distractions of learning at a customer location would be similar to the typical apprentice situation with real-life working issues. I decided to investigate how the technicians handled various distractions.

John Thomason planned for some additional service time in the SightPros-VirTechs system for individuals using the training scenario in the field compared to the service time for the traditional apprentice. He categorized the service call as both productive work time and training time. Nonetheless, he planned less total service call time since the call required only one person on site versus two or more.

Since computer usage seemed more commonplace for adults in 2007 than it seemed during the earlier pilot studies, I anticipated that some of the early approaches to the training used by Metro Environmental might need updates. For instance, Internet communications transpired faster in 2007 than in the pilot study. So, I decided to investigate how recent changes in communications technologies impacted training in the SightPros-VirTechs system at Metro Environmental. I also investigated how comfortable the current technicians appeared with computerized technologies in general and the SightPros-VirTechs system in specific.

### *Adult Learning*

My literature research showed that adults learn differently than children. Educators used the term andragogy for adult learning versus pedagogy for teaching children. Adults liked to help determine what, how, and when they learned. Knowles

(1996) listed six assumptions about adult learners based on his studies of various researchers from 1926 through the late 1970s:

- Adults needed to know why they should learn something.
- Adults felt a deep need to self-direct.
- Adults had a greater volume and different experience quality than younger learners.
- Adults became ready to learn when their life situation created a need "to know" or "to do." This generated a more effective and satisfactory outcome.
- Adults entered into a learning experience with a task-centered (or problem-centered or life-centered) orientation to learning.
- Adult motivation to learn came from both intrinsic and extrinsic factors.

Because of these assumptions, Knowles (1996) suggested that for enhanced learning, adult educators should ensure a good learning climate that included mutual respect, collaboration, support, mutual trust, fun, and attention to basic human needs such as comfortable temperatures, short breaks, and proper lighting. They also needed to include their learners in the planning; diagnosing; objective setting; designing and managing of learning experiences; and evaluating achievements.

Sternberg (1996), a noted cognitive psychologist, discussed both learning and cognition. He defined overall intelligence as follows:

Intelligence is the capacity to learn from experience using metacognitive processes (you thinking about how you think) to enhance learning, and the ability to adapt to the surrounding environment, which may require

different adaptations within different social and cultural contexts. (p. 460)

Sternberg (1996) noted that adults actually had different types of intelligence. He stated that cognitive psychologists often distinguished two major types of intelligence:

- Fluid intelligence: Our cognitive processing skill that helps us to manipulate abstract symbols such as those used in math. Younger adults have higher fluid intelligence than older adults. It increases up through the 20-40s but declines slower after that.
- Crystallized intelligence: Our stored knowledge of declarative data (such as vocabulary) or procedural data (our expertise in a field). Older adults have higher crystallized intelligence than younger adults. It builds throughout our life spans.

Sternberg (1996) discussed other ways in which adult intelligence changed as people aged. He noted that:

Older adults generally do not demonstrate the same speed of information processing shown in younger adults, they may show instead the benefits of taking time to consider alternatives and to reflect on past experiences before making judgments – a skill often termed wisdom. (pp. 452-53)

All trainees at Metro Environmental were adults. During the pilot studies, I classified all of the service technicians as younger or middle-age adults since the older adults usually left the field operations due to the difficult working environment.



Nonetheless, the state licensed expert at Metro Environmental, John Thomason, would fall into the older adult category. During this study, I observed how the Training in the SightPros-VirTechs system helped or hindered the adult learning styles.

### *Training in a Small-Business Environment*

Broadwell (1996) noted that small business owners/managers often had the same training needs found in larger businesses, but they lacked the trained or dedicated staff to make it happen. Moreover, the owners found it hard to spare employees long enough to send them away to a formal training class. In a small-business environment, the typical trainer had many other job responsibilities on top of the training tasks so their instructional skills might be weak. Broadwell wrote that generic training programs seldom addressed specific tasks needed within their business. Nonetheless, Broadwell summarized that training must occur for the business to survive well and the training that occurred needed evaluation.

During the early pilot studies at Metro Environmental, the service personnel and the president/co-owner discussed various training options. They noted the availability of various courses by manufacturers and industry organizations, online training, local schools, and CD-ROMs that had troubleshooting flowcharts. The technicians kept themselves up-to-date on changes in HVAC systems to obtain and maintain their licenses. For this study, I explored whether the SightPros-VirTechs system offered a realistic way to deliver just-in-time training wirelessly from co-workers, management, in-company experts, and/or other outside experts.

## *Silent Curriculum*

Educational discussions have addressed silent curriculum in educational situations. Silent curriculum applies to training and professional situations as well. Hosford (1976) discussed efficient improvement of instructional programs and the leadership role of curriculum workers. In his discussion he addressed some positive aspects of silent curriculum.

The time has come for us to modify our culture so that we may assume the proper leadership role implied in the listing of our professional responsibilities.

Four objectives of public school education consistently are selected out as the most important objectives. They are: (a) desire for learning; (b) achievement in the 3R's; (c) healthy self-concepts; and (d) respect for others. I have labeled three of these areas as the "silent curriculum" because we do not often plan for them overtly as we do the 3R's and we seldom attempt their evaluation.

Our instructional programs include human interaction processes which affect learners in the silent curriculum areas. Much of the silent curriculum influence is created in the process of instruction. . . . Many of the results of the silent curriculum can be defined in advance and are highly valued to professionals in the field.

We are also concerned about a curriculum which overtly ignores areas of moral behavior, respect for others, and a desire for learning. Such curricula deserve honest inquiry and we need procedures to evaluate the silent curriculum areas now. (pp. 483, 485)

Rigoni (1995) noted that instructional settings had an explicit curriculum, but they also had an implicit (silent) curriculum. He found that if the students did not consciously or unconsciously change their basic world views to match that of the professionals it proved very difficult for them to successfully complete the explicit curriculum.

Some writers expressed concern about the negative impacts of silent curriculum.

Hedbring (1995) warns against "the ignorance-driven pernicious silent curriculum and functional fixity." He suggested that:

The Silent Curriculum is a mix of popular wisdom, personal beliefs, attitudes, and views that get passed along as "fact." Supported by bias and prejudice, the Silent Curriculum consists of "dogma neither scientifically based nor proven." Our challenge is to replace fiction with fact, fantasy with research, myth with science. Otherwise, Functional Fixity results -- inflexible thinking unmoved by logic, fact, or research.

Other writers expressed concerns about the impact of silent curriculum on students with different cultural backgrounds. Hatfield (1993) in a discussion about a film that dealt with AIDS warned about cultural problems with silent curriculum:

The ways in which these authoritative instructional messages were expressed by the students might be read as a silent theme of the film, or the silent curriculum, reflecting the way that instructional practices, rules, and behavioral codes are often established in the classrooms of minority students (Bowles and Gintis, 1976; Anyon, 1981; Weis, 1988).

Since different communities of viewers will read or interpret the text differently according to their culture, background, and experiences, it becomes necessary for educators to ensure that racial and ethnic minority voices are included in the evaluation, selection, and utilization of texts.

Teachers, media specialists, and instructional and curriculum specialists must become cognizant of the culture, language, signs, and symbols of communication used by both the producers and viewers of texts.

We must be vigilant of the silent curriculum embedded in texts and the silent messages encoded within these texts that profoundly impact students' self image and racial identities, while these embedded codes foster the continuation of underclass positions of oppressed racial and minority groups. (pp. 120-121)

For this study, I decided that I would look for instances of silent curriculum at Metro Environmental in the training environment with the SightPros-VirTechs system. I also looked for it in the context of the entire business operation.

### Knowledge Management

My literature research suggested that managing the knowledge within a business seemed important to the successful operation of the business. Business knowledge included information about procedures, personnel, and customers. Knowledge management appeared more critical for businesses with employee turnovers. Hoefling (2001) in describing knowledge management summarized that:

Knowledge management goes beyond the capture, storage, and retrieval of information. It is a way of helping the organization unbury the hidden treasure of knowledge that lie in people's minds (tacit knowledge), and make that knowledge accessible to a larger group of individuals who are responsible for acting and deciding in the best interest of the organization. The virtual environment provides an incredible opportunity to capture knowledge through informal exchange among team members because much of the exchange is captured through email, web conferencing, bulletin boards, and chat rooms and other discussion forums. Effective managers of virtual teams can catalyze learning for their group by asking questions, challenging members to question perspectives, and continuing to push the dialogue. They can then catalyze learning for the organization by connecting the team's learning to the greater whole through various means. Once again, the whole becomes greater than the sum of its parts.

As more organizations are at least partially virtual, the virtual manager's ability to manage the relationship between knowledge management and virtual team collaboration becomes even more critical. (p. 166)

In discussing technology, Hoefling (2001) noted that organizations that wanted to maximize the work use of virtual teams should make the most of relationship tools.

Their useful tools included "web conferencing and other groupware tools (that) build trust, relationships, and interdependence among team members in ways that are - or soon will be - indispensable tools in any organization" (p. 54).

Suchman (1995) wrote about workplace ethnography for system design studies. She discussed the need to make work visible but also that sometimes people or organizations purposely keep it less visible. She noted:

The way in which people work is not always apparent. Too often, assumptions are made as to how tasks are performed rather than unearthing the underlying work practices. (p. 56)

We can ask why it might be not only inevitable but also valuable that members of an organization know their own work in ways that others positioned differently in the organization do not. (p. 56)

Alternatively, we can ask under what circumstances it might be in the interests of some organization members not to know in detail the activities of others differently placed. . . . In the case of many forms of service work, we recognize that the better the work is done, the less visible it is to those who benefit from it. (p. 58)

Things are made visible so that they can be seen, talked about, and potentially, manipulated. (p. 63)

I wondered how Metro Environmental currently managed their knowledge.

Would the SightPros-VirTechs system assist with the capture of some of the current knowledge for future use? The training system design of an expert working with novices provided an ideal distribution channel for knowledge. Would it prove efficient?

### Culture and Cultural Change

Crapo (1993) defined culture as "a learned system of beliefs, feelings, and rules for living around which a group of people organize their lives; a way of life of a particular society" (p. 387). Haviland (1989) noted that societies share and learn culture. They base

culture on symbols such as language, and they integrate culture into the whole.

Haviland also noted that:

All cultures change over time, sometimes because the environment in which they live has changed, sometimes as the result of the intrusion of outsiders, or because values within the culture have undergone modification. Sometimes the unforeseen consequences of change are disastrous for a society.

In the next few sections I discuss the Metro Environmental work culture, the general systems theory which deals with change, and communities of practice.

Understanding those areas helped me significantly with this study.

#### *Metro Environmental Work Culture*

In the business world, Metro Environmental ranks as a small business.

Nonetheless, John Thomason suggested that Metro Environmental ranked as a mid-sized HVAC company since many HVAC companies consisted of just an independent certified technician with additional helpers as needed and an answering service to receive calls. From my pilot studies in 2003 and 2004 (see Appendices A and B) and my part-time employment there, I noted a strong sense of teamwork and community at Metro Environmental. The technicians acted friendly to each other rather than competitive. The president/co-owner of the company remained as accessible to the technicians as did everyone else in the company.

My pilot studies documented that the offices looked highly personalized as most customers never actually visited the home office. Initial customer contact came by telephone, Internet, and advertisements. Most customer contact occurred at the

customer's location. Occasionally, a customer or vendor would stop by to pick up a filter for their HVAC systems or drop off a payment, but this occurred rarely. Most visitors to the offices included (a) Metro Environmental vendors, (b) prospects for the VirTechs negotiations, or (c) cold-call salespeople who wandered through commercial areas hoping to sell their own products.

During the pilot studies, the Metro Environmental technicians met at the office each morning to get new assignments for the day, to get the parts needed for those assignments, and to team up in their trucks as needed. Since calls came in throughout the day and were then dispatched as a technician finished each job, the technicians frequently returned to the office to again get the parts needed for the next customer. At the end of each day, they often returned to the office to complete paperwork; to drop off their trash, empty boxes, and scrapped parts; and/or to drop off teammates.

During the pilot studies, I noted that most technicians carried an extra clean Metro Environmental shirt in case they needed it at a job site and they always kept more back at the offices. The company equipped their offices with showers that the technicians used as necessary. Metro Environmental technicians expressed their need to portray their professionalism as much as feasible in their "dirty" work environments. Moreover, itchy insulation from the attics; muddy access to some HVAC units; extreme heat in the summers; and chemical hazards made occasional on-the-job clean-up a necessity to obtain a professional first impression by the customer.

In my pilot studies, I also found that along with a tough work environment, the service trades technicians faced a poor public image within their social environment. Society most frequently grouped the HVAC technicians with the lower-status construction workers, plumbers, and home appliance technicians rather than with the more professional and higher-status computer and office equipment technicians who typically wore coats and ties (John Thomason, personal communication, March 2003). This meant lower status for the technicians and lower overall pay since Metro Environmental kept the service call charges reasonable to meet customers expectations and compete in the marketplace with other HVAC providers. Nonetheless, in various segments of the service, construction, and trades industries, the unions often negotiated higher salaries for many workers with specialized training so this also put an upward pressure on the salaries of the experienced technicians (Construction Labor Research Council, 1988).

Rosenthal (1990) talked about the construction trade in general. Some of the stigma that he discussed regarding the construction workers bled over to HVAC service and repair providers, also.

It appears that here, a stigma is being cast upon construction trades as low paying, manual, thankless, outdoor work rampant with drug and alcohol abuse. . . . The term “construction worker,” embodied as the unskilled manual laborer, has negative connotations for young people. To youngsters, “construction workers” are ditch diggers they see calling obscenities to passers-by, loafing on the job. Most commonly associated with dirt, sweat, and a gruff demeanor, the construction worker lacks prestige, class, and respectability. (p. 22)



I looked forward to a fresh examination of the work culture at Metro Environmental. I wondered how the work culture had changed since my 2004 pilot study. After rethinking the status issues I found in the pilot studies and reviewing the literature, I wondered how Metro Environmental technicians currently felt about their status. Would the Training in the SightPros-VirTechs system boost their status due to their use of upgraded communications technologies? I also wondered how the customers of Metro Environmental perceived the status of the technicians.

### *General Systems Theory*

Bertalanffy (1968) postulated a new discipline called general systems theory which suggested universal principles that were valid to systems in general. He identified both open and closed systems:

A system may be defined as a set of elements standing in interrelation among themselves and with environment. . . . We term a system 'closed' if no material enters or leave it; it is called 'open' if there is import and export of material. . . . In any closed system, the final state is unequivocally determined by the initial conditions. . . . This is not so in open systems. Here, the same final state may be reached from different initial conditions and in different ways.

Conventional physics deals only with closed systems, i.e. systems which are considered to be isolated from their environment. . . . Every living organism is essentially an open system. It maintains itself in a continuous inflow and outflow, a building up and breaking down of components, never being, so long as it is alive, in a state of . . . equilibrium but maintained in a so-called steady state which is distinct from the latter.

Notions like wholeness, holistic, organismic, gestalt, etc., which all signify that, in the last resort, we must think in terms of systems of elements in mutual interaction. . . . You cannot conceive of a living organism, not to speak of behaviour and human society, without taking into account what variously and rather loosely is called adaptiveness,

purposiveness, goal-seeking and the like. . . . Man is not a passive receiver of stimuli coming from an external world, but in a very concrete sense *creates* his universe.

Senge, et al. (1999) discussed the consequences of the open systems in the general systems theory to the impact of changes critical to learning organizations:

Based on the work of Viennese biologist Ludwig von Bertalanffy [sic], open systems work starts with the idea that the whole of a system is more than the sum of its parts. "Suboptimization," a perennial issue in the quality and reengineering movements, is actually a boundary-definition issue. . . . To an open systems theorist, that meant an organization is a thing that transforms its inputs — everything it eats, breathes, perceives, absorbs, and takes in. These inputs transform the entity as well. To change an open system, you must learn to understand and influence the things that it takes in, and its relationship with its environment. Open systems researchers seek out the unconscious strategies by which the system maintains its integrity.

Smith and Ragan (1993), in discussing the general systems theory, also noted that when any element in any system changed, the change also impacted other interdependent components of the system. Moore and Kearsley (1996) concurred with Smith and Ragan when they stated:

Changes in one component of a distance education system have immediate effects on all of the other components. . . . Distance education should be conceived of and developed as a total system, giving equal attention to all the above interacting components if it is to be practiced successfully. Paying attention to one of the components without regard to the others is a recipe for disaster. (pp. 13-14)

Moore and Kearsley (1996) listed the key components of a distance education system as: (a) Content experts and other sources of knowledge, (b) course design

expertise, (c) communication of information and interaction via technology, (d) management and administration, and (e) learning environments.

Therefore, according to the general systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993), anyone and anything within Metro Environmental could experience an impact from the use of the computerized training scenario in the SightPros-VirTechs system. The trainees, the expert, and the processes closest to the change should experience the greatest impact, but any person in the company could feel an effect. For instance, the dispatcher could watch for and react to new or unusual trainee problems or potential customer complaints. The accounting personnel could adjust their billing system to accommodate the less experienced trainees doing more “expert” tasks. Even my presence during my research could impact the overall Metro Environmental environment.

Moreover, with the use of computerized training scenarios such as the SightPros-VirTechs system, even people and processes external to Metro Environmental could feel the impact according to general systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993). For instance, the extensive use of the on-site computer-assisted training, openly viewed by customers and managers, could improve the public image of the technicians to give them a higher overall social status, more credibility, and/or trustworthiness.

## *Communities of Practice*

Several of my anthropological readings discussed the concept of communities of practice (CoP). Lave and Wenger (1991) first suggested the term *community of practice* to describe a group of people who share an interest, a craft, and/or a profession. When members participate in a group, they learn from each other and develop themselves personally and professionally. In 2002, Wenger, McDermott, and Snyder defined community of practice as:

Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. Engineers . . . soccer moms and dads . . . artists . . . gang members . . . frontline managers . . . don't necessarily work together every day, but they meet because they find value in their interactions. As they spend time together, they typically share information, insight, and advice. They help each other solve problems. They discuss their situations, their aspirations, and their needs. They ponder common issues, explore ideas, and act as sounding boards. They may create tools, standards, generic designs, manuals, and other documents — or they may simply develop a tacit understanding that they share. However they accumulate knowledge, they become informally bound by the value that they find in learning together. The value is not merely instrumental for their work. It also accrues in the personal satisfaction of knowing colleagues who understand each other's perspectives and of belonging to an interesting group of people. Over time, they develop a unique perspective on their topic as well as a body of common knowledge, practices, and approaches. They also develop personal relationships and established ways of interacting. They may even develop a common sense of identity. They become a community of practice. (pp. 4-5)

Lesser, Fontaine, and Slusher (2000) wrote that organizations "have begun to recognize that knowledge critical to business success is often created and shared by

informal groups of individuals. . . . These communities . . . (preserve) valuable insights that can be easily lost in an age of employee mobility and early retirement" (p. vii).

From my earlier studies on Metro Environmental, I knew that their relationships incorporated various communities of practice (Lave & Wenger, 1991; Lesser, Fontaine, & Slusher, 2000; Wenger, McDermott, & Snyder, 2002) both inside and outside of the company. I probed for new or revised communities of practice that developed with the advancement of the SightPros-VirTechs system.

### Summary

In this chapter, I presented an overview of the literature research I conducted for information that applied to the Training in the SightPros-VirTechs system used at Metro Environmental and to this study. Even though I present my review of the research design literature in the next chapter, Chapter 3, I knew that the research model and traditions that I chose would then define the depth and breadth of the literature review. Consequently, I examined research models and research traditions at the start of my literature review.

After reviewing the research traditions and research models, I concluded that I could best examine the training environment in the SightPros-VirTechs system at Metro Environmental by utilization of basic techniques and procedures for case study, ethnography, grounded theory, and participatory action research methods under the qualitative research umbrella. Therefore, I followed the recommended literature review suggestions and strove for broad but solid understanding, not necessarily a deep

understanding of the literature relevant to Metro Environmental and the SightPros-VirTechs system of wireless remote training.

In this chapter, the literature topic of most significant interest to the Metro Environmental study involved remote collaboration on physical tasks. Those studies broke down the physical and linguistic components of remote communications into the basic elements used by helpers and workers. Researchers did this in hopes of finding ways to enhance the collaborations between helpers and workers.

Research on experts and novices interested me since this study examined the apprenticeship environment. A clear understanding of the research in this area highlighted areas of opportunity and risk for this study, such as information sharing/hoarding.

The literature on the HVAC industry provided insights into the operations at Metro Environmental and the employees. This literature provided a vital understanding of job training in general and apprenticeship training in specific. The comprehensive government analysis of the HVAC industry also provided great insight into the job training needs and the apprenticeship training programs.

Several additional areas related to training and learning yielded valuable insights. Distance learning and particularly using the Internet for learning became an area of particular interest for this study. Moore and Kearsley (1996) discussed some of the unique characteristics of distance learning. Mosher (2000) highlighted some key aspects relating to the time factors. Reading the information about adult learning solidified the

concepts needed for this study that dealt with adults in a business environment. My expectations for training at Metro Environmental had to be realistic for the small-business environment. Looking at training in a small-business environment such as Metro Environmental seemed very different from the training in a large corporate environment with a professional training staff. The studies on silent curriculum (Hosford 1976; Rigoni, 1995) highlighted the need to examine both explicit and implicit training.

New learning yields new knowledge to manage. My overview on knowledge management looked at how businesses, organizations, and industries viewed knowledge as a hidden treasure that they needed to capture and share among individuals.

Several areas related to culture change seemed like important aspects of the potential impact to Metro Environmental with the SightPros-VirTechs system. General systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993) indicated that Training in the SightPros-VirTechs system might impact everything within Metro Environmental and might impact multiple industries other than the HVAC businesses. That would put stress on the current communities of practice (Lave & Wenger, 1991; Lesser, Fontaine, & Slusher, 2000; Wenger, McDermott, & Snyder, 2002) and would force changes to the status quo. Potentially, new bonds would develop and yield new communities of practice. I captured these culture change areas as a significant part of the data collection for this study.

In final summation of this chapter, I have used it to present the important literature related to this dissertation. First, I reviewed the purpose of this study which

included my major research questions. Then, I offered a general introduction to the relevant literature. Next, I provided a synopsis of each topic that I researched. Finally, I finished the chapter with a general review of the related literature and how that literature impacted this study.



## CHAPTER 3

### METHODS AND PROCEDURES

#### Chapter Introduction

I recently completed a study at Metro Environmental, a HVAC (heating, ventilation, and air conditioning) company. I researched the impact of training technicians using their SightPros-VirTechs system for remote, wireless, Internet video assistance.

In this chapter, I present the methods and procedures that I used in my study. First I review the purpose of this study which includes my major research questions. Next, I briefly explore the two major research models. Afterwards, I explore in more detail within the qualitative research model the relevant elements that I selected for this study. Then, I provide a general introduction to my methods and procedures. Subsequently, I describe design specifics for my research at Metro Environmental. I discuss the research methods, the population, various participant considerations, and the locations that I used for the study. Then, I explain the research procedures, discuss the potential for researcher bias, and summarize my outputs. Finally, I finish the chapter with a quick summary of the major discussions in this chapter.

## Purpose of the Study

The purpose of my study has been to investigate the SightPros-VirTechs system and to analyze its business impact. The system addresses training and/or assistance via wireless Internet video from job site apprentices and/or technicians to a remote expert.

To investigate and analyze the system, I have explored the following research questions:

- Can the SightPros-VirTechs system as used by Metro Environmental demonstrate that its concepts of just-in-time training and leveraged expertise effectively expand the capabilities of their HVAC workforce?
- Can the SightPros-VirTechs system expand the workforce capabilities in other HVAC companies and/or other service-dispatched industries to positively impact the skilled labor shortages?
- Does the SightPros-VirTechs system generate additional impacts that might influence adoption of the system in other companies or industries?

As part of my investigation of the SightPros-VirTechs system, I have studied the personnel and environment surrounding Metro Environmental. I have documented the business context with both narrative description and statistical data.

As part of my analysis of the business impact, I have compared an apprentice technician who uses the SightPros-VirTechs system frequently with other technicians who use the system occasionally. Also, I have compared this study with my two pilot studies. I have analyzed the business context to determine the impact from the system

and its concepts to Metro Environmental and potentially to other businesses and industries.

### Research Models

As noted in chapter 2, I did significant study of the literature on research design. In the next few sections, I present highlights from the information I found in the literature reviews about various research models. I describe the major research models and give a synopsis of relevant qualitative research information. Subsequently, I discuss the specifics details in my research design for Metro Environmental.

I found many factors that I considered as I selected the best research design for the study of Metro Environmental and the SightPros-VirTechs system. Prior to my selection of the actual research methods that I used in the study, I felt motivated to research the characteristics and expectations of the major research models. First, I present a comparison of qualitative versus quantitative research then I discuss several qualitative traditions in more detail.

Qualitative research most frequently gets reported using narrative descriptors. Quantitative research most frequently gets reported using statistical descriptors. Monaco (2003) mentioned a number of properties of both quantitative and qualitative research models that compared the typical features associated with each model. Table 1 summarizes her classroom presentation and discussion.

Because the study of the SightPros-VirTechs system involved a very complex application of technology with little field research and some unknown variables, I

concluded that qualitative research fit the criteria for the best model. However, I also concluded that some data that I collected could benefit from quantitative analysis.

Table 1

*Comparison of Research Models*

Qualitative Research	Quantitative Research
Complex and dynamic problems or situations	Specific and controlled problems or situations
Goal: To deeply understand a particular context	Goal: Problem solution
Exploratory research	Previously studied
Minimal literature exists	Body of literature exists
Relevant literature research continues throughout study	Exhaustive literature research before research begins
Unknown variables	Known variables
Setting preplanned but full design emerges as study proceeds	Designed fully specified before study begins
Ethnography, case studies, grounded theory, phenomenological studies, etc.	Experiments and surveys
Researcher interacts with subjects	Researcher acts independently
Context bound	Context free
Value laden	Value free
Often lasts a long time	Often lasts a short time
Results yield theories, patterns, explanations, and understandings which can be tested via quantitative studies	Results generalize to yield predictions, explanations, understandings
Informal language	Formal language
Personal voice	Impersonal voice

## Qualitative Research

### *Traditions*

Miles and Huberman (1994) noted dozens of ways to conduct qualitative research – many with years of traditions behind them. They described most qualitative research as naturalistic. They suggested several recurring features of naturalist research:

Qualitative research is conducted through an intense and/or prolonged contact with a “field” or life situation. These situations are typically “banal;” or normal ones, reflective of the everyday life of individuals, groups, societies, and organizations.

The researcher’s role is to gain a “holistic” (systemic, encompassing, integrated) overview of the context under study: its logic, its arrangements, and its explicit and implicit rules.

The researcher attempts to capture data on the perceptions of local actors “from the inside,” through a process of deep attentiveness, of empathetic understanding (*Verstehen*), and of suspending or “bracketing” preconceptions about the topics under discussion.

Reading through these materials, the researcher may isolate certain themes and expressions that can be reviewed with informants, but that should be maintained in their original forms throughout the study.

A main task is to explicate the ways people in particular settings come to understand, account for, take action, and otherwise manage their day-to-day situations.

Many interpretations of this material are possible, but some are more compelling for theoretical reasons or on grounds of internal consistency.

Relatively little standardized instrumentation is used at the outset. The researcher is essentially the main “measurement device” in the study.

Most analysis is done with words. The words can be assembled subclustered, broken into semiotic segments. They can be organized to permit the researcher to contrast, compare, analyze, and bestow patterns upon them. (pp. 5-7)

Qualitative research has been well suited to problems/studies that have involved complex and dynamic problems or situations. Jordan (1999) in discussing a 3-year, multi-disciplinary (anthropology, psychology, management, computer science, and engineering) study regarding self-managed work teams felt that using both a qualitative and a quantitative approach in that study yielded findings that were much more complex and yet also more valuable. The fuzziness and murkiness of their results gave a more realistic picture of the interconnected workings of the teams under study. Her anthropological training helped her to provide a rich, holistic view of the six organizations (25 knowledge-worker teams) under study.

Jordan's study (1999) started with loosely structured, anthropological interviews to help define the right research questions. The researcher team limited the interviews to individuals. They audio-taped most of the interviews, transcribed them, entered them into a qualitative analysis software program, and then coded them into approximately 20 topics. The interview results surprised the research team. However, since the research team designed the initial study as qualitative, the team expanded the focus of their research to include the additional factors now of concern. The revised quantitative instruments better suited the overall needs of the study.

Piantanida and Garman (1999) noted that qualitative research studies in education aimed for deeper understanding of a particular context instead of a problem solution. They felt that the introduction should frame the study. They also mentioned

that qualitative research studies frequently included a personal statement of the context that led the student to the study.

Denzin and Lincoln (2000) included several articles in their handbook regarding strategies of inquiry in qualitative research. I found several strategies of particular interest in this study: case study, ethnography, grounded theory, and participatory action research.

### *Case Study*

Researchers use case study as a strategy of inquiry in qualitative research. Stake (2000) noted that case studies involved the choice about whom or what will be studied - bounded individual cases - rather than the methods that would be used. He also noted that most case studies involved both qualitative and quantitative data.

Yin (1993) noted that case study became the method of choice when a researcher found it hard to separate the phenomenon under study from the context of the phenomenon. He stated that researchers used case study research appropriately when they (a) studied a phenomenon from a broader perspective, (b) used more than one source of analysis, and/or (c) studied a phenomenon within a complex contextual setting. He also noted that case study did not imply any specific means of data collection – rather multiple data collection methods using surveys, experiments, archival records, and history that yielded rich data gathered using rigorous techniques and strategies. He mentioned that higher quality case studies emulated the scientific method by posing clear questions, establishing a formal research design, studying previous research for

hypothesis and rival hypothesis, collecting both verbal and numerical data, creating a database accessible to other researchers, and using both quantitative and qualitative analysis as warranted.

Moore and Kearsley (1996) suggested that case studies in instructional research often helped teachers and institutions. They complemented quantitative type research.

The single largest group of research studies in distance education focuses on the effectiveness of the communications technology. There are two main bodies of this technology-effectiveness research: descriptive case studies and learner achievement.

In the case of distance education, such stories are interesting when they describe an untested technology, which is rare, or a new way of using it, which is needed but also is unusual, or a population or content that has not been described already. Such anecdotal and case-study research points the way for research that is more controlled and systematic and that can therefore lead to results that can be generalized and applied to improve practice in the field. (p. 60)

Moore and Kearsley (1996) cautioned researchers to test for learning instead of satisfaction: "Research is sometimes done to evaluate the effectiveness of a particular program in terms of how satisfied the learners were rather than how much they learned" (p. 65).

### *Ethnography*

Researchers use ethnography as another strategy of inquiry in qualitative research. Fetterman (1998), a practicing anthropologist well known for his step-by-step approach to ethnography, described ethnography as:

The art and science of describing a group or culture. . . . The task is much like the one taken on by an investigative report. . . . A key difference . . . however, is that whereas the journalist seeks out the unusual . . . the



ethnographer writes about the routine, daily lives of people. The more predictable patterns of human thought and behavior are the focus of inquiry. . . . The ethnographer enters the field with an open mind, not an empty head. . . . Biases serve both positive and negative functions. When controlled, biases can focus and limit the research effort. When uncontrolled, they can undermine the quality of ethnographic research. To mitigate the negative effects of bias, the ethnographer must first make specific biases explicit. A series of additional quality controls, such as triangulation, contextualization, and a nonjudgmental orientation, place a check on the negative influence of bias. (pp. 1-2)

Miles and Huberman (1994) noted that social anthropology used ethnography as the primary methodology. They described it as a naturalistic profile using:

Extended contact with a given community, concern for mundane, day-to-day events, as well as for unusual ones, direct or indirect participation in local activities, with particular care given to the *description* of local particularities; focus on individuals' perspectives and interpretations of their world; and relatively little prestructured instrumentation, but often a wider use of audio- and videotapes, film, and structured observation than in other research traditions. (p. 8)

Tadlock (2000) captured some of the essence of ethnography in some concluding remarks as follows:

Long enshrined as a theoretical orientation and philosophical paradigm within anthropology, ethnography has been adopted more recently as a useful methodology in cultural studies . . . and even industrial engineering. Wherever this has happened, a key assumption has been that by entering into firsthand interaction with people in their everyday lives, ethnographers can reach a better understanding of the beliefs, motivations, and behaviors of their subjects than they can by using any other method. . . . Participant observation has become the observation of participation, and the genre of narrative ethnography has emerged from the margins and moved to claim the center. (p. 471)

Jordan (1995) defined ethnography as a holistic description of a society and its culture. It required participant observation to ensure identification of both real and ideal culture.

Hamada (1999), in discussing anthropology in business organizations, noted that ethnography used naturalistic inquiry methods and inductive reasoning instead of testing pre-conceived hypotheses to study a business culture to find the perspectives held by individuals in that culture. Hamada noted that anthropologists typically examined and analyzed formal and informal settings, everyday routines, communication styles, time and space dimensions, artifacts, view points, etc. to find patterns and links that helped to gain an understanding of the hidden dimensions and relationships within a cultural environment.

Chambers (2000) noted that early ethnographers “committed themselves to a style of research and action that would permit them to ‘learn while helping’” (p. 854). The narrative text displayed the researcher’s growth while doing fieldwork. Chambers suggested that ethnographers often described what happened and how people changed cultural meanings while negotiating and adapting to unstable relationships and circumstances. Applied ethnography seemed “by its very nature interventionist and culturally intrusive” (p. 857).

Applied ethnographers have used cognitive approaches. Chambers (2000) noted that researchers used it for studying “failures of communication, or cultural ‘breakdowns’ . . . particular situations and communicative dilemmas that arise when

one group attempts to intervene upon another” (p. 857). Chambers suggested that the researcher did not function as the change agent, but reported problems expressed by the change agents or the involved groups. Chambers recommended that little prior knowledge actually yielded more productive data.

Chambers (2000) also noted that applied ethnographers used action research as another approach that allowed participants to test their own theories in certain social situations and problems. The findings/conclusions of the study proved more convincing to the participants and community members who were not professional researchers.

Chambers (2000) discussed the issues that have emerged in applied ethnography. He mentioned the following points:

- Reliability and internal validity concerned researchers. Some applied ethnographers argued for unique criteria to judge methods validity. Also, cultural truths/validity (utility) differed from “pure” truths/validity (lab results). Over-emphasis on validity could detract from the quest for understanding.
- Historically, researchers found it difficult to analyze the large amounts of ethnographic data collected. Computer-based ethnographic programs helped to manage data and facilitate analysis.
- Some criticisms arose because ethnography took time so results might arrive after the decision makers made major decisions.

- Other criticisms came from the broad focus of ethnography but the broad focus allowed thorough reporting of results.
- Concerns regarding researcher bias extended beyond validity and reliability because of the high standards set for participant protection. Participants and/or clients might have their own agenda and biases. Researchers could present alternative viewpoints. Involvement and insider knowledge provided rich context and added cultural dimensions.
- Ethnographic researchers sometimes found that they must adapt their methods to fit the client, but adaptations could prove either difficult or helpful. New methods such as focus groups, brief field visits to address specific problems, and the use of participants in data gathering allowed more rapid reporting of results.
- The most practical application of applied ethnography occurred in case study research. Nonetheless, researchers seldom reported whether the clients adopted their recommendations. Two factors that influenced adoption of recommendations were (a) getting the client actively involved in the efforts and (b) having the researcher communicate their findings to a wide variety of stakeholders through various media.
- Like reliability and validity in scientific studies, ethnography had five utility criteria vital to it. They included: (a) Accessibility of the research results to the stakeholders, (b) relevancy to the goals and activities of the stakeholders

and clients, (c) responsiveness to a variety of claims for significance, (d) responsiveness to claims of credibility by both clients and stakeholders towards standards set for evidence and proof, and (e) addressability towards future prospects and judgment.

- Major issues included ethics and morality because decision makers used applied research to make decisions. Difficulties arose when the participants ignored personal or professional standards of ethics and morality. Applied ethnographers had three especially difficult areas: (a) Informed consent, (b) confidentiality of participants, and (c) open and public dissemination of the research results. Current professional codes allowed researchers to reveal identities as long as the researcher informed the participants that the researcher could not maintain confidentiality.

### *Grounded Theory*

Researchers use grounded theory as another strategy of inquiry in qualitative research. Strauss and Corbin (1998) defined grounded theory as:

Theory that was derived from data, systematically gathered and analyzed through the research process. . . . A researcher does not begin a project with a preconceived theory in mind (unless his or her purpose is to elaborate and extend existing theory). . . . Rather, the researcher begins with an area of study and allows the theory to emerge from the data. . . . Ground theories, because they are drawn from data, are likely to offer insight, enhance understanding, and provide a meaningful guide to action. (pp. 12-13)

Strauss and Corbin (1998) discussed the use of literature for grounded research. They noted that research should be driven by concepts that actually emerged while doing field research rather than from exhaustive research prior to field entry.

The researcher brings to the inquiry a considerable background in professional and disciplinary literature. This background may be acquired while studying for examinations or simply through efforts to “keep up” with the field. . . . Let us assure our readers that there is no need to review all of the literature in the field beforehand, as is frequently done by analysts using other research approaches. It is impossible to know prior to the investigation what the salient problems will be or what theoretical concepts will emerge. Also, the researcher does not want to be so steeped in the literature that he or she is constrained and even stifled by it. (pp. 47-48)

Strauss and Corbin (1998) noted that researchers developed theories to explain or predict. They suggested various ways in which qualitative researchers could analyze data to arrive at grounded theories. Many of their recommended procedures involved analysis of coded materials and writing of researcher memos. They defined theory as:

A set of well-developed categories (e.g., themes, concepts) that are systematically interrelated through statements of relationship to form a theoretical frame that explains some relevant social, psychological, educational, nursing, or other phenomenon. The statements of relationship explain who, what, when, where, why, how, and with what consequences an event occurs. (p. 22)

### *Participatory Action Research*

Researchers use participatory action research as another strategy of inquiry in qualitative research. Miles and Huberman (1994) noted that in collaborative action research “the researchers join closely with the participants from the outset. The aim is

to transform the social environment through a process of critical inquiry – to act on the world, rather than being acted on” (p. 9).

Berg (2004) noted that:

Action research targets mainly two primary tasks. First, it is intended to uncover or produce information and knowledge that will be directly useful to a group of people (through research, education, and sociopolitical action). Second, it is meant to *enlighten* and *empower* the average person in the group, motivating each one to take up and use the information gathered in the research. (p. 197)

According to Kemmis and McTaggart (2000), participatory action research has included a variety of research approaches carrying a multitude of names most of which have used the action research label. All of the approaches have used designs that looked at how things came to be or can become (diachronic) and how things are (synchronic).

They noted that:

Participatory action research is a form of “insider research” in which participants move between two thought positions: on the one side, seeing . . . from the perspective of insiders . . . on the other side, seeing . . . from the perspective of an outsider . . . who does not share the partiality of the inside view but who also does not have the benefit of “inside knowledge.” Alternating between these perspectives gives the insider critical distance . . . and it was for this reason we conclude that participatory action research is the preferred approach to social and educational research aimed at social and educational change. . . . To the extent that it does so, social and educational research is likely to be regarded by participants as legitimate and thus to secure their consent and commitment. To the extent that social research ignores the participant view . . . it is likely to be regarded as illegitimate, to foster alienation or hostility, and thus to provoke resistance. (p. 590)

Kemmis and McTaggart (2000) mentioned that in most action research, face validity (making sense within the context) overcame the lack of methodological and

technical rigor. Sophisticated methods were not as significant in first person research

because the:

Participants live with the consequences of the transformations they make. The inevitability . . . provides a very concrete “reality check” on the quality of their transformative work. . . . Most action research (and most participatory action research) is, in our view, correct to choose practical significance over methodological sophistication in the trade-off between epistemological and methodological gains – the choice between what evidence makes critical sense to participants and what evidence would satisfy the contextually nonspecific methodological criteria likely to satisfy external researchers. (p. 592)

Kemmis and McTaggart (2000) discussed the key features of participatory action research when they noted that:

It is generally thought to involve a spiral of self-reflective cycles of planning a change, acting and observing the process and consequences of the change, reflecting on these processes and consequences and then replanning, acting and observing, reflecting, and so on. (p. 595)

They also noted that the process seemed fluid, open, and responsive. They expected collaboration by co-participants.

C. Wasson (personal communication, March 21, 2003) noted that researchers considered the collaborative approach as appropriate in anthropological business studies. As an approach, the researcher participant acted as more than strictly an observer. Therefore, the researcher participant could provide input and suggestions as the study progressed.



### *Researcher's Voice and Stance*

Piantanida and Garman (1999, p. 111) noted that qualitative dissertations might read more like a scholarly book than like a science report. Kemmis and McTaggart (2000) noted that many researchers using a participatory action research design which has reflexive characteristics reported their finding using a first-person perspective rather than the second or third person.

### *Analytic Methods*

Seidel (1998) described qualitative data analysis as a process of noticing interesting things and coding them; collecting and sorting instances of those things; and thinking about those things; putting the parts in context (finding “patterns among the patterns”); intensively analyzing relevant small pieces of the data; mapping the data landscape; and finally reporting the results. Discoveries emerged from the sorting and sifting process or from simply examining the coded transcripts. He noted several characteristics about the analysis:

- Iterative and Progressive: The process is iterative and progressive because it is a cycle that keeps repeating. For example, when you are thinking about things, you also start noticing new things in the data. In principle the process was an infinite spiral.
- Recursive: The process is recursive because one part can call you back to a previous part. For example, while you are busy collecting things you might simultaneously start noticing new things to collect.
- Holographic: The process is holographic in that each step in the process contains the entire process. For example, when you first notice things you are already mentally collecting and thinking about those things. (p. 2)

Although researchers have taken many different approaches to the qualitative model, Miles and Huberman (1994) noted that many of the analytic methods used a “classic set” of procedures as presented below:

- Affixing codes to a set of field notes drawn from observations or interviews
- Noting reflections or other remarks in the margins
- Sorting and sifting through these materials to identify similar phrases, relationships between variables, patterns, themes, distinct differences between subgroups, and common sequences
- Isolating these patterns and processes, commonalities and differences, and taking them out to the field in the next wave of data collection
- Gradually elaborating a small set of generalizations that cover the consistencies discerned in the database
- Confronting those generalizations with a formalized body of knowledge in the form of constructs or theories. (p. 9)

#### *Evaluating Qualitative Reports*

Gall, Borg, and Gall (1996, Appendix G) created a list of items for readers to ask when they evaluate a qualitative report. For each item they described the information needed and provided a relevant example.

For the introductory section, Gall et al. (1996) suggested that the reader check that the "researcher's affiliations, beliefs, values, or theoretical orientation" (p. 745) did not influence the research. For instance, the reader could ask if the researcher stayed free of preconceptions during data collection. The reader should check for undue positive or negative bias. For instance, the reader could look for adjectives or other words that described clearly positive or negative terms. They suggested that the reader check for comprehensive and relevant studies in the literature review. For instance, the

reader could look for cited recent and relevant reviews to problems, not extensive pre-data collection reviews. Also, the reader could look for ongoing literature searches as questions emerged in the research.

In the research procedures section, Gall et al. (1996) suggested that the reader check that a case or cases involved particularly interesting samples and/or phenomena of interest. For instance, the reader could ask how the researcher chose the sample(s). They suggested that the reader check for the intensity of the data collection. For instance, the reader could evaluate the time period for sufficiency, continuity, and/or fragmentation? Also, the reader could determine how extensive the researcher analyzed the cited documents. They suggested that the reader check that the researcher demonstrated validity. For instance, the reader could watch for carefully taken notes and how the researcher used the notes? Also, the reader could look for mention of multiple knowledgeable individuals? They suggested that the reader check for reliability. For instance, the reader could determine if all participants took the interviews seriously and/or if the same questions on different occasions yielded similar responses. They suggested that the reader check for appropriate measurements for the sample. For instance, the reader could determine if the researcher sufficiently described the targeted population and how the researcher made the participants feel comfortable with the research? They suggested that the reader check that the researcher developed and clearly stated appropriate procedures so that other researchers could replicate them. For instance, the reader could look for specified procedures and any sequences?

In the research results section, Gall et al. (1996) suggested that the reader check that the researcher wrote thick descriptions that enlivened the individuals and their behavior. For instance, the reader could determine if the researcher described participant strategies or behaviors in enough details and with enough examples. They suggested that the reader check that each variable emerged from the data in a meaningful way. For instance, the reader could look at the analysis of interviews to determine if the researcher found repetitive themes in comments and then labeled those themes in words the participants would have understood. They suggested that the reader check that the researcher clearly stated hypotheses or questions and that the researcher then checked to see if they emerged from the collected data. For instance, the reader could determine if the researcher wrote the narrative account and developed hypotheses as to why events occurred so that future researchers could test them. They suggested that the reader check for appropriate statistical techniques used and used correctly. For instance, if the researcher could easily quantify time, the reader could verify that the researcher collected some time data and reported the means and standard deviations.

In the discussion of results section, Gall et al. (1996) suggested that the reader check that the researcher used multiple sources of evidence to support the conclusions. For instance, if a researcher made a statement that the participants were frustrated then the reader could check that the researcher documented this frustration in interviews, in field notes, and in letters. They suggested that the reader check that the

researcher noted reasonable explanations for the findings. For instance, when the researchers noted findings, the reader could check that the researcher included reasonable explanations and considered reasonable alternatives for those findings. They suggested that the reader check that the researcher appropriately qualified the ability to generalize to the findings. For instance, if the researcher inappropriately generalized a finding only to the participants, then the reader could examine the findings for significant implications for a larger audience. Moreover, the reader could determine whether readers could not generalize for themselves because the researcher failed to describe the participants thoroughly. They suggested that the reader check that the researcher used their findings to draw reasonable implications for practice. For example, if the researchers found benefits from a program, the reader could determine whether the researcher encouraged others to follow the program, and whether they grounded their recommendations regarding the benefits.

#### *Validity and Reliability*

Leedy (1997) also talked about validity and reliability of a qualitative study and various methods for judging them. Leedy noted that no commonly accepted standards existed and that researchers rarely used all of the techniques in one study. Table 2 includes my summary of the suggestions made by Leedy.

Table 2

*Judging Validity and Reliability of a Qualitative Study*

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Validity
Usefulness – the results enlighten readers or users.
Contextual completeness – comprehensiveness of situation achieved through history, physical setting, activities, schedules, routines, individual perceptions and meanings.
Researcher positioning – awareness and reporting of the researcher’s subtle and direct influences (beliefs, values, biases) in the research setting.
Reporting style – researcher’s reporting of participants perceptions need to reflect authenticity.
Triangulation - to check the validity of the findings, the researcher uses multiple data collection methods, data sources, analysts, or theories. The credibility of interpretations increases if similar themes get noted in data collected from a variety of sources.
Member checking – the researcher has the participants review reports for accuracy and completeness. It often leads to corrections, revisions, and deeper insights.
Chain of evidence – Stronger validity occurs when the researcher can establish a strong link between the research questions, the methods, the raw data, and the findings. By being able to follow the researcher’s logic, the readers can also detect where the conclusions seem logical.
Outlier analysis – When the researcher examines cases that differ from the common findings, the presence or absence of key elements in the extreme cases actually strengthen the common findings.
Pattern matching – After an intervention study (as in many quantitative studies), if the researcher finds anticipated behaviors or patterns in the observations for a specific case, the validity of the qualitative study increases.
Representativeness checking – Conduct checks at a site to determine whether a finding seems typical, an artifact of the interviewee, or an artifact of the researcher’s presence.

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## Reliability

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Long-term involvement – Data collected over longer periods of time help to distinguish whether perceptions seem situational or follow a consistent trend.

Coding checks –A high interrater reliability coefficient when more than one researcher codes data suggests a highly reliable coding process.

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## Introduction to My Methods and Procedures

The SightPros-VirTechs system revolutionized the way Metro Environmental conducted their business and training. Using the general systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993), I determined that the SightPros-VirTechs system potentially impacted all personnel at Metro Environmental, their customer contacts, their business contacts, their industry contacts, and/or other industries. I suspected the changes because the SightPros-VirTechs system altered the overall working environment at Metro Environmental.

The owners of Metro Environmental let me work as an independent researcher to study the impact of their SightPros-VirTechs system on the overall operation of their business. John Thomason, the president/co-owner, asked me to let him include information from my study in his current and future publications.

I considered the changing environments at Metro Environmental and the impacts as I selected my methods and procedures. I also considered the participants and the potential publication of study data and conclusions in my selections.

## Research Design for the Metro Environmental Study

In the previous sections, my exploration of the benefits and limitations of quantitative and qualitative research left me with a better understanding of why qualitative research, and more specifically participatory action research, seemed like the best design selection for this study of Metro Environmental and their SightPros-VirTechs system. Wireless video technology within apprenticeship training seemed like an area without much prior research, in a very fluid environment, and without sufficient data to fit a quantitative model. The qualitative pilot study in the spring of 2003 revealed that the environment at Metro Environmental operated in flux in trying to adapt to new call management software and in trying to set up the remote communications systems that allowed the SightPros-VirTechs system to operate. The setting seemed complex. The problems and situations appeared dynamic. However, where opportunities have existed to supplement the qualitative data with statistical findings, I include those findings in this dissertation. I also include both qualitative and statistical findings from the previous pilot studies (see reports in Appendix A and Appendix B).

For this study, I selected the qualitative research model. I opted for an overall design of participatory action research with aspects of case study, applied ethnography, and grounded theory traditions. In an attempt to document the impact of the SightPros-VirTechs system on Metro Environmental, I planned the study as:

- Exploratory (I mapped new territory to find relevant materials.)
- Collaborative (I collaborated with my participants.)



- Adaptive (I made modifications to the study as the needs changed.)
- Iterative (I repeated methods and procedures to discover relevant patterns.)

For this study, I spent approximately 3 months of on-site and/or Internet time with the Metro Environmental personnel, customers, and business contacts as a participant observer and collaborator. I focused on the impact of the currently established strategies and techniques used by Metro Environmental in training their technicians using the SightPros-VirTechs system and on any modifications to those strategies and techniques.

I also investigated individual and group characteristics and behavior at Metro Environmental. My research included data on cultural beliefs and/or practices, social behavior, language, communication, motivation, identity, perception, and cognition. Research involved various materials and records related to Metro Environmental and also to the HVAC industry. Some of the materials and records came from service call reports, time logs, Internet communications, etc. that were business relevant, not strictly research relevant. Other material came from recordings made directly for research purposes such as audio and video tape recordings made during my visits at Metro Environmental and to customer locations.

As part of my participatory action research, I met with all Metro Environmental personnel a minimum of once a week and usually more frequently. I purposely attended morning meeting on many days where I collected on-site data since all technicians would meet in the morning to get assignments for the morning/day. As appropriate, I

shared information and suggestions with management, technicians, and other office personnel. The information and suggestions came from my observations, participant feedback, and additional research explorations and readings.

I decided against an evaluation study, but I included some elements of evaluation. Metro Environmental had not documented the actual and/or estimated development costs needed for a thorough evaluation study.

### Research Methods

The methodology for this study combined participatory action research methods with methods from case study, applied ethnography, and grounded theory. I included participant observation, mapping, audio recordings, video recordings, telephone, email, audio conferencing, interviews, and survey methodologies. When opportunities arose, I used other methodologies from oral history, focus group, program evaluation, human factors evaluation, and quality assurance. My collection of data included business literature, business records, personal observations, notes, researcher and participant reflections, video, audio recordings, Internet communications and searches, site mapping, photographs, etc.

With this study, I used some techniques and methods from grounded research such as coding data. I looked for themes to discover potential theories in the SightPros-VirTechs system. It did not include full grounded research due to the limited timeframes for this study. By using some of the grounded theory methods, I found answers to most of the intended questions and answers to some questions for which I had not planned.

Overall, I intended to document my finding with “thick description” (Geertz, 1973) (very detailed) of the environment through narratives and statistical records.

My two pilot studies at Metro Environmental tested many of the research methods used for this study. Appendix A and Appendix B contain the reports submitted at the end of each pilot study.

### Population

The target population for this study included all businesses and industries that dispatched service calls and their customer, business, and industry contacts. I limited the population for this study to adults.

### *Sample*

I considered the sample as critical case since John Thomason developed the SightPros-VirTechs system and Metro Environmental remained the only site using it in 2007. The sample population for this study included (a) all personnel at Metro Environmental who chose to participate and (b) all customer, business, and industry contacts of Metro Environmental who chose to participate and who had direct contact with me during the site visits and/or observations.

All participants had to sign a written permission form. As long as they expressed willingness to participate and to sign the form, they did not undergo additional screening. I did not include or exclude any participants by gender, adult age, health, race, or ethnicity. All participants verified that they were 18 years or older. I presumed that all participants had good health and had full mental capacity. The study populations

roughly mirrored the population of the HVAC industry and their customer, business, and industry contacts.

I designed this study as a qualitative study not a quantitative study. I did not include a strict comparison between populations. Therefore, I did not need a control population.

I gave no cash payments for participation in this study. However, I gave an occasional snack, meal, or other appropriate gift of appreciation for the participant's time.

#### *Subpopulation 1*

This sub-population included all 12 Metro Environmental personnel. It included: owners, management, sales personnel, office personnel, and field technicians/apprentices. Everyone in this subpopulation agreed to participate.

Historically, the HVAC business has attracted significantly more male than female employees because of the high technical skill requirements, the lifting of heavy equipment, the temperature extremes, and the dirty work environments. Participants in this subpopulation included a total of 12 participants, 4 females and 8 males. This included 7 office participants (the owners, management, sales personnel, and other office personnel) with a gender ratio of 4 females to 3 males. This also included all 5 field technicians with a gender ratio of 0 females to 5 males.

Other than gender, the composition of the study participants included a mix of adult age, health status, racial backgrounds, and ethnicity factors. The gender, adult age,

health status, racial background, and ethnicity composition of this subpopulation roughly mirrored the population of business personnel for all service-dispatched industries.

### *Subpopulation 2*

Subpopulation 2 contained all adult customers, business associates, and industry contacts of Metro Environmental. I considered everyone for participation in this study unless a Metro Environmental personnel requested exclusion for them or they excluded themselves. I had 2 exclusion requests for privacy and safety concerns. None of the requested exclusions occurred due to gender, adult age, health status, racial backgrounds, and/or ethnicity reasons.

Participants from this sub-population included approximately 40 Metro Environmental customers and 4 Metro Environmental business and industry contacts. Selection of specific customers, business, and industry participants essentially depended on random customer calls, pending meetings, available personnel, management schedules, and my availability. I selected participants strictly by the random contacts that I made during the research period and on those contacts who then agreed to participate. I personally invited everyone that I contacted during my site visits to participate. The gender, adult age, health status, racial backgrounds, and ethnicity ratios for this subpopulation varied and roughly mirrored the population of the customers, business contacts, and industry contacts for all service-dispatched industries in North America.

## Participant Considerations

I applied standard ethical guidelines to interactions with all research participants. First, I identified the risks by this study to the participants and devised precautions to protect the participants from those risks. Next, I considered the confidentiality of the participants in this study and again devised precautions. Lastly, I monitored the amount of time that each participant in this study contributed to this study so that I did not demand unreasonable and/or excessive time from any participant.

### *Risks and Precautions*

I focused this study on the impact of the Training in the SightPros-VirTechs system on Metro Environmental and others. This study included participant observations that documented the normal job duties and interactions for personnel, customers, and business/industry contacts. I did not find any hazards generated by my research.

I studied normal events in their natural environment. Historically, an ethnographic study like this one has presented a very low level of risk, especially when the researchers have maintained standard ethical precautions. My investigative procedures involved minimal risk to any participants. Participants were at no more risk in this study than those risks they typically experienced during their normal work days.

Participants encountered no physical or psychological risks due to this study. The study caused no discomfort. Participants sometimes experienced minor discomforts or

stresses due to problems in their HVAC system that resulted in the service calls or to the environment surrounding the HVAC system, but none that directly resulted from this study. Participants experienced only minor inconvenience. No painful or drugged conditions occurred as a result of this study.

I felt an ethical need to protect all of my participants from harm. With help from my committee and/or my participants, I worked out all issues that arose before and/or during the study. I explained in written consent forms and in verbal discussions the potential ramifications regarding ethics, informed consent, and confidentiality.

John Thomason agreed that no one would be compelled to participate in the study without his or her freely given and written permission. He mailed a signed agreement to the UNT IRB (University of North Texas Institutional Review Board) stating that any person who preferred not to participate in the study or later withdrew from participation would suffer no prejudicial actions regarding their employment status with Metro Environmental. I include an unsigned copy of his agreement in Appendix C.

Prior to the actual research, I created a set of informed consent agreements that satisfied my ethical standards, the ethical standards of Metro Environmental, and the ethical standards of the UNT IRB. I include final approved copies of those agreements in Appendix D and Appendix E.

Whenever I met any potential participants for this study, I briefly described the project to them so that they fully understood the goals and possible risks. If they acknowledged willingness to participate, I had them complete and sign two copies of

the consent form - one for them to keep and one for me to keep. I answered any questions that they had and verbally verified that they understood and fully appreciated their participation in the study.

Especially because I designed this as a collaborative research project, I made all participants aware that they could review, comment, and potentially correct my forms and reports prior to discussion or distribution. None of the participants requested to review or comment on any forms or reports. I requested that John Thomason review all of my forms and reports prior to use or publication. He suggested a few minor clarifications/corrections to the HVAC terminology in Appendix J and minor corrections to the consent forms.

I did not work as an employee of Metro Environmental. So, prior to any field visits, either someone from Metro Environmental or I obtained verbal permission from the customer for me to visit the customer site with a Metro Environmental team member(s).

I carefully have reviewed all public information and published materials to verify the protection from harm for all participants. I have withheld information such as unedited video files that I cannot make public so as to protect the participants. I have made some edited portions of the video files public to demonstrate situations, procedures, training, etc.



### *Confidentiality and Precautions*

Many studies require full confidentiality. I felt that I could not assure full confidentiality to the research participants in this study for the following reasons:

- As part of the Training in the SightPros-VirTechs system and job requirements, Metro Environmental sent live, streaming video over secured wireless Internet connections. John Thomason typically watched the video to monitor the work site situations and listened to the audio-visual communications. Moreover, the office personnel, customers, and business/industry contacts have monitored this live, streaming video. However, my request to save the video streams as computer files, audio recordings, and/or video recordings constituted a slight change from their normal procedures. I wanted to save them for analysis of terminology, communication patterns, etc. instead of allowing the streaming video software to immediately discard them. Metro Environmental recorded participants (and possibly their identities) on these audio and video files so I considered and specified the confidentiality issues and precautions on the consent form.
- Because of the collaborative design of this study, I could not maintain total confidentiality of information between customers, business contacts, office personnel, and management. I permitted and occasionally requested

management to review feedback and reports from my observations, interviews, and/or surveys.

- The small size of the Metro Environmental business created a close relationship between management and all other personnel.
- The future license potential of the SightPros-VirTechs system created a need for an open business environment and recognizable personnel.
- The results of most studies get discussed and/or published. My two pilot studies resulted from class projects so I included the results in classroom discussions and reports. I include the results of all three studies in this dissertation and/or the appendices. Both John Thomason and I have planned to publish my results on his Internet sites, in articles for trade magazines or journals, and possibly in a book about Metro Environmental and the SightPros-VirTechs system.

I made all participants aware of the previous facts regarding their full confidentiality. My additional precautions to minimize concerns for confidentiality have included:

- Upon meeting potential participants, I stated that I could not maintain full confidentiality.
- Before joining the study, I made the potential participants sign a written consent form that discussed the confidentiality issues. I made all participants aware in their letter of consent that I could not maintain full confidentiality

so that information they shared with me could be made available to Metro Environmental personnel. However, I pledged that their identities would be withheld in any public publications unless they consented otherwise.

- I allowed participants to review my findings prior to their presentation to the owners/management. No participants requested review of any findings.
- I allowed participants to review and comment on report materials prior to any presentation to the management, before presentations in public forums, and/or before publication. No participants requested review of report materials.
- I have maintained under lock and key all handwritten documents pertinent to this study (such as interviews, surveys, notes, etc.) so that it will not appear publicly. However, I have reserved the right to make the documents accessible to future researchers to view the data to validate my results or analyze the material for additional research study. If other researchers would like to study the materials, I will only make the data available to them with the restrictions that they maintain the privacy of the Metro Environmental business-critical records and/or the privacy of the participants.
- I have maintained under lock and key all other raw data pertinent to this study that I collected (such as artifacts and my audio and video files). I will not release any raw video and audio files that I recorded on the various site visits (including office visits) to public distribution. For all digital files, I have

kept the files and one backup copy. I have kept my analysis software off-line and password protected. Most of the raw data that I collected will not appear publicly. Nonetheless, I have reserved the right to release certain artifacts (such as old parts or samples of supply materials) for brief public presentations. Moreover, I have reserved the right to make the raw data accessible to future researchers to view the data to validate my results or analyze the material for additional research study. If other researchers would like to study the materials, I will only make the data available to them with the restrictions that they maintain the privacy of the Metro Environmental business-critical records and/or the privacy of the participants.

- I have maintained under lock and key some raw data pertinent to this study that Metro Environmental collected. For example, John Thomason recorded the streaming videos to files on his personal computer. He then burned a copy of those computer files to a CD or DVD disk which he gave to me for use and for permanent storage. Also, I copied some Metro Environmental records and reports that I used and I have archived them with my other study materials. I will not make this raw data public. However, John Thomason has those files, records, and reports on his computer and he could make them public. Moreover, I have reserved the right to make the raw data accessible to future researchers to view the data to validate my results or analyze the material for additional research study. If other researchers would like to

study the materials, I will only make the data available to them with the restrictions that they maintain the privacy of the Metro Environmental business-critical records and/or the privacy of the participants.

- I have edited the video and audio files to maintain the confidentiality of participants during public presentations unless the participants consented otherwise. I have used segments of edited files to present information to managers, participants, presentations, and/or publications.
- I have kept customers and business contacts anonymous for all public reports by using pseudonyms and by modifying or eliminating any identifying information. I have not released any identities except the business relationships with Trane, Inc. - the known major supplier of Trane® HVAC systems and HVAC units to Metro Environmental.
- I have used real names for the Metro Environmental participants for all public reports but with the expressed permission of those participants and with permission of the management. I had planned to use pseudonyms and modify or omit any identifying information for personnel who requested anonymity. However, all Metro Environmental personnel expressed interest in and permission to use their real first names for any publications. John Thomason requested that I use real first and last names for his family and the real company name for my publication.

Metro Environmental has operated as a small family-owned business managed by the owners. They already had first-hand knowledge of existing skill levels and attitudes, so I felt that the confidentiality issue could not harm any of the personnel, customer contacts, or business contacts any more than they might experience harm without this study.

Additionally, since 1998, John Thomason has written articles for leading magazines in industry regarding the use of computers in the HVAC industry and in his business in particular. So, the Metro Environmental personnel expected additional publications. Therefore, new publications should not present new or additional risks because of this study.

I found instances of minimal risk due to the study for some participants not directly involved in the study. Because some site visits included live, streaming video over secured Internet connections, technicians recorded audio/video transmissions that unintentionally included more than the adult customers, technicians, and the HVAC system at the customer's premises. For instance, several recordings included background audio of the customer's young children. I treated this unintentional capture as "background noise." I could not control all of the "background noise" but I found it irrelevant to this study so I mentally noted it, ignored it, and then limited access to the files. Therefore, I concluded that no physical or psychological risks occurred due to the study for any participants not directly involved in the study.

### *Time Requirements for the Participants*

The research study focused on participant observation, interviews, and surveys of the Metro Environmental personnel and their customer, business, and industry contacts. I observed each participant as they went about their normal activities as follows:

- Metro Environmental office personnel in 15-minutes to 4-hour sessions
- Metro Environmental field personnel in 15-minutes to 8-hour sessions
- Metro Environmental customers, business, and industry contacts in sessions that varied depending on the length of the visits with the Metro Environmental personnel. Some service calls to a customer only took 30 minutes. New system installations took about 1 day. System replacements with multiple HVAC units took as long as 3 days.

I conducted interviews and/or surveys for all study participants. The interviews/surveys included some specific questions and some open ended, anthropological-style questions specifically designed to probe the participant's relationship with Metro Environmental and/or the Training in the SightPros-VirTechs system. I include blank copies of my customer pre-site interview forms, my customer post-site interview forms, and my customer survey forms in Appendix F.

I determined overall customer satisfaction through current Metro Environmental processes, site and telephone interviews, my email surveys, and surveys conducted by Trane Corporation. I elicited customer satisfaction feedback from all customers and

business contacts that I observed and interviewed during each field visit. I also designed a post-site interview on the same sheet as but immediately after the pre-site interview to reduce my paper copies. I sent or conducted either a post-site survey or interview approximately two weeks after the time of the on-site visit.

I calculated the times for the customer and business participant's interviews and surveys as follows:

- The on-site interviews took between 5 minutes and 20 minutes each. They averaged 12 minutes.
- The telephone interviews lasted between 6 minutes and 14 minutes. They averaged 11 minutes.
- The email surveys probably took as short as 5 minutes and as long as 15 minutes. (I estimated the email survey times from the amount of data included on each feedback e-mail that I received.) They averaged 10 minutes.

In addition to my observations, I created structured interviews for the Metro Environmental personnel. I created one set of questions for the technicians and another set of questions for all of the office personnel. The length of time it took me to conduct the interviews depended on the relationship of the participants to the study goals, the openness of the participant, and the conversational skills of the participant. The interviews for most of the technicians took approximately 30 minutes, but the interview for the apprentice lasted approximately 1 hour. The interview for the co-owner/president lasted approximately 1 hour because I used both ME interview forms



for him since I considered him as both a certified technician and an office personnel. The interviews for the rest of the office personnel lasted approximately 30 minutes each. For all Metro Environmental personnel, I conducted those interviews during work hours but when management considered their work activity as at a minimum. I include blank copies of my interview forms in Appendix G and Appendix H.

Due to the open-ended nature of ethnographic studies, the multi-tasking of personnel necessary to operate efficiently in a small-business environment, and the collaborative processes that occurred, I could not calculate exactly how long it took me to document satisfactorily the role each person played in the business. I questioned some participants with critical information (mainly John Thomason and Kwame) extensively using an unstructured interview format during my participant observations, but I always interviewed them at the participant's convenience and only on an as-needed basis to obtain additional study insights.

#### Research Locations

I focused this study on Metro Environmental, a HVAC company. I made most of my observations at the home office or on their customer job sites, both residential and commercial. I made occasional observations at fast-food and/or other commercial locations. I made some observations strictly through the streaming video from the SightPros communication tool.

Metro Environmental located their headquarters in Lewisville, Texas. I conducted approximately half of my observations at their headquarters. I typically observed the

office personnel in their Metro Environmental work spaces - sometimes in their offices, sometimes in open areas, sometimes in the warehouse. Although the technicians did not have specific offices, I typically observed the Metro Environmental technicians in the work spaces at Metro Environmental, at various field and customer locations, through online observation of the streaming video, and/or through video recorded independently by John Thomason.

Metro Environmental serviced HVAC systems throughout the Dallas/Fort-Worth Metroplex and the surrounding North Texas region. I typically met their business and industry associates at Metro Environmental and/or at various parts houses throughout that region. I rarely saw any customers at the Metro Environmental offices. I observed the customers during the field visits with the technicians, with the salesperson, and/or with John Thomason. I conducted approximately half of my observations during field visits with Metro Environmental personnel to their customer, business, and industry contacts. Therefore, the study locations also included sites related to those field visits.

Selection of specific customers, business, and industry locations essentially depended on random customer calls, pending meetings, available personnel, management schedules, and my availability. Because Metro Environmental considered the fieldwork as business sensitive, I cannot reveal the exact locations of the customer, business, and industry participants other than to say that their locations coincided with the entire North Texas area serviced by Metro Environmental.

## Research Procedures

This section captures the design and essence of my research procedures. Due to the open-ended nature of ethnographic studies, the multi-tasking of personnel necessary to operate efficiently in a small-business environment, and the collaborative processes that occurred, I have found it difficult to specify every detail about the procedures that I needed and used to document satisfactorily the role each person played in this study. Nonetheless, I include all relevant procedures in this section.

### *General Research Procedures*

I conducted this research study as a qualitative study that focused on participant observations, interviews, and surveys of the Metro Environmental personnel, customers, and business contacts. As part of normal ethnographic activities, I (a) mapped locations to provide visual orientation to notes and observations; (b) observed participants as they went about their normal work activities; (c) conducted interviews and surveys; (d) collected appropriate documents, records, and artifacts; and (e) analyzed the data.

I used participative action research and collaborative techniques. Therefore, I revised the study, the procedures, and/or the narratives as the study developed whenever I, my committee, the UNT IRB, and/or Metro Environmental personnel deemed them more appropriate, efficient, or effective. For instance, I based my IRB application for this study on the IRB application for the pilot studies. Later, John Thomason requested minor revisions to the customer consent form and all of the

interview forms so I honored that request and the UNT IRB approved them.

Nonetheless, most of the initial processes were useful and iterative (repetitious) throughout the study.

My investigative instruments (surveys and interviews) were not standard. However, I patterned them after typical interview and survey questions from training evaluation studies, anthropological studies, and customer satisfaction instruments. The final versions of each form are the only ones included in the appendices.

The field study started in December 2007 and ended in March 2008. During that timeframe, I systematically observed and recorded locations and individuals who were both connected with Metro Environmental in the course of normal work activities and who agreed to participate in this study.

#### *Data Collection Procedures*

I coordinated scheduling of data collection activities with either the owners/managers or the dispatcher on a weekly, daily, and sometimes hourly basis depending on the level of activities of the personnel and specific opportunities that arose. Being a small, friendly business, I did this easily.

My observations and interviews included all personnel at Metro Environmental, some customers of Metro Environmental, and some business/industry contacts. As an observer, I watched the personnel, customers, and contacts as unobtrusively as feasible. I observed the participants during normal office hours and/or during lunch. I

participated in some activities whenever and wherever feasible and helpful. As appropriate, I even assumed the role of a technician assistant.

Whenever possible, I carried a digital audio recorder and/or a camcorder to maximize data capture of the typical working communications and the interview data. After obtaining the appropriate approvals, I recorded my observations and my interviews as digital audio and/or video files. I recorded all of my direct contacts and/or briefly summarized them later on my audio recorder notes. I captured recordings of Metro Environmental personnel during the training in the SightPros-VirTechs system. I captured recordings at multiple study locations including the customer site visits.

I observed some personnel in multiple sessions including normal work activities, training, and team meetings. Because of the teamwork that occurred, I frequently observed several personnel simultaneously in many of the sessions.

As noted previously, I conducted open-ended interviews with the Metro Environmental personnel, the customers, and the business contacts. I recorded audio for all my interviews. For Metro Environmental personnel, I conducted the interviews during normal work hours but when management considered their work activity as at a minimum. I conducted on-site customer interviews once for every site visit.

Other than installation surveys conducted by the HVAC supplier, Metro Environmental did not routinely conduct other formal customer satisfaction surveys. They conducted many informal customer satisfaction surveys via ongoing conversations with their customers. To gather customer satisfaction data relevant to my study, I also

created short email and/or telephone surveys for those customers/contacts that I observed during the field visits. I sent or conducted my surveys/interviews approximately two weeks after the time of my on-site visit.

I recorded and/or wrote notes and personal memos throughout the study. Before and after each field visit, I briefly recorded my personal thoughts, reflections, and feelings so that later I could summarize the activities, provide insight into my personal biases, and notate areas for additional research and/or inquiry. During the field visits along with my recorded field observations, I frequently recorded notes as I mentally analyzed the activities, interactions, and skill levels. I recorded additional notes while driving home or later in the evenings as I rethought the day's activities. I created personal memos regarding the study to rethink areas for further exploration and to rethink the environment.

I transferred all audio and video files at least once a week to my personal computer, made back-up copies to a My Book<sup>®</sup> Essential 500 GB external hard drive, and then deleted the original audio and video files from the digital audio recorder and the camcorder. I generated an index of individual files and briefly identified the file data for easier reference and retrieval during my data analysis.

I entered all handwritten notes into my computer. I then transferred them into my Transana<sup>™</sup> qualitative analysis software for video and audio data (Woods & Fassnacht, 2007).

I collected some artifacts appropriate to the study. For instance, John Thomason used call data software to track both customers and technicians. I collected printouts of various Metro Environmental records such as the call data information and various reports. I received originals of many artifacts that were dispensable to Metro Environmental (like extra printouts of call records or discarded parts). However, in a few instances, I copied the artifacts, but Metro Environmental maintained the originals.

#### *Additional Hardware and Software Details*

Once my committee approved my study, I purchased a new JVC® Everio® hard disk camcorder for this study. This camcorder satisfied all of my dreams for capturing video. It could record up to 37 hours of video on its 30GB drive. It had 800x digital zoom. It had both a compact and lightweight design. I could operate it with ease. It weighed less than a pound. It worked great in low light conditions, even producing slightly better video than the network camera used in the SightPros communication tool. The battery that came with the camcorder lasted only about 1.5 hours, but the camcorder came with a battery charger that also worked as a transformer for direct power recording. Optional accessories included a 3-hour and/or a 4-hour battery, but I elected to use power cords instead of purchasing those batteries because of the high prices for them. I purchased an accessory kit (a small camcorder bag and tripod) that the store offered at a pre-packaged, reduced price with the camcorder purchase.

I also purchased a new digital audio recorder, Panasonic® RR-US450 IC recorder, to capture most conversations throughout the study. It could store up to 66 hours of

recorded audio. This allowed me to capture a full week of recordings before downloading them.

My Panasonic RR-US450 IC recorder came with a cable which allowed direct downloads of audio files to my personal computer. It came with software that converted the stored files into wave files (.wav) that I then download into my Transana qualitative analysis software for video and audio data (Woods & Fassnacht, 2007). These features proved helpful for this study as I saved and backed up the files and then reset the recorder.

The Panasonic IC recorder had 5 folders. They designed the first three folders for general recording. They designed the fourth folder as a security folder in which a user could maintain password protection for the recordings. They designed the fifth folder as a dictation folder that they set to automatically record with ideal settings for voice recognition.

On first connection of the Panasonic RR-US450 IC recorder to my computer, the program asked me for an authentication code of up to 128 characters. However, I failed to write down or properly remember the authentication code and according to the manufacturer even they could not reset it. I tried every password code that I had ever used and I still did not determine my original code so it created several problems. I did not store any recordings in the security folder because I could not retrieve any files stored in the security folder without the code. Because I did not use the security folder, I had no password protection. Once I accidentally selected the folder and recorded to it



so I lost those files because I could not retrieve them without the proper authentication code.

The Panasonic RR-US450 IC recorder also came with associated voice recognition software that the package touted as allowing faster transcriptions. After multiple tries at understanding the two distinct booklets - one for the recorder and one for the software, I never successfully trained the recognition software for even close recognition of my recorded audio, although I demonstrated expertise with other common hardware and software applications.

I purchased the Transana qualitative analysis software for video and audio data (Woods & Fassnacht, 2007) recommended by my anthropology professor as the best overall qualitative software for video analysis (C. Wasson personal communication, spring 2004 & fall 2007). The software had minor glitches with the files it supported, but overall it worked wonders for this study. I uploaded audio files from my digital audio recorder. I uploaded video files from John Thomason as well as video files from my digital camcorder. I successfully used the qualitative computer analysis program to analyze both the audio and video files. The program successfully handled the multiple files and most of the file formats from this study.

The JVC Everio hard disk camcorder saved files as digital (.mod) files. Once I downloaded them to my personal computer using the CyberLink® PowerCinema® NE for Everio® software (2006, Version 1.0), I played them directly on the computer. However, the audio track did not display when I entered these files into my Transana qualitative

analysis software for video and audio data (Woods & Fassnacht, 2007). Nonetheless, I took the .mod files, ran them through my Pinnacle Studio Plus (2007, Version 11) and then saved them as .mpg files. The new .mpg files successfully showed both the audio and video in the qualitative data analysis software.

I purchased Dragon® NaturallySpeaking® speech recognition software (2006, Version 9.0) and had used that program for some speech recognition. However, I felt insufficiently experienced at either dictation or using the speech recognition to match the speed at which I typed, so I did not use that software for this study. Moreover, the qualitative data analysis software that I used for the video analysis did not properly support the speech recognition features.

I purchased a My Book Essential 500 GB external hard drive to store the digital files. I felt that this would be significantly large enough to store any computer files associated with the research. I password protected the folders on the external drive for additional security purposes. After I have completed analyzing all of the files, I will remove the files to DVDs that I can secure easier.

I had a Dell® Inspiron® laptop computer with a Microsoft® Webcam that I carried daily. Practically, however, I liked using the two small, independent digital recorders (the audio recorder and the camcorder) and then doing my computer work on my residential personal computer with its full-size keyboard. Essentially I devoted my on-site research time to capturing information. I never used the Webcam for this study and seldom used the laptop computer.

### *Data Analysis Procedures*

My analysis blended the structural (inherent patterns of discourse, text, events, or other phenomena) and the reflexive styles (reflection and self-reflection). When I used it, the structural style allowed a scientific approach to my analysis. When I used it, the reflexive style allowed my voice to portray the study and reveal my biases.

Whenever possible, I triangulated the findings (using multiple data collection methods, data sources, analysts, or theories to check the validity of my findings) and made them useful (helpful to the participants or readers). I constantly compared all of the data and simultaneously made revisions to the study (a) if I felt that the revision appropriately fit the study, (b) if both a member of my doctoral committee and Metro Environmental approved of the revision and (c) whenever necessary, the UNT IRB approved of the revision.

I used appropriate qualitative data analysis software for my analysis. That software assisted me with transcription, coding, and analysis of data - especially the audio and video recordings. As I collected recorded audio and video data, I input it into my software. On a weekly basis, I selected key data segments to transcribe and review. I added notes as appropriate to each file. I coded important segments of the collected data using a coding scheme. I analyzed them from a variety of perspectives. The coded data assisted me in determining important interactions and patterns in the Metro Environmental operations. I built appropriate analytical categories. I then tied the categories into parent/child relationships, concepts, and models.

I reviewed the transcriptions of my personal notes and memos to rethink areas for further exploration and to rethink the environment. I wrote reflexive remarks. I then added further clarifications as needed.

I also utilized appropriate quantitative data analysis software for my analysis of Training in the SightPros-VirTechs system. As available, I entered statistical data such as interview times, survey results, etc. I grouped the data and analyzed the results throughout the study.

I examined all appropriate artifacts for additional insights. I then confirmed my reasoning through discussions with John Thomason, the expert, and others.

To provide validity and reliability to the study, I used several techniques. As noted earlier, whenever possible, I triangulated the findings with other data that I gathered - such as the information found in my literature searches, data from my pilot studies, and data from other service calls or personnel in this study. I strived for contextual completeness and usefulness. Whenever possible, I adapted the findings to Metro Environmental and/or other HVAC or service-dispatched industries. I reviewed, along with several other participants, narrative reports for corrections, amendments or editing. My extensive audio and video recordings, my transcripts, my consent forms, my interview forms, my artifacts, and my notes have provided a strong chain of evidence for my findings. In this report, I detail explicitly my biases and my positions in this study.

## Researcher Bias

The ethnographer enters the field with an open mind, not an empty head. . . . Biases serve both positive and negative functions. When controlled, biases can focus and limit the research effort. When uncontrolled, they can undermine the quality of ethnographic research. To mitigate the negative effects of bias, the ethnographer must first make specific biases explicit. A series of additional quality controls, such as triangulation, contextualization, and a nonjudgmental orientation, place a check on the negative influence of bias. (Fetterman, 1998, pp. 1-2)

To control for any researcher bias in this study, I had to first recognize the potential for biases and then eliminate or minimize those biases. As noted in chapter 2, I elected to seek a broad but solid understanding to minimize researcher bias and/or preconceptions and to avoid information overload (Chambers, 2000; Strauss and Corbin, 1998; Yin, 1993) even in my literature reviews.

Throughout the study, I reviewed personal thoughts that I captured on the Panasonic RR-US450 IC recorder and analyzed them again as I transcribed them. I then discussed those thoughts and/or feelings with family, friends, and peers but only in generalities rather than specifics so that I maintained the confidentiality of the participants. As appropriate, I offered my thoughts and insights in discussions with Metro Environmental management. Those discussions with the management often added clarification and new or clarified insights into the Metro Environmental environment. For example, some of the materials presented in this study, on the perceived social status of the technicians, were a result of reflections on my biases which I later discussed with John Thomason.

I have worked with computer and technology applications for many years so I have a potential bias towards applied technologies. My expertise in computer applications, training, and technical writings began in high school. I personally have found computer technology helpful, but also very expensive, time consuming, and often frustrating whenever problems occur as they always do.

I had no vested interest in the outcome of this study. I have had a working relationship and an extended acquaintance with the owners of Metro Environmental because of our mutual interest in applied technology, but nothing that would unduly influence my objectiveness in the findings. Prior to the first pilot study, Metro Environmental performed one HVAC service call and one HVAC system replacement at my home. During the first contact, in July 2000, I spoke directly to John Thomason, the president/co-owner of the company, regarding the service call and we discovered and discussed our mutual interest in streaming video. During the second contact, in September 2002, I met face-to-face with the president/co-owner during an HVAC system bid process at my home. We again discussed computer applications and then exchanged communications for the next several months. By February 2003, I called the president/co-owner to propose a full study on his training as the topic for my dissertation, but stated that I wanted to start my research with a small pilot study. In the early spring of 2003, as part of a qualitative analysis class, I conducted my first pilot test. During the summer of 2003, the president/co-owner realized that the use of personal computers on job sites seemed impractical in the hot summer under the

extreme conditions that the HVAC technicians faced. In November 2003, I used Metro Environmental for a fall tune-up of my household HVAC system. In the spring of 2004, I conducted a second small pilot test for this study as part of an anthropology course on language and culture. In conjunction with that study, I helped John Thomason apply for a NIST grant which regrettably proved unsuccessful. At that time, the SightPros-VirTechs system and the portable, wireless audio/visual equipment he tested still remained impractical for normal field use. In the summer of 2004, I assisted Metro Environmental in their office when one of their key office personnel took a medical leave of absence. In May 2007, I used Metro Environmental for a routine HVAC service call on my outside condenser. Later that summer, the president/co-owner of Metro Environmental contacted me to report their newest prototype of the SightPros communication tool and the pending negotiations for hardware production. The president/co-owner suggested a potential opportunity to again study the SightPros-VirTechs system. I now report that study in this dissertation.

### Output

Because I designed this as a collaborative study, I felt that my output benefited both the personnel at Metro Environmental and the business of Metro Environmental because I recorded and analyzed their system and I suggested improvements. Also, I provided independent insights into recent studies similar to the SightPros-VirTechs system that benefited their training. The study benefited their personnel, customers, and business contacts by giving them an independent avenue to voice their opinions.

This study helped to make the Metro Environmental training more efficient and effective which then helped the technicians become better skilled in shorter time frames. Moreover, the improved training could help the technicians and apprentices to better prepare for industry exams sooner in their careers.

This study confirmed the usefulness of the SightPros-VirTechs system, training, and the prototype SightPros communication tool. As John Thomason and I publish reports about this study, the results could encourage other companies to use the SightPros-VirTechs system and/or SightPros communication tools. If other companies adopt them, the entire dispatched-service industry could benefit by making other technicians more useful earlier in their careers and enticing them to stay in their field longer than normal. Their adoption could also enhance opportunities for some currently under-represented populations.

My narratives showed both the emic and the etic perspectives. My output included reflective (I included my intuitions and judgments.) details and "thickly" described details (I included many details so that the reader develops a better understanding of events, rituals, or customs.) about the SightPros-VirTechs system and the Metro Environmental environment. Additionally, I categorized and reported (with appropriate statistical techniques) the statistical data that I collected.

I built analytical categories, concepts, and models. I began development of some basic content dictionaries, taxonomies, mental/cognitive maps, schemata (shared cognition) and ethnographic decision models.



Sternberg (1996) noted that different people use different words to refer to the same category of things. Using classification schemes (taxonomies), I discovered various hierarchical structures (in sets of their terms) among elements in the HVAC domain at Metro Environmental. To identify the structures at Metro Environmental, I also built basic organizational charts (branching tree diagrams). Once published, these structures could provide important information for training and communications organizations.

Sternberg (1996) proposed that mental maps/mental models suggested internal representations of information/knowledge. These could then show visual displays of similarities among items (concepts). Sternberg noted that these worked best for displaying fuzzy constructions and dimensions. I used them for both analogical and symbolic knowledge representations at Metro Environmental. I used them to determine the skill levels for decision making and reasoning. They helped identify important concepts that helped technicians develop their troubleshooting and customer relationship skills.

Sternberg (1996) suggested that people develop cognitive maps. Cognitive maps capture the mental imagery or mental representation of the physical environments. Cognitive maps illustrate information analogous to physical maps in noting the landmarks, pathways, and mileage/spatial relationships between objects. I identified some of the cognitive maps used by the Metro Environmental personnel. I utilized their cognitive maps to reduce their words to fundamental meanings in the HVAC environment. Their cognitive maps illuminated a network of concepts. Sternberg

suggested that people based their cognitive maps on their procedural knowledge (so I analyzed the order in which participants did things), on their propositional information (so I analyzed the mental heuristics or rules of thumb participants created), on their observations (so I analyzed the things participants noticed), and on their verbal descriptions (so I analyzed the things participants mentioned). However, as Sternberg suggested, I sometimes perceived distortions in the cognitive maps. Overall, I analyzed their cognitive maps by combining intuitions from my coding with other methods of network analysis. These helped to reveal more about the working environment and the communications at Metro Environmental, more about the customers and industry contacts, and more about the locations they visited.

For the Metro Environmental training and environment, I developed some schemata (cognitive simplifications or organizations of concepts that helped me to make sense of their complex information). These schemata should enable culturally skilled people to fill in some of the details of the Metro Environmental stories and events as well as their own stories and events. These could help to demonstrate the potential benefits and/or risks of using the SightPros-VirTechs system in other organizations and or industries.

I looked for both what participants said and what participants assumed, but did not say, to help me identify underlying cultural assumptions. By identifying the underlying cultural assumptions, I then identified cultural changes that the general

systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993) predicted.

Moreover, I used ethnographic decision models to predict behavioral choices under specific circumstances. I assisted John Thomason with building preliminary decision trees, flowcharts, and nested if-then statements that could link different criteria to different behaviors of interest. These could prove important especially for training and troubleshooting.

### Summary

My overview of the research models used in both quantitative and qualitative research helped me to determine the methods, procedures, and evaluation goals that I selected for this study. I determined that mainly qualitative research and specifically participatory action research represented the best method to study the SightPros-VirTechs system at Metro Environmental. Participatory action research allowed me to take advantage of many qualitative traditions, methods, and procedures from case study, ethnography, and grounded theory. Where opportunities arose to supplement the qualitative data in this study with quantitative data, I collected and then included that statistical data in my analysis.

I conducted this study partially as a case study since the SightPros-VirTechs system represented a unique case for a study on wireless technologies in remote training, especially apprenticeship training. The use of the SightPros-VirTechs system remained in development and with very limited availability at the time.

I selected the "thick descriptions" typically used in ethnography to portray the use of SightPros-VirTechs system at Metro Environmental. I documented the impact of the SightPros-VirTechs system on training at Metro Environmental using a combination of participant observation, interviews, surveys, etc. to collect data on the perception and application of the system and the impact on the business. I opted to document the environment with media recordings, interviews, participant observations, and personal notes.

I also looked for grounded theories relative to the practical use of SightPros-VirTechs system in a real world environment. The site employed complex tasks and highly-trained experts versus the more-simplistic physical tasks and less-trained task helpers that many of the previous studies on the remote collaboration on physical tasks used.

The study benefited the company and the personnel. It benefited from collaborative methodology. John Thomason, the president/co-owner at Metro Environmental utilized his tremendous insights. His enthusiasm extended into improving his system and seeking input from others. Since I selected a collaborative research scheme, John and I used my background in analysis, computers, training, and development to further enhance his SightPros-VirTechs system.

The SightPros-VirTechs system suggested potential operational changes for other service-dispatched industries. I studied the impact of the SightPros-VirTechs system on Metro Environmental so that other organizations could gain insights into the system.

Metro Environmental represented the ideal sample to study the SightPros-VirTechs system because:

- One of the co-owners owned the patents for the SightPros-VirTechs system.
- Metro Environmental exemplified the few HVAC businesses that merged leading edge computer and communications technologies.

The target population for this study included all businesses and industries that dispatched service calls and their customer, business, and industry contacts. The "sample population" for my study at Metro Environmental included the following participants:

- All 12 personnel at Metro Environmental since they all agreed to participate,
- The 40 customers who agreed to participate, and
- The 4 business contacts who agreed to participate.

I felt that the study included a minimal risk to the participants and that I could not ensure total confidentiality so I needed to inform the participants. I included the risks regarding confidentiality as part of the consent form and then ensured that each participant understood and approved of the risks.

I collected and then analyzed data from observations, interviews, business records, computer communications, etc. using appropriate software. My output included "thick description" of the environment at Metro Environmental, of the use of the SightPros-VirTechs system, and of the impact of that system on the company, the HVAC industry, and/or other industries.

In final summation, I used this chapter to present the methods and procedures for my qualitative study on the use of the SightPros-VirTechs system for wireless, remote training. First, I reviewed the purpose of this study which included my major research questions. Next, I briefly explored the two major research models. Afterwards, I explored in more detail within the qualitative research model the relevant elements that I selected for this study. Then, I provided a general introduction to my methods and procedures. Subsequently, I described design specifics for my research at Metro Environmental. I discussed the research methods, the population, various participant considerations, and the locations that I used for the study. Then, I explained the research procedures, discussed the potential for researcher bias, and summarized my outputs. Finally, I finished the chapter with a quick summary of the major discussions in this chapter.

In the next chapter, Chapter 4, I will present my findings. In Chapter 5, I will discuss the results and analyze the implications of my findings and then list my recommendations for improving instructional support of similar programs.

## CHAPTER 4

### PRESENTATION OF FINDINGS

#### Chapter Introduction

I recently completed a study at Metro Environmental, a HVAC (heating, ventilation, and air conditioning) company. I researched the impact of training technicians using their SightPros-VirTechs system for remote, wireless, Internet video assistance.

In this chapter, I present the findings from my study. First, I review the purpose of this study which includes my major research questions. Then, I provide a general introduction to the findings. Next, I describe my findings about the company, their Web sites, their personnel, their SightPros-VirTechs system, their SightPros communication tool, their work environments, and their training. Then I discuss additional findings of interest from the interviews and surveys and discuss more findings about the initial questions that I developed for guiding my research. Finally, I finish the chapter with a general review of the findings from my study.

#### Purpose of the Study

The purpose of my study has been to investigate the SightPros-VirTechs system and to analyze its business impact. The system addresses training and/or assistance via

wireless Internet video from job site apprentices and/or technicians to a remote expert.

To investigate and analyze the system, I have explored the following research questions:

- Can the SightPros-VirTechs system as used by Metro Environmental demonstrate that its concepts of just-in-time training and leveraged expertise effectively expand the capabilities of their HVAC workforce?
- Can the SightPros-VirTechs system expand the workforce capabilities in other HVAC companies and/or other service-dispatched industries to positively impact the skilled labor shortages?
- Does the SightPros-VirTechs system generate additional impacts that might influence adoption of the system in other companies or industries?

As part of my investigation of the SightPros-VirTechs system, I have studied the personnel and environment surrounding Metro Environmental. I have documented the business context with both narrative description and statistical data.

As part of my analysis of the business impact, I have compared an apprentice technician who uses the SightPros-VirTechs system frequently with other technicians who use the system occasionally. Also, I have compared this study with my two pilot studies. I have analyzed the business context to determine the impact from the system and its concepts to Metro Environmental and potentially to other businesses and industries.



## Introduction to the Findings

The data collection for this qualitative study began in early December 2007 and continued through March of 2008. As a participant, I observed the experts, the service technicians, the apprentices, and the customers in their normal working and training environments. I also examined their operation and usage of the SightPros-VirTechs system and the SightPros communication tool.

I used audio and video recordings and computer technology to help me capture and analyze the majority of the data that I gathered in this study and that I now present in this dissertation. I captured approximately 20 hours of digital video recordings and approximately 60 hours of digital audio recordings at the offices of Metro Environmental and at various customer locations. John Thomason at Metro Environmental recorded approximately 10 hours of additional video files captured from the streaming videos of the customer locations.

From the study and the collected data, I discovered insights relative to the company, to their personnel, to their SightPros-VirTechs system, and to their SightPros communication tool. I gained some of these insights through participant observations. I gained more insights through both structured and unstructured interviews and surveys on the Metro Environmental personnel, customers, and business contacts regarding the use of the SightPros-VirTechs system.

## Metro Environmental

### *Overview of the Company*

Metro Environmental has operated as a family-owned business, a HVAC company, with the heart and soul of a small company. The Metro Environmental office facilities currently reside in a business district in Lewisville, Texas. At the beginning of the study the Metro Environmental personnel included 11 individuals: the president/co-owner, the vice-president/co-owner, 1 salesperson, 2 managers, 1 accounts receivables clerk, and 5 technicians/installers. At the conclusion of the study, one additional person joined the full-time personnel as a corporate salesperson.

### *Overview of the Facilities*

During the study, the environment at Metro Environmental transitioned because of their facilities. On December 1, 2007 (just prior to the start of my data collection), Metro Environmental leased the entire bottom floor of a different Lewisville, Texas building and the associated lot. In December, they moved from their old leased location (the location of my pilot study in 2004). I categorized this new location as their third location since 2000 when I first began conversations with John Thomason.

Retired plumbers, two brothers, owned the lot and building at the new location. Prior to their retirement, they operated a plumbing business from this location. Metro Environmental has expressed an interest in purchasing the entire lot and facility if the brothers ever decide to sale it.

At their new location, the bottom floor contained offices at the front of the building and a warehouse (about double the size of the offices) behind that. The building had a second story above the offices and accessible from the center interior. Metro Environmental leased the upper offices and facilities in February 2008 - near the end of my study.

The recent relocation generated some confusion with the personnel and the schedules, but also a lot of excitement over their new facilities. Since customer service calls during this time of the year typically remained low for the HVAC businesses in this area, the relocation had minimal impact to service calls and installations. However, I noted some minor delivery problems in the study due to the relocation of their facilities. A parts order got returned to the manufacturer since it arrived at the old location instead of the new one. Also, the office staff still checked on the USPS® (United States Postal Service®) mailbox at their old location to make sure that they received all of their mail since no one occupied the old location to even check and/or forward their mail.

With each move, Metro Environmental used their HVAC technicians and other personnel to move everything and to personalize the layouts of the offices to the needs of the company and/or the personnel. This included tasks such as electrical wiring, wall additions, staining and adding shelves, etc. as well as the routing of new ductwork for the HVAC systems. The normal job requirements for HVAC technicians included general construction skills as well as specific HVAC skills. Their general construction skills proved valuable for these relocations and reduced the overall costs associated with relocations.

The Metro Environmental offices included typical furnishings and office items such as desks, chairs, file cabinets, storage areas, customer records, and office equipment. The staff highly decorated the offices with knick-knacks, figurines, and stuffed animals.

The bottom floor of the new location contained three enclosed offices, three open offices, an entryway, and a large work area that also included a kitchen and restroom for the office personnel and visitors. Metro Environmental typically held their training and their meetings in the large work area of the facility. At the rear of the office area were two doors: one exited directly to the warehouse, the other exited to a stairway for the second floor facilities but also exited to a second doorway that then lead into the warehouse.

The second story at the new location contained a large office space that Metro Environmental converted into four enclosed offices. The president/co-owner, the vice-president/co-owner, and the two salespersons moved upstairs into these new offices near the end of the study.

The upstairs area also had restroom and shower facilities that were important to any HVAC business in the area. The personnel always needed to portray a professional appearance. So, they used the shower facilities to refresh their appearance as needed after returning from a hot or "dirty" work location. The shower facilities also helped with safety cleanup if a worker got exposed to a chemical or material hazard such as asbestos or fiberglass.

The warehouse appeared as a large, open, area behind the front offices. The technicians used the restroom located against the front wall. Metal racks that stored pallets, filters, and some HVAC units lined the eastern wall. Trucks and trailers drove into the warehouse through a drive-in entrance on the rear wall. The western wall opened into a loading dock (high bay) towards the front and contained a medium-size room, with an open second story, near the back. Metro Environmental stored small parts in the lower room and historical records in the open second story above it. Two exterior walls of the warehouse closed two sides of the open second story. Fencing closed the other two sides. The Metro Environmental personnel climbed a steep, narrow wooden stairway to access this open second story.

A fork lift stayed in the warehouse area. The Metro Environmental personnel used it to move large refrigeration units that they refurbished for a customer and to move other large parts and HVAC units that they stored. All the technicians, the president/co-owner, and the salesperson drove and operated the forklift on various occasions.

A chain-link fence surrounded much of the property. Metro Environmental used the fenced area to store a large flat-bed trailer and all of the old HVAC units removed from customer locations and awaiting pickup by a recycling company.

Most times the Metro Environmental personnel parked their vehicles in the front or side parking lots outside the chain linked fence. However, the front and side parking areas had limited spaces especially when they needed room to load or unload from the

dock area. So, occasionally, the technicians parked their trucks on the pavement inside the fenced area. However, they seldom left the vehicles parked inside the fenced area near the end of the day since Metro Environmental locked that area overnight.

### *Computer and Telephone Networks*

The offices had both a telephone network and a computer network. Both networks played an integral part in the effective and efficient operation of Metro Environmental operations and of the SightPros communication tool.

Telephones proved critical to Metro Environmental. Office personnel and customers used their telephones to schedule most service for the HVAC customers. Each office at Metro Environmental had a multi-line business telephone. The president/co-owner, vice-president/co-owner, salespersons, and all technicians carried cell phones and used them extensively for business purposes. Metro Environmental provided the cell phones and paid for business air time. Some of the cell phones had advanced features such as cameras, blue-tooth capabilities, etc. Some of the technicians also carried their personally-owned cell phones. A nearby telephone communications tower provided reliable communications links for their cellular and Internet connections.

My original plans for this study at Metro Environmental changed slightly due to delayed improvements in their local and remote telephone communications. The telephone provider used by Metro Environmental had originally scheduled Wi-Max communications capabilities to launch in the Dallas/Fort-Worth Metroplex by December 2007 which would have coincided with the start of this study, but then the telephone

provider delayed the launch until at least April 2008 which occurred after the planned end of data collection. This capability would have ensured faster and more stable wireless communications with their SightPros communication tool throughout the Dallas/Fort-Worth Metroplex. I adapted the study to the lower speed and reliability of the communication tools, but the usability of the communication tools still remained viable and the collected data from this study still proved important.

Computers were critical to Metro Environmental. Each office had a computer. Personnel used the computers for service call management, parts management, customer records, payroll, accounting, access to information from HVAC manufacturers, email communications, etc.

During the study, the environment at Metro Environmental changed somewhat due to improvements in their computer systems. For instance, Metro Environmental negotiated for all new computers through a service provider that also provided ongoing computer and network maintenance and repair services. These systems impacted the operation of the SightPros-VirTechs system by providing faster computer and network processing which then allowed an enhanced Internet speed and reliability. However, the two field personnel for that service provider worked at the offices multiple times checking computer and network equipment, solving computer software and hardware conflicts, and running new network cables.

During the study, the environment at Metro Environmental changed somewhat due to new call management software. They used the software to print service call

tickets, manage parts and billing, access customer information, etc. On multiple occasions the office personnel had to access customer data in the old system since they had not yet converted all of the old information into the new system. This new software replaced call management software purchased several years earlier. My study data now included printouts from three of their software systems beginning with my first field visit in 2003.

### Web Sites

Metro Environmental registered multiple Web site names that they associate with their business and with the SightPros-VirTechs system. I found one site, <http://www.BuyTrane.com>, fully operational with multiple links directly associated with Metro Environmental. I found a second site, <http://www.VirTechs.net>, inactive. I found a third site, <http://www.SightPros.com>, in the design stages. Another two sites, both protected by unique passwords, directly link to the two SightPros communication tools through a dynamic DNS service <http://www.TZO.com>.

#### *BuyTrane Web Site*

Metro Environmental registered the <http://www.BuyTrane.com> business Web site on June 9, 1999 (Better Whois, 2008a). They used this Web site to attract customers wanting Trane® HVAC systems in the Dallas/Fort-Worth Metroplex. However, this Web site attracted customers from across the United States because of its name and its exposure on many search engines. Since the early 2000s, the Web site included a link that potential customers used to enter their detailed requests for work estimates and



submit the request directly to Metro Environmental. John Thomason and/or the salesperson received and answered these requests for estimates every work day. They typically informed potential customers outside of their service area that they did not service them.

At the time of this study, the <http://www.BuyTrane.com> site had a link to a streaming video provider, TZO. From that link, users downloaded the software application necessary to access the streaming video from the SightPros communication tool. Each communication tool had its own unique TZO address. John Thomason provided those site addresses to approved users only.

#### *VirTechs Web Site*

With the idea that the VirTechs system, once launched nationally, would attract more than just HVAC customers, John Thomason registered his <http://VirTechs.net> Web site on January 12, 2000 (Better Whois, 2008d). Later, he decided that a ".com" Internet address seemed friendlier, more valuable, and that it might indicate to customers that he had an older, more established business. However, a foreign company had acquired the VirTechs.com Web site name in 2004 (Better Whois, 2008c). Since he had never really advertised or commercialized the VirTechs.net address, he felt that this site cost more than it benefitted them and could be confused with the foreign site. During this study John Thomason purposely let the registration of the VirTechs.net Web site expire by not renewing it for 2008. Instead he registered a new ".com" Internet address - the SightPros Web site.

### *SightPros Web Site*

John Thomason spent hours trying to find a name that (a) would appropriately fit his VirTechs application, (b) would be an easy name for potential customers to locate and use, and (c) would end with the ".com" extension. After much research on available names, he selected <http://www.SightPros.com> for the site name and registered for it on July 31, 2007 (Better Whois, 2008b). From then on, he began to change to the SightPros nomenclature instead of the VirTechs nomenclature.

During the study, I used two Whois database search engines (Internic Whois, 2008; Better Whois, 2008) to try and find other available names with a ".com" extension and an easy name for customers to remember. Most easy names were already registered, many by companies simply wanting to sell the site name for top dollar. I discussed some of the potential names that I found with John Thomason, but SightPros fit his criteria better than any of the available alternates that I found.

I also helped John Thomason redesign his logo for this site. He then contacted the same Web site designer that he had used previously for a professional redesign of the BuyTrane Web site and asked the designer to now design the Web site for the SightPros Web site. However, the designer had nothing updated by the end of this study. John Thomason planned to use this new Web site for advancement of the SightPros-VirTechs system and training.

### *TZO Web Sites*

Two sites directly linked to streaming videos from the prototype SightPros communication tools used in this study. The communication tools connected to the Internet through a dynamic DNS service, <http://www.TZO.com>. For privacy and security purposes, Metro Environmental limited access to these two sites. As needed, the Metro Environmental site administrator provided the site name, a unique name for each user, and a unique password for each user.

### *Teamwork, Camaraderie, and Communities of Practice*

Metro Environmental operated like many family businesses. Every person at Metro Environmental felt like they were part of the family and expressed ownership in its success. The co-owners, John Thomason and his wife Christine, both actively managed the business, one as president, the other as vice-president. They had actively employed their two children there in the previous pilot studies. At the end of this study, their daughter, Rachael, returned to work for Metro Environmental in their corporate sales. At the time of the study, their son worked on his career in music in New York City, but still helped them when he came home to visit.

Metro Environmental did not have many layers to their management but they had multiple "managers." Everyone remained totally accessible to everyone.

## *Office Personnel*

### *John*

John Thomason, the president/co-owner of Metro Environmental, held the Texas state, Class A license for their HVAC business. John obtained certification by North American Technician Excellence® (NATE®) and held many other certificates for a variety of training. He worked as a technician by trade and as an expert in his field. He had many years of experience in the trade, beginning with 2 years of vocational education in high school. Early in his career, he taught trades and industrial classes for one year to high school students. His work with technicians and with me always put him back into an instructional mode. He actively managed the field technicians and the development and marketing for the SightPros-VirTechs system and the SightPros communication tools. As he stated in one interview, he wore many hats. I saw that in action. He got involved in most decisions and all critical ones.

John considered himself as a great believer in applied technology. He mentioned several times that he had a love/hate relationship with computers. John's considered his personal computer as his most useful tool, but he had basically self-taught its programs and features. He felt that he worked more effectively and efficiently with them. He considered his cell phone as his second most useful tool.

John indicated that the HVAC industry existed since about 1900. He declared it as relatively mature, but that it has experienced a severe shortage of skilled laborers. He felt that his company used more high-tech than many in the industry. At the time of the

study he had three patents relative to the HVAC industry: U.S. Patent No. 6,690,273 (2004) (wireless video audio data remote system), U.S. Patent No. 6,317,039 (2001) (wireless video audio data remote system), and U.S. Patent No. 5,469,933 (1995) (vehicle mounted ladder). He has a fourth patent pending which extends one of his earlier wireless patents.

John loved storytelling as a way to teach others about life as a HVAC contractor. John shared one tale of working as an Air Force HVAC technician in the Vietnam era when he fell through a ceiling in Washington (state) onto a mess table. He shared other tales about running possums out of air ducts in Palestine, Texas and meeting two governors of Texas.

As stated in earlier chapters, John had published technical articles regarding wireless video in the Air Conditioning Contractors of America® (ACCA®) industry magazine and the national Contractor Magazine. He expressed a desire to continue writing and giving conference presentations on the SightPros-VirTechs system and the SightPros communication tools.

### *Christine*

As vice-president/co-owner, Christine handled outside sales, new clients, problems with vendors or customers. She helped train all new employees, evaluated software, and organized many other necessary tasks imperative to running a small business. Everyone came to her for computer and software evaluations.

Christine strove for efficiency and productivity. Christine often ran interference for John, as did other members of the Metro Environmental personnel, by screening phone calls, etc. She had software that enabled her to monitor and track the Metro Environmental trucks as they traveled across North Texas. Because the trucks were equipped with tracking devices, Christine could locate as needed their exact positions at any time over the Internet.

Christine mentioned that the HVAC industry in general and Metro Environmental in specific constantly changed and got more technical. Christine remarked that the Internet caused a great deal of change in that consumers became better educated. Their knowledge then raised their expectations for quality and expertise.

Christine shared stories of surprising customers when she diagnosed, by herself, difficult HVAC system problems over the telephone that other competitors had not correctly solved. She indicated that she felt rewarded when she stole those customer accounts away from her competitors by using her great problem-solving skills. Christine loved the fact that she successfully burst into this male-dominated industry.

Christine spoke about Metro Environmental personnel policies. She mentioned that most businesses had rules against hiring relatives. For Metro Environmental, hiring relatives seemed critical to their success, helped to build a sense of ownership by all the personnel, and added to the overall camaraderie. At the time of this study, they had three family relationships: (a) The owners' family - John, Christine, and Rachael

Thomason; (b) a mother/son team - Susan and Josh; and (c) a husband, wife, and son team - Greg, Coby, and John the technician.

Christine strengthened the Metro Environmental camaraderie by planning quarterly company events. She cited that over 60% of all previous employees had asked, at one time or another, to return to Metro Environmental after leaving the company for a variety of reasons. Christine occasionally brought either one of her two large dogs, Natasha or Boris, to the office.

Christine had a vested interest in the SightPros-VirTechs system but she envisioned a tremendous potential for other applications and uses for it. She felt that the more people used it, the more ways people would find ways to use it. Christine seemed very interested in the training, quality control, compliance, and protection aspects of the SightPros-VirTechs system. She saw a high benefit for consumers. Christine encouraged the company to establish management processes and procedures for using it.

#### *Susan*

Susan functioned as the operations director. She scheduled the technicians, the service calls, and the training at Metro Environmental.

Susan had worked at Metro Environmental for many years and considered John and Christine as family members rather than really dear friends. She seemed highly protective of John, of Christine, and of Metro Environmental. She felt that all employees and customers of Metro Environmental were treated as friends, not just as a number.

Prior to Metro Environmental, Susan majored in business when she attended college. After graduation, she worked at a large corporation. She felt that her 33 years of business experience and good business sense brought strength to Metro Environmental. Susan appreciated the family atmosphere of Metro Environmental and especially the lack of corporate politics.

Susan acted as tough as nails if the situation required and/or as loveable as her little dog, Tex, that she brought everyday to the office. Her burning candles filled the entire office with wonderful scents. Christine noted that Susan created the at-home atmosphere at Metro Environmental.

Susan felt that the SightPros-VirTechs system would be highly beneficial in training and in business operations. She suggested that technicians would learn more effectively when actively monitored while performing their tasks. She liked the idea of not sending a second technician out to a site when the technician experienced problems. She had fewer rescheduling conflicts when the expert remotely corrected problems by observing the problem in real time and advising the technician currently at a problem site. Susan felt the SightPros system saved Metro Environmental fiscally through lower labor and travel costs. She mentioned that their lower costs would then save the customer from additional time charges, extra labor charges, and added travel expenses.



### *Joshua*

Joshua (better known as Josh) functioned as the accounts payable manager and the parts manager. He handled many other duties around the offices. He readily acknowledges his family ties as Susan's son. Throughout the study he greeted everyone as they entered the offices. He worked with the salesperson, with Susan, and with the technicians to ensure that Metro Environmental had the right parts in stock and that the right parts went to the customer sites.

Josh considered the SightPros-VirTechs system as "almost beyond anything that could be imagined." He felt it added to customer service and helped the technicians do the job right the first time. He felt that it saved the customers money and patience since an expert saw what might otherwise be overlooked. He suggested various useful purposes for any service oriented business including lawn care, plumbing, governments, and even wartime.

### *Coby*

Coby functioned as the accounts receivable clerk. She had only worked at Metro Environmental since April - not quite a full year. She also ran out-of-office errands and had just started to answer and direct the telephone calls. She used the computer but wanted to learn more about the various programs.

Coby saw the SightPros-VirTechs system as useful in helping her quickly learn her job. She could observe the job tasks that the technicians performed. She could watch

the customers and technicians interact. She felt that it helped her see and learn about her customers instead of just knowing them via mail and phone contacts.

Since Coby married one of the technicians and therefore became a step-mom to another one of them, she reported and helped to confirm the technicians' actual perception of the SightPros-VirTechs system. Her husband, Greg, functioned as the senior technician. Her step-son, John worked as one of the younger, but experienced technicians. Metro Environmental considered these two technicians as their freezer and refrigerator technicians. Coby indicated that the experienced technicians did not necessarily like being watched but that there really felt no perceived negatives to it and lots of positive outcomes.

### *Ray*

Ray functioned as the comfort consultant (salesperson) that responded to customer requests for quotes and helped generate leads for potential customers. He handled job permits, orders for HVAC systems or HVAC units, and final inspections of HVAC installations. He also fixed some computer problems for the company.

Ray worked in the field as one of the technicians for six months prior to assuming his current position. His background included employment as an applications developer programmer. When he finished one of his programming jobs and he had no other employment, his neighbor Greg, a Metro Environmental technician, encouraged him to come to work as an apprentice technician for Metro Environmental.

Ray saw the SightPros-VirTechs system as awesome. He perceived it as abundantly useful for a wide variety of occupational and site issues. He used it as one of his selling points to customers for choosing Metro Environmental.

### *Rachael*

Near the end of the study, Rachael, the owners' daughter, returned to work full-time for Metro Environmental as their corporate salesperson. Ours paths did not cross long enough for a full interview, but we met briefly several times around the office. She had worked for her parents at Metro Environmental during the pilot studies, but mostly on an occasional basis whenever her schedule permitted. Her knowledge of all aspects of the business, her outgoing personality, her camaraderie with the Metro Environmental personnel, and her past experience with promotional activities for motocross bikers made her an excellent choice for her new position.

### *Technicians*

Those working for smaller operations tend to do both installation and servicing, and work with heating, cooling, and refrigeration equipment. (Bureau of Labor Statistics, 2003a, Nature of Work section, ¶13)

Metro Environmental employed five technicians during the time of this study. Including John Thomason, there were six. Although I never observed the president/co-owner personally servicing the customer accounts as a technician, he did make on-site visits as needed for sales estimates or customer service issues. He also acted as the remote, expert technician for the SightPros-VirTechs system. All of the technicians were full-time, hourly-paid employees. When they were not fixing customer accounts, they

were remodeling the facilities at Metro Environmental, rearranging the warehouse, and/or training. All the technicians were EPA (Environmental Protection Agency) certified. All of them had taken multiple classes presented and certified by Trane trainers.

The experienced technicians at Metro Environmental really loved their jobs. As one of the technicians noted, the variety in their everyday schedule made the job fun. They worked in new homes, meeting new individuals, and solving new problems everyday. They took lunch breaks at a convenient break point. These technicians could not imagine sitting in an office or working on an assembly line doing the same thing constantly.

The technicians often worked independently on service calls and maintenances, but sometimes in teams. Apprentices often started with the installation team. Two technicians worked as a two-person installation team for many installations, but technicians and numbers varied depending on the number of HVAC units needing installation and the overall work load of the other technicians at the time of the installation. Some installations required all five technicians. All service technicians alternated adeptly between the service and installation environments.

### *Greg*

Greg, the oldest technician and the most experienced, acted as the leader of the technicians. As noted earlier, he also handled most of the refrigeration calls and also the corporate customers. Greg considered himself a "jack of all trades." He described two

installations where they positioned HVAC units using helicopters and many others using cranes.

The technicians often turned to Greg for assistance and troubleshooting advice. Greg stated that he seldom needed training and often took active calls when the other technicians were in training.

Greg had not used the current prototype version of the SightPros communication tools but had used earlier equipment configurations in previous field tests at Metro Environmental. He discussed how much better it worked now to have John Thomason remotely move the camera in the SightPros communication tool rather than using the wearable cameras or the technicians moving Webcams mounted on tripods for John Thomason to view their work and their work sites. He viewed the SightPros-VirTechs system as providing him with a possibility of productive work even after he no longer had the physical ability to work at actual job sites.

Greg felt that technology in some ways cost more to the customer but it also allowed more sophisticated features. He cited how the current systems used circuit boards instead of the less expensive relays used in older systems.

#### *John*

John, the younger technician, son of Greg, now had logged a lot of experience as a technician. He learned mechanical skills from his early childhood exposure to the HVAC business through Greg. Asked to describe the working environment, he stated: "Hot is HOT. Cold is COLD. When it rains you get WET."

John felt comfortable with computers. He had functioned as the apprentice technician in my two earlier pilot studies when Metro Environmental used the laptop computers. He had the most experience at Metro Environmental with earlier testing of the camcorders on tripods and the wearable camcorders attached to vests.

On multiple job sites where I observed his work alongside of Kwame, John seemed much more confident and proficient than he seemed when I observed him in the pilot studies. He worked independently on his tasks and took job site leadership. He assisted Kwame occasionally when John Thomason could not assist or when the SightPros communication tool experienced communications difficulties. His job related conversations with other Metro Environmental personnel including the expert mostly addressed discussions of customer requirements rather than specific field procedures or training.

#### *Kwame*

Kwame functioned as the new-hire apprentice. He had a business degree. He felt slightly familiar with HVAC from when he had worked construction sites installing windows. He had taught technology discovery classes to 8th graders in Mississippi. In his research for those classes, he decided that he wanted to work as a HVAC technician. He contacted Metro Environmental when he saw their Internet ad for an apprentice technician. He moved to the Dallas/Fort-Worth Metroplex when John Thomason offered him this job.

Kwame loved technology. He felt that computers made the newer generation lazy. He felt that students today wanted convenience in their careers versus hard-work. He felt excited about the SightPros-VirTechs system and discussed how it boosted his confidence to have the SightPros communication tool with him and to have John Thomason monitoring his progress. He felt that using this technology gave him an opportunity to experience the very best training. He also spoke about how much help Greg gave with telephone troubleshooting when he could not access John Thomason. Frequently, when he did not have any specific activities on a job site, he watched and learned from the other technicians.

After I completed the data gathering phase of this study, John Thomason disclosed in a telephone conversation that Kwame had accepted an offer for a management position with another company at a good salary. Kwame accepted the new offer and gave his notice to Metro Environmental. John fully understood the decision because of the traditionally high turnover rate of HVAC technicians despite the attractive salaries.

### *Luis*

Luis worked as the lead installer for Metro Environmental. He demonstrated proficiency in doing his tasks. After Kwame left, John started using Luis on a part-time basis to do service and maintenance calls.

Luis came from a Hispanic heritage. He spoke English proficiently. Occasionally, he expressed slight difficulty with an unusual vocabulary term or concept but overall he

had little difficulty communicating with others. In some conversations with Oscar, another Hispanic installer, Luis would occasionally revert to Spanish or a mix of English and Spanish. At one customer location when Luis and Oscar worked alone in an attic, they brought an AM/FM radio and tuned it to a Spanish radio channel. That remains the only customer site where I observed technicians playing an AM/FM radio.

Luis saw both good sides and bad sides to computer technology. He expressed some concerns with privacy with the SightPros-VirTechs system. Nonetheless, he had used the SightPros communication tool for about 15 installations over several months.

Luis described one wheel-chair bound customer and several other older customers that seemed happy to watch the work in progress via the Internet links since they could not climb into their attic to see the work otherwise. He also described the SightPros communication tool as a very handy tool. He liked the idea of service technicians getting immediate feedback when problems arose.

#### *Oscar*

Oscar started at Metro Environmental 5 years earlier as an A/C helper. He appeared proficient at his tasks and worked as a key member of the installation team. Oscar and Luis seemed to work together as friends as well as good teammates.

Oscar shared stories of two customers. One customer cooked for their team and gave them water throughout the day. Another lady baked a cake for them. He felt touched by these unusual displays of appreciation.



Oscar described some of his more difficult times as working in tight attics. His worst experience occurred in a house where the installation team and other technicians replaced two furnaces. They carried one of the heavy furnaces across a tight attic because the customer would not let them into the house to access the attic from a closer location.

Oscar did not feel comfortable with technology in general and computers in specific. He planned to improve his computer skills because he realized the need for knowing how to use them. He talked about accompanying his wife when she went to the library to access the Internet and how he intended to buy a computer to learn how to use it better.

In describing the SightPros-VirTechs system he saw it as a way for people who might not trust the technicians to watch the quality of the workers via the Internet. He saw it as more work for Metro Environmental, but more comfort for the customer. He noted that although few customers used it, they liked having it available. He had not used the SightPros communication tool much and expressed some concerns with the system because of his difficulty with English. During his interview, Oscar and I discussed the ability to use his bilingual skills as an advantage in the future, particularly with foreign markets like Central or South America, if and when he became a HVAC expert.

#### The SightPros-VirTechs System and the SightPros Communication Tool

New technology, in the form of cellular "Web" phones that allow technicians to tap into the Internet, may soon affect the way technicians diagnose problems. Computer hardware and software has been

developed that allows heating, venting, and refrigeration units to automatically contact the maintenance establishment when problems arise. The maintenance establishment can then notify the mechanic in the field via cellular phone. The mechanic can then access the Internet to "talk" with the unit needing maintenance. While this technology is cutting-edge and not yet widespread, its potential for cost-savings may spur its acceptance. (Bureau of Labor Statistics, 2003a, Nature of the Work, ¶ 10)

The SightPros-VirTechs system added a new dimension to the troubleshooting processes envisioned by the Bureau of Labor Statistics in 2003. It allowed not only talk, but also visuals through the streaming video.

#### *Leveraged Expertise*

John, the president/co-owner of Metro Environmental, also functioned as the resident HVAC expert. As he watched and worked (Figure 1) with the remote technicians via the SightPros communication tools and/or cell phones, he also interfaced with the office workers and answered any questions that arose in the office. Occasionally, he needed to shut his office door just to minimize the noise or the interruptions, but usually he handled the multi-tasking with open office doors.

John envisioned wireless video as a way to leverage his expertise to the field while he still maintained his office duties. His design of the SightPros-VirTechs system and the SightPros communication tool allowed him to:

- Monitor the field technicians as needed,
- Monitor multiple work sites and/or locations for work location layouts, site problems, and progress,

- Interact as necessary with the technicians, customers, and/or office personnel, and
- Monitor the on-site work for quality controls and safety issues.

I watched him accomplish each one of those efficiently and effectively.

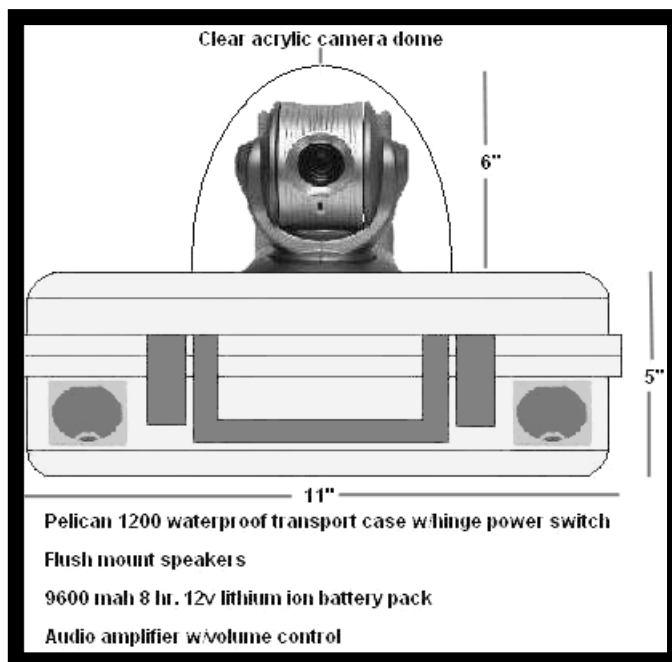


*Figure 1.* Thomason used his cell phone and headset to talk with the customer and the technician at a remote site where two SightPros communication tools let him view the customer location. Thomason could watch on his computer screen either or both videos. He used an Interaction Log (Appendix I) that he positioned under his right arm to record important call information.

### *The SightPros Communication Tools*

Metro Environmental built two prototypes of the SightPros communication tools similar to the one shown in Figure 2. The communication tools contained commercial-quality D-Link® network cameras frequently used for security monitoring. John designed the case and dome for durability so that they protected the network camera for

portable use in harsh conditions. The communication tools sent video from the network cameras to the remote expert through wireless network connections to the Internet. The speakers and audio amplifiers designed into the transport case allowed two-way synchronous conversations between the technician(s) and the expert.



*Figure 2.* Thomason built this unit as a prototype for his SightPros communication tool. Used with permission from J. Thomason, the artist and patent holder.

Each D-Link network camera contained a high-quality glass lens rather than a less expensive, lower quality plastic one. Each network camera could rotate to where the remote viewer saw the dome in front of the lens. The clear acrylic dome still allowed a fairly good image through it. Nonetheless, I noted some minor video distortion when John pointed the network camera directly towards the dome.

One prototype SightPros communication tool, Cam1, in a yellow transport case, required a direct 120-VAC (volts alternating current) power connection. The other prototype SightPros communication tool, Cam2, in a silver transport case, contained a lithium ion battery pack. On Cam2, a switch allowed it to work on either a 12-VDC (volts direct current) battery or on a 120-VAC power connection. The switch minimized battery use so that the battery drained only when the user needed battery power. The battery lasted for approximately 3 hours of active communication tool use since the network camera, the wireless network card, the speakers, and the audio amplifier all used its power. The technicians recharged the Cam2 battery in the service van using a standard 12-VDC charging adapter and/or at the home or office locations using a standard 120-VAC power cord. It took approximately 3 hours to recharge a fully depleted battery. Typically, the technician would recharge the Cam2 on the way back to the office and/or in the evenings.

John equipped a second transport case for the battery-operated Cam2. The second case carried the 12-VDC charging adapter, the 120-VAC power cord, and a handheld remote control that the technician could use to control the network camera from his location. I never saw the technicians use the remote control since John controlled the camera angles from the home office.

Kwame, the apprentice, carried the battery-operated Cam2 almost every day. He positioned the communication tool, if possible, at a location with a good viewing angle,

good lighting, and a good pathway to the tower for connectivity. Occasionally, John had him reposition it for viewing purposes or in an attempt to get a better signal.

When anyone used the SightPros communication tool outdoors, poor placement generated some problems. If the technician placed it in bright locations or in dim-light locations, John remotely adjusted the iris to bring the color balance back into the video. If the technician placed it where the network camera faced the sun, the sunlight sometimes reflected from the camera housing and distorted the streaming video images.

Lighting in attics always caused a problem. Initially, John attempted to use customer attic lighting or a typical service drop light. In the attics, John opened the iris to allow more light for better viewing. Even in dimly lit video, John could tell where the technician worked and what the technician did because of John's knowledge and experience with HVAC units and components. Eventually, with my encouragement, John realized that the attic sites needed additional lighting for good video for the customers, for recording of job activity, and for potential future training purposes. Metro Environmental purchased a halogen quartz lamp to provide better lighting for those reasons.

When they used it, a tripod helped to situate the SightPros communication tool at a better viewing angle, but the technicians often worked in tight areas in the attic where a tripod took up valuable work space. Moreover, the technicians saw the tripod as just another tool that they carried up ladders when working in an attic or on top of a

building. The tripod might mean an extra trip up and down the ladder. If the technician placed the communication tool on the attic floor or roof, it frequently captured poor viewing angles. If the technician set the communication tool on any of the HVAC components, the video images rocked with the movement or vibration of the component especially if the component hung from the attic joists by long, flexible metal straps - a common practice.

Cam1 typically stayed at the office. Any of the technicians, the salesperson, or the president/co-owner could take that SightPros communication tool into the field on an as-needed or as-planned basis. On occasions during the study, technicians or the salespeople returned to the office to get Cam1 so that they could communicate with John Thomason, the resident expert/president/co-owner. This allowed John to view the video back at his office computer or on his laptop computer during travels without actually having to go to the remote sites.

The technicians found that securing the SightPros communication tools every time they went back to their truck for a part, moved away from the communication tool for discussions with a customer or to work at other on-site locations, or made quick trips elsewhere, etc. proved impractical. So, occasionally they took some risks that nobody nearby would see their absence as an opportunity for theft. I observed, on one occasion, that the technicians left a communication tool alone at an outside location. John monitored the video from the office as he had time but sometimes he worked away from his desk or failed to watch constantly. At this account, John had asked us to leave

Cam2 focused on the outside condenser and to leave Cam1 focused on the attic work area. A little while later, John called and asked for one of us to check Cam2 because he had lost the connection to the video from it. We found Cam2 still safe outside but it needed the 120-VAC outlet power due to a low-battery-power condition.

### *Power Considerations*

The ability to connect the SightPros communication tool to a power outlet proved extremely beneficial to the battery-powered Cam2 and essential to the hard-wired Cam1. Although the HVAC units required power to operate, architects frequently provided inconvenient or distant access to additional power outlets for the service technicians. On many of the field visits the technicians and I struggled to find enough available connections or extension cords to accommodate the power tools, the communication tools, and/or the supplemental lighting. The drop light had one built-in outlet plug if the technician found an outlet plug for that light.

On my very first field visit, the technician connected a 50-foot extension cord for the attic power. The attic had an attic light but no power outlets. The technicians plugged an extension cord into a hallway outlet near the base of the attic ladder and then ran it through the access hole into the attic to give them the needed power for a drop light for better visibility. During the first week, I brought a heavy-duty 15-foot extension cord and several electrical plugs to accommodate both grounded and ungrounded outlets for my camcorder. The extra cord and plugs allowed everyone to share a single outlet when necessary.



On several occasions the technicians needed additional extension cords to accommodate their power tools, their lights, and/or their SightPros communication tool. On one occasion, even a 50-foot extension cord proved too short to accommodate the communication tool situated near an outside condenser.

Metro Environmental had one tool that they kept at the headquarters called a power robber. Technicians used that tool to create an electrical outlet where none existed nearby. They connected it to a power source on an AHU or a condenser with a connection similar to battery jumpers for automobiles. Usually, they planned its use in advance for specific job conditions since a trip back to the office frequently took too long to justify. I heard about it twice in discussions, but I never observed them use it in the study. For one situation that I observed, the technician purchased an extra 100-foot extension cord at a nearby hardware store instead of making the trip back to the office.

#### *Wireless Connectivity*

The SightPros communication tools did not require connection to the customer's Internet or network. However, to have effective communications in the field, the communication tool needed a strong wireless signal to a local tower. John Thomason tested the frame rate for best streaming video over the fastest and most reliable wireless network currently available at that time. He decided that 2-3 frames per second provided the most reliable transmission while still maintaining an appropriate sense of the working environment. Although audio transmission did not take a lot of bandwidth,

he decided to use cell phones for audio and to block transmission of the audio over the streaming video to minimize the bandwidth.

During the study, John had an auxiliary antenna connected to Cam2. He did not have an auxiliary antenna for Cam1. At several customer locations he compared the quality of the communications by setting the two SightPros communication tools side by side. Cam2 with the auxiliary antenna provided noticeable improvement in connectivity and signal quality. Nonetheless, John and I noted signal interferences to some degree from each study site. By the end of the study, John discussed the purchase of another auxiliary antenna for Cam1, but he decided to wait to see if the new Wi-Max services (planned for a spring 2008 launch in the Dallas/Fort-Worth Metroplex) would make the auxiliary antenna unnecessary.

Sometimes the SightPros communication tools experienced negligible interferences at a site; sometimes a site never connected to the tower. Variations occurred by customer location, by communication tool location (higher elevations even in attics generally worked better than on-the-ground locations), by day, by time of day, by the amount of cellular traffic, by weather, by angle or path to the tower, and by obstructions (vehicles, HVAC units, other equipment, walls, even the technician, etc.) between the communication tool and the tower.

I noted multiple variations in the wireless signal interferences on the streamed video. Temporarily stalled video streams occurred as the first sign of any communication interference. The second indication of interference displayed as a black screen for a

short timeframe. The third indication included a reconnection message. The fourth indication displayed as if totally disconnected.

Initially when the SightPros communication tool did not connect well with the nearest tower and/or the tower activity seemed extremely busy; the streaming image would stall at the last good image. John Thomason, as the expert, appeared very adept at rapidly noting these frozen frames by watching the clock on the screen. When he detected frozen frames, he often mentioned them (a) as he recorded the video; (b) as we watched the video together at the office; or (c) in discussions over the cell phones with me, the customer, and/or the technician. Typically, unless John mentioned it, neither the customer nor I noticed this stall if the screen action remained minimal. However, the stall seemed quiet obvious even for this initial indication of signal interference, if the captured video activity included on-screen motions such as when a crane lowered a RTU (roof-top unit) onto the roof or a technician moved about. I laughed at one instance when the technician's knee and foot stayed suspended in mid-step during one prolonged stall.

After a few seconds of stalled streaming video, the browser would show a black screen for a short timeframe. This stage of signal interference depended on the total amount of time of the signal loss. Sometimes the black screen flickered on and then went immediately to a new streamed image. At other times I noted that this black screen stayed solid for up to 15 seconds.

If the black screen remained for an extended period of time or the viewer interacted with the Web browser during that timeframe, a reconnection message displayed at the top of the black browser screen. The typical reconnection message displayed as "Connecting to virtechs2.tzo.com....." for the Cam2. As seen in the message, the Web site address for that specific SightPros communication tool displayed in the message. John referred to this type of reconnection problem as a "signal dropout." Each time, he hoped the communication tool would reacquire a connection fairly quickly; most times it did.

If John totally lost the signal or the SightPros communication tool lost power, the Web browser would totally disconnect. For this condition, the browser message showed: "Internet Explorer cannot display the webpage."

When video seemed intermittent or unavailable, Metro Environmental took backup actions for training purposes or call closure. They sometimes completed the call successfully with audio only communications. They sometimes completed the call successfully with the cell phone cameras that some technicians and the salespeople carried. However, the cell phone cameras only sent lower-quality short videos or stills. If the technician did not complete the call successfully without assistance, the dispatcher rescheduled the call and/or scheduled another technician to (a) join the original technician and assist with tips and instructional advice on the call; (b) join the original technician, take charge, and provide a learn-by-observing opportunity; and/or (c) take the call in place of the original technician.

### *Office and Home Usage*

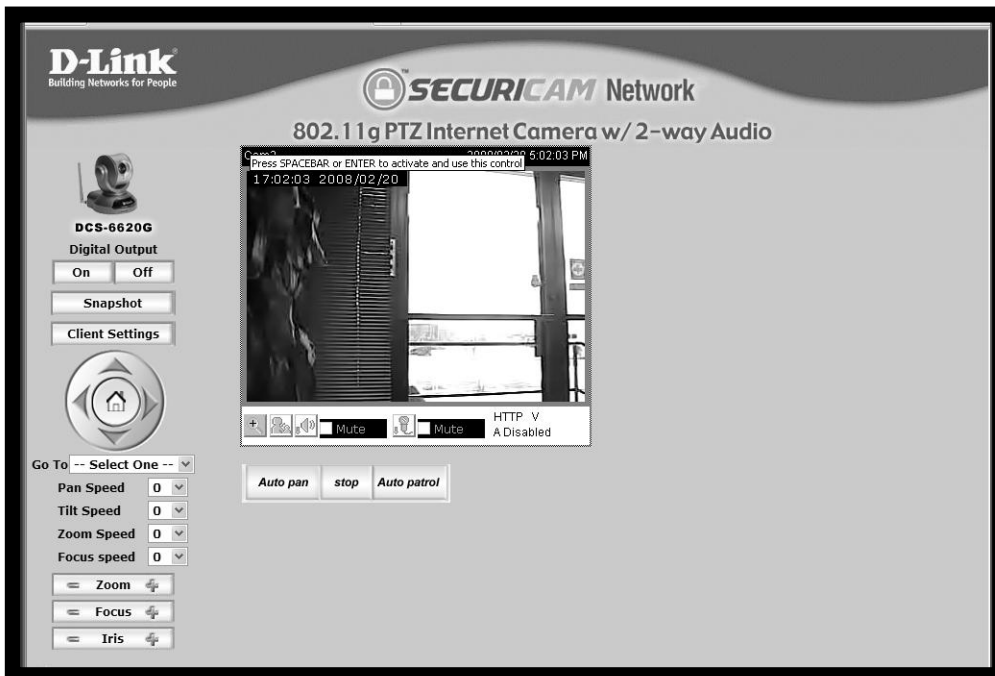
The SightPros communication tools used streaming technology - "true streaming" rather than progressive streaming. Wilkinson (2006) noted two key points about true streaming: (a) To achieve live streaming it took a few seconds to buffer the signal before the video stream played and (b) the content simply played, but did not store. Wilkinson also noted that the main advantages included speed, host control and flexibility.

Metro Environmental used the host controls to set frame rates, choose whether to use audio and/or video streams, set digital rights, and password controls. For example, John Thomason, as the software administrator, listed me as a user, set up a password for me to login, and then allowed or disallowed the various rights for me to use the various camera controls. I then accessed the Web site address and logged into the site. Prior to my first use of the video stream, I downloaded and installed a small ActiveX program on my computer.

Each user typically performed all of these steps once for each computer/browser. Although initially this appeared troublesome to do for each user and browser, the ability to keep the video private seemed extremely important to Metro Environmental. Most of the customers in this study and all of those who actually attempted to use it felt that the privacy justified the effort.

The use of video from inside a home or business and the need for securing customer information that a competitor or other inappropriate user could obtain made

these steps important for everyone's privacy. Overall, John Thomason found this ability to share video with a customer an excellent marketing tool that fully offset any nuisance with the initial setups. Since ideally Metro Environmental would maintain a customer on a permanent basis, John considered the initial setup time and effort a minimal price to pay by Metro Environmental.



*Figure 3.* The computer screen displayed one of the views from the SightPros communication tool. Thomason used the controls on the left of the screen to adjust the camera settings.

John Thomason typically issued (to the other users) all camera control rights other than frame rate and the audio. Those rights gave those users the ability to easily adjust camera angles, pan, tilt, zoom, focus, and light exposures on the SightPros communication tool without any assistance from the technician (Figure 3). Moreover,

the camera would auto-focus whenever the scene changed. Users centered an item being viewed by simply clicking the item. Since up to ten users could log in at up to ten different locations and view the streaming video from one communication tool simultaneously, John removed those rights to any user that abused the privilege by interfering with the active technician to expert communications.

The streaming application utilized true streaming and not just a file that the user downloaded. This generated both benefits and problems. The most significant benefit involved the file sizes, the footprints, which remained small since streamed video discarded the video immediately after displaying it. The biggest problem that a user experienced involved getting past network firewalls. In this study, one commercial customer quickly stopped trying to overcome their company's computer network firewall. In another instance, the facility manager at a commercial business contacted the computer network manager who quickly accommodated the streaming application by changing the network security access settings for that one Web site. Another customer, a residential customer, wanted to sit in his office at work and watch the Metro Environmental workers at his home. The business firewall seemed more problematic as an employee since he felt it equated to a personal request for access rather than a business request and therefore he decided to simply allow his wife who worked at home to view the workers in the attic through their home computer. Another residential customer with a wireless laptop bypassed the company's firewall by connecting through an available nearby Internet connection.

### *Permanent Records of the Streaming Video*

John Thomason purchased screen capture software for his office so that both of us could capture a permanent record of the streamed videos. We both easily operated the screen capture software. We opened the Web browser, started the streaming video, then opened the screen capture software, defined the area of the screen that we wanted to capture, and finally clicked the start icon. The screen capture software also captured the mouse pointer which proved very helpful for instructional and/or discussion situations. We captured both videos and quick snapshots. As needed, we edited the videos post-capture. We picked our preferred file format to save the video files from a wide variety of available file formats. We kept the size of the screen captures to a minimum so that file sizes, although large, would fit about one hour of video to a CD or many hours to a DVD.

While using the screen capture software to capture screen images, we sometimes opened another application over the streaming video screen so the captured information might not be what we anticipated. For instance, John Thomason apparently wanted to check the SightPros communication tool settings during the recording of one account so he opened the appropriate menu. The recorded information now displayed the IP address, the subnet mask, the default router, the primary DNS, and the secondary DNS settings for the communication tool instead of the intended streaming video from the remote location. A moment later, he selected the tools menu which then displayed the screen for entering the administrator password. Although the password showed as



asterisk characters instead of real characters, a computer hacker could gain an advantage by knowing how many characters the password contained.

With the screen capture software, John found the video and audio captured so easily (Figure 4) that he stated his desire to create a short instructional video for each customer to discuss such items as how to change the filter on their specific site and where they could locate their filter. He suggested doing this using video captured during installation while he followed a pre-designed template of instructions for site wrap-up procedures. He envisioned this as a great competitive tool to gain and maintain customers.



*Figure 4.* This close-up showed an active screen capture of the streaming video from the SightPros communication tool.

John transferred all of his saved video files from the screen capture software to DVD disks for me to also use in this study. His files aided my research as they provided

additional video angles and his instructional discussion of the captured service, maintenance, and/or install calls.

### Work Environments

To service HVAC systems properly, technicians needed ready access to vehicles, parts, supplies and the proper tools when they were on the job sites/customer locations. Not having the right materials at the needed times meant extra trips for somebody.

### *Vehicles, Parts, and Supplies*

All of the technicians had service vans, but for some jobs two technicians traveled together in one van. Nonetheless, both technicians needed their own tools. So, the passenger technician shifted his personal tools to the van in which he rode. To transport the large HVAC components, the installation team used the larger Metro Environmental box truck.

The technicians stocked some standard parts and supplies in both the trucks and vans. For instance, they stocked some copper tubing, PVC pipe, common sizes of nuts used on the HVAC systems, booties, drop cloths (to keep the customers floor clean), etc. They seldom stocked a wide variety of parts on their trucks and vans because of the Metro Environmental inventory controls and cost exposures.

For both the vans and the truck, the technicians took the parts and supplies that they expected to use for a specific job or site and then Metro Environmental would charge the customers for those parts. If they did not have a needed part on the van or

truck, the technician would make a trip to the office and/or an appropriate supply store, or another technician would deliver it. Occasionally, especially for installs or large corporate accounts, the salesperson would get the needed part and deliver it to the account.

Metro Environmental controlled some supplies like filters and refrigerants due to their higher costs. The technicians needed access to a wide variety of sizes and compositions to match the many HVAC manufacturers and their various equipment designs that had changed over time. The technicians charged the customers for the specific filters they installed. The technicians charged the customers by the number of pounds or cubic feet of refrigerants used. They also charged the customers by the number of feet of copper tubing and/or PVC and metal pipes.

Typical parts and supplies for the heating system included PVC and metal pipes; stats (thermostats), filters, fuel lines, evaporators, water lines, overflow pans ducts, pumps, fans, and switches, burners, nozzles, motors, etc.. Typical parts and supplies for the cooling systems included condensers, compressors, dryers, schrader valves, refrigerant lines, refrigerants, etc. With this report, I include a list of some additional parts in the HVAC terminology in Appendix J.

### *Typical Tasks*

Heating equipment technicians follow blueprints or other specifications to install . . . gas, electric . . . heating systems. . . . Air-conditioning mechanics . . . install fuel and water supply lines, air ducts and vents, pumps, and other components. They may connect electrical wiring and controls and check the unit for proper operation. . . . To ensure the

proper functioning of the system, furnace installers often use combustion test equipment such as carbon dioxide and oxygen testers . . . service and adjust burners and blowers. If the system is not operating properly, they check the thermostat, burner nozzles, controls, or other parts to diagnose and then correct the problem.

During the summer, when the heating system is not being used, heating equipment technicians do maintenance work, such as replacing filters, ducts, and other parts of the system that may accumulate dust and impurities during the operating season. During the winter, air-conditioning mechanics inspect the systems and do required maintenance, such as overhauling compressors.

Refrigeration mechanics . . . follow blueprints, design specifications, and manufacturers' instructions to install motors, compressors, condensing units, evaporators, piping, and other components. They connect this equipment to the ductwork, refrigerant lines, and electrical power source. After making the connections, they charge the system with refrigerant, check it for proper operation, and program control systems. (Bureau of Labor Statistics, 2003a, Nature of the Work, ¶ 4-7)

Technicians and installers at Metro Environmental fixed everything from air conditioners, furnaces, humidifiers, electronic filters, commercial freezers, ice machines, and commercial refrigerators. During the study, the various technicians and installers serviced everything mentioned by the Bureau of Labor Statistics as noted in the quote above.

I observed one unexpected but interesting task. Greg finalized his refurbish activities on a refrigeration unit for a commercial grocery chain and wrapped it for shipping. On the refrigeration unit, Greg and John, the young technician, had already checked the charging pressures, cleaned the interiors and the exteriors of the refrigeration unit, and then repainted the exterior. Greg took the bracket hardware that the customer would use to mount the interior shelves, counted the proper number of

brackets for that refrigeration unit, and then wrapped them in plastic sheeting and taped them to the shelves that lay on the interior floor of the refrigeration unit. Once they got everything ready to go, Greg wrapped the refrigeration unit in plastic sheeting to seal the doors closed. Next, he got on the fork lift, lifted the refrigeration unit, and placed it near the dock where the truck driver could easily load it for delivery to a store. Even for commercial companies, many people associate refrigeration units, refrigerators, freezers, and ice-making equipment with appliance repair services rather than HVAC services.

The technicians considered themselves as a jack-of-all-trades. Their tasks included installations, replacements, maintenance, troubleshooting, and repair of HVAC systems - usually at customer locations. Moreover, their service tasks included:

- Pipe work (often associated with plumbers),
- Electrical work (often associated with electricians),
- Natural gas work (often associated with the utility company technicians),
- Flooring installations in attics to prevent ceiling damage and to meet requirements by building permit inspectors (often associated with carpenters),
- Metal strap installations to hang ducts and HVAC units (often associated with builders),
- Flue pipes installations requiring sawing through roofs (often associated with builders),

- Sheet rock repairs as necessary (often associated with carpenters),
- Plant trimming and/or landscape clearing to access outdoors HVAC units (often associated with landscapers),
- Concrete pad installations for footing under outdoors HVAC units (often associated with masons)
- Freezers, ice makers, and refrigerators refurbishing (often associated with appliance repair companies), etc.
- Facility remodeling at the Metro Environmental facilities to accommodate the needs of the company.
- Miscellaneous tasks (See Appendix J for some other tasks that I observed.

### *Tools*

Heating, air-conditioning, and refrigeration mechanics and installers are adept at using a variety of tools, including hammers, wrenches, metal snips, electric drills, pipe cutters and benders, measurement gauges, and acetylene torches, to work with refrigerant lines and air ducts. They use voltmeters, thermometers, pressure gauges, manometers, and other testing devices to check air flow, refrigerant pressure, electrical circuits, burners, and other components. (Bureau of Labor Statistics, 2003a, Nature of the Work, ¶ 9)

Tools proved a vital part of every technician's workday. All of the technicians at Metro Environmental carried their tools in small zippered pouches or in medium-sized buckets with handles. John mentioned that larger containers proved difficult to manipulate up and down ladders and in the attics. He stated that they no longer used

tool belts due to the physical strain on the technicians from the constant, excess weight and the mobility restrictions.

Technicians at Metro Environmental paid for most of their own tools. If they needed a really expensive tool, the technician purchased it through their Metro Environmental tool account and then had Metro Environmental deduct for it over several of their paychecks. I include many of the tools that I observed during the study in the HVAC terminology in Appendix J.

Cell phones were one of the important tools at Metro Environmental. The technicians used them multiple times throughout the day to stay connected with dispatch, with John Thomason, with the parts houses, with other technicians, with customers, and sometimes with family. As noted previously, Metro Environmental purchased them, provided them, and had all billings for them sent to Metro Environmental. The technicians informed Metro Environmental of excessive personal calls and paid for unusual air time charges, if applicable.

I observed a technician use one very interesting tool - an infrared thermometer with a laser pointer. It looked like a small hand-held electronic tool, shaped like a small gun. Luis stood on the ground and aimed the laser pointer at a vent in the steeple ceiling at least 20 feet away to determine the temperature of the air at that vent. Prior to this tool, he would have used a tall ladder to measure the temperature properly. Luis noted it as an invaluable tool to help quickly balance the airflow throughout a house or office.

Orr (1996), in a major qualitative study on Xerox® technicians, discussed the status criteria among service technicians. His discussion on the preservation of order and understanding applied to tool skills as well as technical knowledge and social skills.

He noted:

Technicians' discourse reveals that they value most highly those attributes that contribute to the preservation of order and understanding. Reputations are built on technical skills, memory, ability to gather information, verbal performance, and the general ability to retain control of the situation. (p. 144)

Since the technicians owned their own tools, they were careful not to leave them when they finished at a customer location. Each experienced technician had a favorite organization to their tool bag, so they could locate a tool rapidly and/or do a quick check of tools at the end of the job by checking that everything got returned its proper location.

During installations where multiple technicians worked on a job site, or when an apprentice technician or a helper rode for the day with another technician, one technician might want to borrow a tool instead of returning to where they left their own tool bag. For these occasions, they always asked permission. They seldom removed tools from another worker's tool bag or work area. Usually, the lending technician removed the requested tool and passed it to the borrowing technician. This worked fine if the lending technician stayed nearby.

Sometimes, a technician left the work area to go for a part or supply, to check another area for progress, or to take a short break. I observed several different



occasions when the borrowing technician could not ask permission. In those instances, the borrowing technician would either purposely disturb the normal placement of tools or leave the replaced tool beside the tool bag to signal its recently borrowed status. When the absent technician returned, the technician saw the misplaced tools, asked about them, and then gave a "delayed permission."

Twice, I observed purposeful misplacement or removal of tools, when no one really needed to borrow them. The other technicians just wanted to trick the absent technicians into thinking that the absent technicians had misplaced their own tools. The trickster would wait to see how long it took the absent technicians to notice the misplaced tools and/or to see how convinced that the absent technicians remained that they did not actually do it to themselves. The trickster would then reveal that the trickster had not really used the missing tool. This trickery between technicians seemed as if they did it in fun, usually with other technicians as witnesses, and usually received with a fun spirit.

Sometimes, the technicians got creative with their tools. At one customer site, Oscar and Luis had to move the location of a thermostat. Because of the new location, they had to drill a hole in a bedroom wall, then continue it through the insulation, and finally through the bricks on the exterior of the house. They tried to do this as one of the last tasks of the day so the batteries for the power drill functioned at less than full strength. Moreover, they needed a thick drill bit, about an inch in diameter, which meant drilling through a lot of material. The two technicians traded off pushing on the

drill trying to get it through the walls. Twice the batteries died so they had to find different ones, attached to other tools, and switch them out. Finally, they depleted all the batteries and both the drill motor and bit were smoking. They still had not made it through the bricks on the other side. Luis used a flashlight to locate the cause of so much resistance, but he struggled to find it. He finally saw brick mortar and a little brick. Oscar then confirmed what Luis saw.

Oscar had a long chisel, but its rubberized handle (positioned partway down its shaft) kept it from being useful for this problem. So, he took a hammer and pounded the handle further up the shaft to modify its working length to make it through the last bit of wall. With a tape measure, Luis confirmed that they had drilled the current hole about seven inches deep. He felt like they had another two inches to drill. Both Oscar and Luis attempted, but they never got the handle off the chisel. Finally, Luis removed the drill bit from the drill to work the two tools as one. Then, Oscar realized the loose drill bit gave them some additional length. Nonetheless, even when Oscar hammered on it, it did not push through to the other side. Finally, Luis took a long screwdriver which had a smaller tip and hammered it almost flush with the interior wall. When he pulled it back out, they had finally made it through the exterior wall. Outside, they saw that the hole missed three bricks. It appeared exactly centered on the junction of a "T" between a row of bricks and between two adjacent bricks. The entire hole went through mortar instead of all brick or some brick and some mortar. Concrete in the brick mortar makes it very hard, much harder than brick. They identified the mortar as the culprit.

### *Travel*

For many service calls, the technicians consulted their MAPSCO® maps and/or had the staff search for the location on the office computers. With the maps, they would plan the best route to travel to their work site. They considered the available roadways, the road conditions, and the usual traffic patterns for those roadways. For the new apprentice technician, finding locations using the MAPSCO proved slow. For the experienced technicians, they easily read the MAPSCO and/or remembered how they got to a previously visited location.

The technicians accessed the new and old offices via nearly identical routes. They drove on Highway 121 (a major North Texas highway) most of the way from interstate freeway I-35 as it ran through Lewisville to get to either office. They drove about a mile east of I-35 to get to the new office. They drove about a half-mile west of I-35 to get to the old office.

I noted that on two occasions, the technicians drove past the old location first and then followed the minor traffic arteries to a customer location from there instead of taking the shorter, more direct route down I-35. I wondered if roadway habits died hard or if they planned this due to early morning traffic delays on I-35. When I questioned them about this, the technicians gave a partially unexpected answer - they wanted to stop at a local gas store for some refreshments and/or to get cash from an ATM. They chose a favorite store they already knew near their old office instead of several that

they passed between the new office and the freeway. They then took the closest route from the store to their final destination.

To access one site scheduled for an installation in a gated community, Ray (the salesperson) drove in his personal car, Oscar and Luis (two technicians) traveled in the Metro Environmental box truck, Kwame (the third technician) drove a Metro Environmental van, and I drove my own car. Ray wanted me to follow him and for everyone to meet at the gate so that we could get past the guard together. Ray and I drove directly to the freeway. The three technicians left a few minutes earlier to make a short stop in Lewisville prior to accessing the freeway. Since we wanted to get to a customer site across the Dallas/Fort-Worth Metroplex, we planned to drive the quickest, least expensive route down I-35 and then across I-635.

Traffic did not cooperate since we got stalled by an accident about 5 miles down I-35 that brought traffic to a crawl except for the HOV (high occupancy vehicle) lane. When Ray noticed the box truck, with the two technicians, go past him in the HOV (high occupancy vehicle) lane, he entered the HOV lane illegally in order to catch up with them and to help them get past the gate guard. Since he did not know my cell phone number, he called John Thomason on the phone and asked John to call me to explain why he altered his route/plans.

For this situation, the cell phones and plan clarifications proved extremely helpful for communications and understanding. In an attempt to catch up with Ray, I took two toll roads instead of the planned freeways, since conveniently nearby I saw an

exit to the first toll road. My decision generated unnecessary access fees but saved me valuable time. The gate guard let me enter the customer site since Ray had arrived, had explained the traffic problems to the guard, and had obtained the necessary approvals. Kwame, in his company van, stuck to the original route as planned, probably because he still felt somewhat unfamiliar with the roadways in the Dallas/Fort-Worth Metroplex and/or he had not planned an alternate route. On other trips, I noted technicians used the toll roads and paid the fees so I viewed the reimbursement fees as probably not a factor. Kwame arrived at the customer location approximately 30 minutes later than everyone else, because of the traffic delays.

#### *Customer Sites*

The broad electro-mechanical service industry sets up a number of expectations regarding anyone in that industry environment. Orr (1996) in a major qualitative study found that Xerox Corporation technicians shared "war stories" about various machines, accounts, customers, managers, and other technicians. He noted:

There is an existential dilemma at the heart of service: the technicians are responsible in a world in which they have very little control. Their job is to respond to trouble and to anticipate and avoid trouble when they can, but the setting in which they perform is largely constructed by other people, is inhabited by other people, and is inherently unpredictable. (p. 158)

I categorized the environments for the HVAC technicians as more extreme than environments that the typical copier technicians serviced. Each house or business that the technicians visited seemed essentially different since no two appeared exactly alike.

The builders had several master plans for each sub-division and commercial area, but they customized each location to the buyer's tastes/budgets. Moreover, the technicians serviced the HVAC systems throughout the Dallas/Fort-Worth Metroplex and in houses/building built even generations ago. Over the years, builders added new additions to the homes and reorganized office layouts. Residents made changes for their convenience or for access to the attics, closets, or other workspaces. Some builders thought about/planned the impact of future revisions to systems, but most did not. They wanted to keep the costs low and found ways to hide problems inside the walls.

Residents treated the attic spaces and/or utility closets differently - some were crowded with storage items, some were virtually empty. Sometimes the technicians were there to repair or just do seasonal maintenance, other times to do HVAC systems and/or HVAC unit installations or replacements. They were on call as needed or requested. The technicians installed mostly Trane units and systems, but the original HVAC units and systems in each house or business came from a multitude of different manufacturers. Sometimes, technicians added new concrete pads, new wiring, new ducts, or new plumbing to accommodate new systems, new thermostats, or new regulations. They sometimes laid new "flooring" in attics for safety issues. Other than those additions, they dealt with the customer locations as they found them.

Early thermostats and systems needed only a couple of wires, newer systems designed for better efficiency with variable speed motors and/or for user programming of variable settings throughout the day, utilized five wires. Trane management

recognized the resultant problems for HVAC systems replacements. They recently redesigned their HVAC systems to move away from the five wires in their newest high-end units. They used wireless communications between HVAC units instead of extra wires. I observed a Trane training session that introduced the wireless components in new HVAC systems that Trane just started to ship.

One location in this study (new system, but not the newest wireless units) created numerous call-backs. This customer had a two-story home with lots of large open areas and two HVAC systems - one for upstairs and one for downstairs. In a recent replacement of both systems, the technician moved one thermostat because the technician encountered problems with running new wiring in the wall behind the original thermostat location. The technician placed the new thermostat too close to the return vent. The new, stronger HVAC units now drew air from the upstairs register past the new thermostat and into the downstairs return vent. This resulted in uneven temperature sensing for both heating and cooling throughout the house. This wiring problem reminded me of the location, as described previously, where the technicians ran wires externally to the house because they had impossible access to the original wiring path.

When heating, air-conditioning, and refrigeration mechanics service equipment, they must use care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants used in air-conditioning and refrigeration systems. The release of CFCs and HCFCs contributes to the depletion of the stratospheric ozone layer, which protects plant and animal life from ultraviolet radiation. Technicians conserve the refrigerant by making sure

that there are no leaks in the system; they recover it by venting the refrigerant into proper cylinders; and they recycle it for reuse with special filter-dryers. (Bureau of Labor Statistics, 2003a, Nature of the Work, ¶ 8)

All of the technicians in the study took care to properly handle the charging of the compressors with the refrigerants. Some of the technicians used leather gloves during this process, others did not.

The following transcription describes in detail what John captured through the recorded video from the SightPros communication tool as three technicians charged the compressors in each of three new condensers. It provides valuable insight to their working environment and it also captures some of John's thoughts and actions regarding the use of the SightPros-VirTechs system.

Center view: ((The video showed three technicians working outside on the back half of a one-story red brick building with a gray roof. It showed three white windows with white trim. It showed six condensers set on a long concrete pad next to the building. Metro Environmental technicians were installing the first three condensers. I called them condenser 1, condenser 2, and condenser 3. The last three, condenser 4, condenser 5, and condenser 6, were older condensers that the technicians had disconnected. The video showed bare ground in front of this side of the building. The lower right side of the video showed one slightly used but new wood plank with three containers sitting on top - possibly one large soda with a straw, one medium soda with a straw, and one coffee. The video showed a large fallen tree limb on the ground in front of that. It showed one light green refrigerant tank sitting next to the first condenser on the left, condenser 1.))



Panning far right: ((The video showed a red barn just past the rear of the red brick building but also to the right of it. It showed a trailer with a liquid tank on 1/2 of the trailer situated in front of the barn. It showed a large oak to the right front of the screen, just right of where the technicians were working. It showed broken branches, more slightly used but new wood planks, and more bare ground in front of the oak.))

Panning slightly left: ((The video showed a power bank of seven metal panels to the left of condenser 1. Starting on the left of the screen, I named the first one as panel 1 (probably a gutter panel). I identified it as the tallest panel and noted it as vertically mounted. The bottom of panel 1 aligned with the bottom of panel 2, a horizontal gutter panel. Panel 1 extended upward so that it also appeared even with the tops of panels 3 and 5. Panel 2 sat slightly underneath the panels 3 thru 7. Panels 3 thru 7 appeared aligned along their bottoms and located to the right of panel 1. I identified panel 3 and panel 5 as vertical, rectangular panels. Panel 4 and panel 6 appeared vertical, square, and about half the height of panels 3 and 5. Panel 7 appeared vertical, rectangular, but about 3/4 the height of the panels 3 and 5. Panel 1 had two large PVC pipes and one smaller pipe coming out of the base. The horizontal panel had one small black pipe coming out of the base and probably a PVC connection to panel 1 but from the viewing angle, I could not tell. Panels 3 thru 6 sat slightly above the horizontal panel 2 and connected to that panel with short thick PVC connectors. Panel 7 sat slightly above panel 2, but it connected to panel 6 with the same type PVC connector. Panels 3, 4, and 6 had electric meters. The video showed three bushes in a single railroad tie planter under the panels.))

Panning further left: ((The video showed a side entrance to the building to the left of the power bank. It showed a dolly to the left.))

- Panning further left: ((The video showed the front half of the building with three large windows. Small bushes also decorated these windows (none higher than the bottoms of the windows) in a single railroad tie planter. It showed two cars in the parking lot but any others were blocked from view by the building. It showed the bottom edge of the Metro Environmental truck.))
- Luis: ((The video showed that the technician wore a heavy jacket with a large star on the back. A band with smaller stars decorated each sleeve near the top. His medium blue jeans were muddy with an obvious tear in the upper left leg. He did not wear either a hat or gloves. He wore black leather tennis shoes and a Metro Environmental tee-shirt under the jacket.))
- Oscar: ((The video showed that this technician wore a heavy blue jacket with a white stripe down the top of each sleeve. His medium blue jeans were muddy. He wore a baseball hat and gray tennis shoes. He did not wear gloves.))
- Kwame: ((The video showed that this technician did not wear a jacket. He wore a medium-blue, long sleeve Metro Environmental shirt that appeared clean; loose fitting darker blue jeans with leg pockets; a dark-blue knit cap with yellow and white bands around the face; and black, gray, and white tennis shoes.))
- John: ((John introduced the video to potential viewers by providing explanatory statements.))  
Again, having the camera on the job site, uh, allows me • to, uh, see th- where they are in the scheme of things, uh, and, and, help to estimate a time they are going to remain on the job • and also as, uh, as an opportunity for me to interject

*((John left the cursor stable on the lower left of the video screen. Oscar watched Luis charge the compressor on the new condenser 1 that appeared on the far left of the screen. Kwame, visible on the right half of the screen, stood and looked at the charging gauges on the compressor on the new condenser 3. Luis looked up at Oscar and said something. Kwame moved forward to watch Luis. Oscar then walked back to condenser 3 to watch the gauges on the compressor.))*

John: if I, uh, think of things they need to be doing, etc.,  
*((John moved the cursor right to point at Oscar who he saw on the right of the video screen. John moved it back to the bottom center of the screen, and then moved it left past Kwame, who still watched Luis. He then stopped it at Luis who still charged the compressor for condenser 1.))*

John: I can go ahead and just get them on the phone and, uh, and we can talk together about what is necessary. •

*((John clicked the mouse on Luis then quickly moved the cursor to the bottom center of the screen. The network camera on the SightPros communication tool shifted to put Luis into the center of the screen and then it automatically focused the shot. Kwame remained visible, but Oscar worked off-screen, to the right. Luis and Kwame talked briefly then Kwame bent down to put his hand on the top of the refrigerant tank then moved his hand down to the back center of the tank. (See Figure 5.) Oscar moved back into the screen and stopped to look at the gauges on the compressor for condenser 2. John moved the cursor to Kwame's leg and then it past the bottom center of the screen.))*



*Figure 5.* The SightPros communication tool captured three technicians installing new condensers at a customer site. Luis talked with Kwame. Oscar watched on the right. The video also showed power bank panels 2, 6, and 7 on the left.

- John: Panning back to my left. •  
 ((At the start of this screen, the video did not show the cursor on the screen. John moved the cursor in from the lower left and clicked on the center left of the screen - on one of the three visible electrical panels on the far left. The network camera panned to the left to center the clicked panel and then sharpened the focus. The technicians worked off-screen. John still pointed the cursor at the center left of the screen after the network camera panned left, but he then moved it towards center screen.))
- John: Main power feed coming in. •  
 ((John moved the cursor from the meter down to the ground in front of panel 1 then up to the center of panel 1.)) •
- John: Underground service here, coming in  
 ((John moved the cursor across the ground in front of panel 1 then up panel 1 until he located it past the left edge of panel 2. Next he moved it to the right stopping momentarily on the meter on panel 3 and then moved it left until it stopped halfway up panel 1.))

John: through the meter •  
 ((John pointed at the meter on panel 3 then pointed it towards panel 7.))

John: and being distributed through this, uh, power bank  
 ((John circled the cursor around all seven panels once. He then moved the cursor to the left and then to the right over panel 2 twice. He finished by circling the cursor around panels 3 thru 7 twice, and then ended at panel 4.))

John: to all of these sub-panels.  
 ((John moved the cursor quickly over panels 4 thru 7, down over panel 2, up again and past panel 1 to the far left.))  
 (3.5 - • •)  
 ((John clicked on the screen on the far left. The network camera again centered the screen at the point John clicked and then focused the image. The video showed the side door of the building and a dolly in the foreground on the far left. John moved the cursor once up and down the dolly.))

John: Here's our dolly.  
 ((John clicked on the dolly and the screen again panned left and focused with the dolly in the center of the screen. The video showed two of the windows to the left of the side door on the left of the screen. John left the cursor towards the center left of the screen.))

John: Panning back to the front of the building •  
 ((John moved the cursor slightly further left and clicked. The network camera panned left and then it refocused the image. The video showed the front of the building and the left side of the parking lot with two parked cars. John circled one of the parked cars.))

John always, as early as possible, recorded the full view of the SightPros communication tool using the pan, tilt, zoom, and iris adjustments to check the overall

job layout and work site conditions. As needed, he manipulated the settings to find and watch workers that had moved off screen.

### *Customer Service and Care*

Technicians recognized themselves as "visitors" in the customer's homes and offices. Often these visitations occurred during a time of intense customer discomfort due to the failed HVAC systems. Customers felt helpless in their broken environments; the technicians were there to help.

Some customers essentially ignored the technicians other than to let them in and out of the premises. Other customers watched closely, from a distance, trying to pick up a few tricks that they might use later to help themselves out of a similar bind. When the technicians fixed the problems, they felt good and had instant gratification by seeing the HVAC systems working properly and the customer happy. To some customers, these technicians assumed a hero status.

Technicians took special pride in keeping the customer environment clean. They wore booties over their shoes whenever they worked inside a house. They used drop cloths from the front door to the work areas to capture mud and other debris for easy removal. At the end of each service call, they brought in a vacuum to pick up any debris that floated out of vents unexpectedly and/or fell off of the drop cloths. They also used drop cloths and vacuumed when they drilled through walls for thermostat placements/replacements. As needed, they took rags and dusted nearby furniture if a dust cloud dropped debris.

## *Safety*

Hazards include electrical shock, burns, muscle strains, and other injuries from handling heavy equipment. Appropriate safety equipment is necessary when handling refrigerants because contact can cause skin damage, frostbite, or blindness. Inhalation of refrigerants when working in confined spaces is also a possible hazard. (Bureau of Labor Statistics, 2003a, Working Conditions, ¶ 2)

All new HVAC units, some parts, and some supplies came with relevant MSDS (material safety data sheets) warning of any potential dangers upon use and/or in the future. All new HVAC units, some parts, and some supplies displayed relevant caution and/or warning labels on the packaging and/or on the materials themselves. For instance, the cardboard covering new HVAC units illustrated potential hazards, such as equipment damage, and/or potential problems, such as painful back injuries (box showed a stick person with a lightning bolt near the lower back), if the installation team improperly handled the units.

However, technicians dealt with other hazards inherent in any building. Every attic had insulation that stuck to their shoes and clothing. Modern building had fiberglass insulation which itched and/or cut when handled. Older buildings often had asbestos insulation with known links to lung cancer.

Christine stated that the HVAC industry included many hazards. She mentioned that technicians used ladders to climb up buildings, but ladders sometimes fell if a technician did not properly secure them. Especially in windy conditions, anything could fly off of a roof or building and down upon unsuspecting people, cars, etc.

I accompanied Kwame and John, the young technician, as they performed service maintenance for 14 RTUs (roof-top units) at one account. John secured his 30-foot ladder against the building by strapping it with a bungee cord to one of the metal pipes running to the roof. Both technicians carried their tools, 14 large commercial filters for the RTUs, and both SightPros communication tools up the ladder. I had climbed many ladders before and did so at this account while I carried my camcorder, camcorder case, and tripod. I carefully completed the trip up the ladder.

The technicians could not access any electrical outlets on the rooftop as the building manager had enclosed the outlets and then padlocked the enclosures. John descended the ladder, walked around three other businesses in the strip mall to get to the front office where he then got the key for the locks. Meanwhile, from the home office, John Thomason recorded video from Cam2. When the technician finally accessed the electrical power outlets, John recorded video from Cam1, also.

Once on the roof, I realized that the weather felt very cold. I had worn a light jacket and no cap since at ground levels the temperature approached 50 degrees. The technicians had dressed properly in heavy hooded coats and knit caps since the winds had blown at 35-50 mph that morning. John Thomason, still at the home office, called me on my cell phone and noted how cold I looked and how badly my hair blew in the stiff winds. John Thomason and I chatted briefly several times as he recorded both the technicians and me as we worked. It felt odd in that I recorded the SightPros



communication tools and technicians at the same time that John Thomason recorded me recording those technicians.

John Thomason remotely analyzed the capabilities of the HVAC units and the SightPros communication tool in this work environment. As the technicians checked each RTU, John Thomason viewed the units and the technicians. He mostly spoke with Kwame, the apprentice technician, and reminded him about items to check and instructed him on how to do the actual check such as belt tensions, flashing LEDs, etc. He also discussed mechanical theory and potential adjustments that Kwame could make.

As the two technicians wrapped up the call, they located an open commercial dumpster and dropped the old filters directly in it from the rooftop. Most of the filters landed in the intended destination, but the cold, hard wind blew one of them too far. John, the lead technician for this call, carried Cam1 and his tool bag down the ladder, retrieved and discarded the stray filter, and then waited for us down below.

I got slightly frightened getting back off of the roof, particularly in the transition between the rooftop and the ladder. The building seemed really tall. The winds blew very strong. My knees ached from age and prolonged standing. I needed both of my hands to carry my camcorder and accessories. Thankfully, Kwame recognized my hesitation and my attempt to rearrange my load. He offered to help me by carrying the tripod back down the ladder along with his tools and Cam2. I descended first; Kwame

followed. Part way down, Kwame removed the bungee cord then completed his descent.



*Figure 6.* The building owner had locked this ladder cage. The customer did not have a key. The Metro Environmental 30-foot ladder would not reach the roof. The technicians decided to climb the building on the outside of the ladder cage. They carried parts, tools, and the SightPros communication tool to and from the roof.

Near the end of the study, two technicians serviced an account at a building built a little too tall for the Metro Environmental 30-foot ladder that they carried on their truck. The building had a ladder built into the end of it. A metal cage surrounded the ladder to prevent unauthorized access to the roof (Figure 6). However, the account that they serviced did not have a key to the cage and the account manager did not know

where to get it. The technicians decided to carry their tools, the SightPros communication tool, and the filters up and down the outside of this cage.



*Figure 7.* Luis carefully followed safety precautions as he soldered a connection with an open flame torch. He worked next to a gas line, a gas meter, and a drier exhaust vent in a very tight space between a bush, a condenser, and a brick house.

Christine mentioned that the technicians also dealt with gas leaks, flue pipe poisons, welding tools (Figure 7), acids, and other hazardous chemicals. They dealt with 230-VAC HVAC systems which if not disconnected could result in electrical shocks and burns. For certain jobs, depending on the city where they did the work, Metro Environmental had to obtain permits to do any welding and other major HVAC system change outs. Certain commercial customers had specific safety standards that the technicians had to meet when they were on-site such as wearing hard hats, fluorescent vests, using cones for outside work, etc.

Often the HVAC systems, especially for commercial accounts, included very large and very heavy units. For one study location, where the technicians replaced multiple RTUs, Metro Environmental rented a crane and hired a crane operator (for the day) to move the RTUs to the rooftop of the building. Most of those RTUs measured 10 feet by 12 feet. The largest RTU at this site had 15 tons of refrigeration. Metro Environmental serviced RTUs with as much as 120 tons with appropriate increase in sizes. John sat in the home office (miles away) and observed and recorded the roof top activity from the streaming video from Cam2. At one point John noticed Ray, on top of the building, helping the technicians guide a RTU into position as the crane lowered it. John called Ray's cell phone and warned him to keep his hands from under the RTU as the crane lowered it onto the curb - the raised edging along the roof cutout. John saw the potential hazard because he monitored the worksite with the SightPros communication tool.

To get an idea of what happened and the potential safety concerns, imagine the crane on ground level with the 10-foot by 12-foot RTU dangling above the roof by metal cables attached to the four corners of the RTU. The crane operator inside the crane saw only the closest edge of the roof. So, he climbed up to the roof to get a first-hand visual but then climbed back down to get into the crane. The RTU itself had plenty of extra sway as the crane operator swung it across to the center of the roof. Three technicians guided the RTU into position and removed each cable while the fourth technician signaled the crane operator from the edge of the roof as to the direction to move it and

how far to lower it to align it with the roof curb. Once the cables were loose, they continued to sway due to winds and the movement of the crane arm back to ground level. The technicians needed to maintain situational awareness before and after the delivery of the RTU as that remained critical to everyone's safety.

### *Dreams for the Future*

All of the technicians recognized that without the opportunities provided by SightPros-VirTechs system that they probably had to quit or change their job if they had problems working in the harsh environments of this industry. Almost all of the technicians expressed a desire to own their own business at some time in the future. Most, but not all, of the technicians wanted to own their own HVAC business, eventually. Metro Environmental set a good example of a quality business to emulate.

### Training

All the Metro Environmental technicians obtained EPA certifications and State of Texas registrations so that they could legally purchase and then sell refrigerants and HVAC units containing refrigerants to customers (Texas Administrative Code, 2006). John mentioned that the industry has moved towards a requirement of NATE certification for all technicians.

Texas Administrative Code also required all technicians who worked for an HVAC and refrigeration contractor to register yearly with the Texas Department of Licensing and Regulation (2007). This registration ensured that any HVAC technician, who entered a home or business to do contracted work, underwent a criminal background check

every year. John stated that by June 30, 2008, all Metro Environmental technicians had to register with the State of Texas so that they could legally perform maintenance for a licensed contractor under that provision.

Greg mentioned that most of the schooled technicians learned the basics, but then worked for a company where they actually learned how to do the job. As noted previously, Greg said he seldom went to new classes unless they addressed new HVAC systems and/or features.

Kwame felt that he had a firm foundation in HVAC schooling. This included information on temperature and pressure gauges and the refrigeration cycle. He acknowledged, however, that he still had a great deal to learn.

Luis noted that he had learned a lot while working for Metro Environmental. He learned new tools from John, learned by watching others at Metro Environmental, and especially learned from some picky customers.

Oscar felt like he learned something new every day. John sent him to various courses offered in the industry. He felt that he learned by working with other individuals and seeing different ways to do things. He also felt like the learning he received here involved more knowledge. Initially, he knew charging of systems. Now, he understood the big HVAC units and the entire system.

John, the young technician, first learned HVAC by being a "go for" without any training. He started as an installer then went to schools, became EPA certified, and gradually worked in the field. He noted that the basic schooling felt easy, clean, almost a

joke compared to the actual field environment of dirt and weather conditions.

Nonetheless, he mentioned that knowing the basics of what he did helped him on the job sites.

John, the president/co-owner, started in high school in a 2-year vocational education program. He also worked for an HVAC contractor while in high school. After graduation he received three scholarships to attend a junior college where he stayed until he joined the Air Force. After the Air Force, he spent a year teaching trades and industrial classes to high school students. He later earned an associates degree. He spoke about the extensive, routine training he had taken through Trane classes. As president/co-owner, he also took classes to learn about effectively and efficiently operating a HVAC business. John expressed his desire to become a mechanical engineer, but considered himself as too old and too busy now. He expressed regret that he never achieved that level of education.

#### *Training in the SightPros-VirTechs System*

The following transcription shows how businesses can use the SightPros-VirTechs system for one-on-one training of an apprentice technician. It demonstrates a typical training scenario and the use of the SightPros communication tools. This service call occurred in an attic at a customer location. Their system had a noise problem. This service call happened early in my study. John used his cell phone. John had not started using the speakerphone to record both sides of the conversation so often I could not hear the responses by Kwame.

John: ((John talked with Kwame over the cell phone.))  
So, nonetheless, what I want to determine is: is if we can hear any unusual noise. So, you just started it up on its second cycle. Is that correct?

Kwame: (inaudible)

John: Okay.

Kwame: (inaudible)

John: Okay. I see much better now. Okay. Alright. I see much better now. Let me scr - scroll down here a little lower in the video field. Ah, there we go. Now, I got a good picture of the furnace

John: and, uh, it's just a hori - standard horizontal gas furnace and of course I see the big brace board right there that - and to the right of it is the panel we'll be taking off to look, to look at the, the blower. Uh.

Kwame: (inaudible)

John: Yep. Now, ah, go ahead and turn it back on to, ah, kick it up again. You're going to have to go down to the thermostat and kick it up so we can start another cycle. (.) And, uh, we want to hear it 'cause it could be anything. It could be in the, in the gas valve, or it could be something as

John: "late igniting," combustion issues, that kind of thing, so let's go down and turn the thermostat up and let's listen to what we hear.

Kwame: (inaudible)

John: Yep. That'll

Kwame: You can hear?

John: There you go. Let's do that. Works for me.  
(19.0)

John: It is now 9:56. I am viewing the furnace in the attic at Carol G's home and we are in the process of trying to duplicate the noise problem that she described to Kwame when we first arrived. So, we're going to recycle the furnace and restart it again to see if we can duplicate that noise issue.  
(28.2)

HVAC equipment: (6.3 - Buzz. Snap. Chug.)

Kwame: John, did you hear it?



John: Yeah. I heard that - it sounded like . . . Did it sound like the motor to you? It's what it sounded like to me.

HVAC equipment: (2.0 Chhhhhhh, Chhhhhhh)

Kwame: Yeah, it sounded like most the damage is.

John: Then it smoothed out, didn't it?

Kwame: Yeah. Yeah. It (inaudible) did the same thing the first time.

John: Was

Kwame: Second and a half, it comes on.

John: Yep. (.) Yeah, that's the - that's the - sounds to me (.) Ah, based on this, the cell phone audio, it sounds like to me, like the blower motor is what the problem is here. • That's certainly what it sounds like when a, an older blower motor

Kwame: It sounds like making a noise.

John: Yeah. It's, it's when it first starts off it's got a growl to it. Now, once it picks up speed, it tends to go away.

Kwame: Uh, huh.

John: And,

Kwame: [ that that's She just told them, you know, it's nothing like, ah, it was this morning before we came.

John: Yep.

Kwame: There's some foil

Carol: full vibration, shakes, rattles, (inaudible)

Kwame: (inaudible shaking it but ah) (1.3) (or, ah, what we probably sound like)

John: Yeah. What we want, what we want to do at this stage - let's just go ahead and, uh, and pull the - the blower panel, uh, off, and let's look inside the blower compartment. And, uh, and we're, we're gonna check several things. We're gonna check the blower wheel, and we're gonna check if that motor has any oil ports on it.

Kwame: [ Uh. (I hear you.)

John: L Uh.  
 It sounds like to me, like the blower, uh, uh,  
 bearings - the motor bearings are starting to go  
 on that furnace  
 ((Momentarily, the video captured a real freaky,  
 face-shaped design on an attic brace board.))

Kwame: She says sure sounds like it.

John: Yep. Let's, uh, lets, uh - If you can try to pull your  
 drop light in a little bit closer to the furnace. Right  
 now you're, ah, ah - I see the back of you. Yeah.  
 There you go. That's good • and I'm getting good  
 video there and let's, ah, let's go ahead and take a  
 look inside that blower compartment.



Figure 8. John viewed this dirty, noisy blower motor in a remote, almost dark attic.

From the transcript, I noticed that John taught Kwame some vocabulary by naming the parts and then several times taught him what to consider in troubleshooting by discussing the potential causes of noises in a furnace, things to look for, etc. Later in

the call John saw the dirt on the motor (Figure 8). They realized that the motor bearings probably had gotten damaged. John determined that this furnace had operated for almost 25 years. Therefore, John and Kwame recommended to the customer that the customer should replace their furnace. The customer agreed so Metro Environmental replaced it the next day. Without the visuals, all John could evaluate would be noise and verbal descriptions by an apprentice technician. With the audiovisuals, John successfully diagnosed the overall problem and then confidently recommended the best solution.

### *Trane Training*

During the study, a local Trane employee, a trainer, needed to practice a presentation for a class on some new HVAC systems that Trane had introduced. The trainer held a 5-hour mini-training session at Metro Environmental on the key points. All of the Metro Environmental technicians attended, as did John Thomason and Ray, the salesperson. Trane and Metro Environmental permitted me to attend and to record the training. Although the trainer abbreviated the session, the training included enough information that the trainer sent certificates of completion to all of the technicians.

The Trane trainer enhanced the training using presentation software given via a laptop computer and a projector that the trainer brought. Each technician received three wire-wrapped booklets. In the books the instructional designer included at least one underline area on each page where the trainee had to write in a correct word or phrase as noted by the instructor. That kept the trainee on the correct page and following the script in the book so that when they finished they had a complete book.

Without some of the correct words in place, they might not understand the paragraphs when they read them later to refresh their knowledge. This design kept the technicians following the overhead presentation, listening closely, and following the text in the books so that at the end they would have a good resource to refer to later, if needed.

### *Experts or Apprentices*

In the interviews conducted for this study, the interviewees defined experts as technicians who took a lot of classes so they had lots of certificates. They spent years on the job so they had good knowledge and skills. They identified an expert as a person in charge of a job not just someone who knew more. Experts had knowledge of older systems as well as newer ones. They considered experts as the people they called when they had a problem. Experts not only knew how to fix a problem, they knew why a component or situation caused the problem. All of the technicians considered both John, the president/co-owner, and Greg as experts in the HVAC field.

The interviewees described an apprentice as someone who had just begun to work at a HVAC business. Apprentices had limited knowledge. They did not know what they needed to do. They missed some key information if not all of the key information. They frequently needed help. They observed and learned techniques from others.

At Metro Environmental, technicians and experts readily shared their knowledge with their co-workers. I found minimal evidence of any knowledge hoarding (Argall, 2002). I found little evidence of psychological resistance to persuasion (Brehm, 1966). I

found little evidence of resistance to advice (Weaver, 1999). I found only minor evidence of subtle threat statements (Weaver, 1999) given with any advice.

### *On-the-Job Training versus Schooling*

The feedback on the quality of the technician training at Metro Environmental compared to prior training revealed that training on the job seemed much more realistic than any school training. All the technicians voiced that sentiment. They liked the courses put on by the manufacturers and others, but even that material did not seem as relevant to them until they actually got back to work and experienced the HVAC systems in the field. One of technicians replied that technicians went to school and got all of the book knowledge but then they came to work. They really learned the job while working on the job. That technician went on to say that the book knowledge felt necessary and helpful as a base for their understanding.

### *Communication Patterns*

I looked for various communication patterns to help me analyze the culture and training at Metro Environmental and in field locations. As in my second pilot study (Appendix B), I again found many examples of expertness relationships, power relationships, politeness, mediated conversations, chunking of information, quiet times, introductory and closing formulas, rules of appropriate conversations, objectifying, specialized language styles, figurative language, narratives, storytelling, camaraderie, and joking.

All participants expressed their own level of expertise in the way they talked to each other. Their expertness relationship patterns helped me to distinguish the levels of understanding by the experts, technicians, installers, and customers. For instance, in the training transcripts, I noticed the level of details in the descriptions of components, what to do, what to look for, etc. I also noticed how John scanned the work area to see what he needed to discuss. When John talked with Kwame, he gave detailed instructions and often one instruction at a time. When John talked with more experienced technicians, the instructions would lean towards concepts instead of details and he would give multiple instructions in one statement. Even the customers exhibited various expertise levels from absolute novice to general mechanical/electrical understanding.

Often the participants expressed power relationships in the way they talked to each other. Kwame, being the apprentice frequently functioned in the less powerful position. However, because he worked on site doing the physical work and observations, his conversations included both powerful statements (temperature reading, customer statements, serial numbers, etc.) and less powerful statements (John, did you hear it?).

I noted that most Metro Environmental conversations included politeness statements (Keenan 1974). Metro Environmental operated as a customer service organization. Politeness extended throughout their organization. The constant practice

and re-enforcement of politeness patterns by the Metro Environmental personnel helped to ensure that their customers also felt and observed their politeness.

All Metro Environmental personnel frequently held conversations mediated by cell phones. They even called each other on their cell phones when they were at the same account but at different locations. The phone conversations were often brief and to the point.

The technicians used short descriptive statements to express instructions and just to talk on the job. I refer to this as chunking the information (see Appendix B for a historical explanation). In the interviews, the technicians talked openly and seemed more expressive in conversations. Kwame, the apprentice, talked more frequently and longer than the other technicians both on the job and in the interview with less chunking of information. During the lunch breaks or gathered in the office waiting for meetings, the technicians conversed freely.

Throughout the day, especially when they were alone at a task, the technicians had extended periods of quiet time with no conversations or communications as they went about their work. Even when multiple technicians worked at a single site, they had prolonged periods of quiet time while doing specific tasks that did not need coordination with others. Conversations often distracted them from their tasks. Frequently, they worked in loud environments.

All participants used special introductory and closing formulas as noted by Irvine (1974) and other sets of rules for appropriate conversations as noted by Frake (1964).

The next two conversations demonstrate good examples of phone and in-person opening and closing statements and other conversational rules by John and Kwame.

John remotely assisted Kwame with a call where Kwame worked all alone doing the maintenance. John discussed the need to disconnect the power and the need to turn it back on. John reinforced the training on each HVAC unit, by repeating some of his prior instructions and/or verifying that Kwame had killed the power and then reconnected the power as instructed.

John: ((John introduced the video to potential viewers by providing explanatory statements.))  
John: We're doing the maintenance today and we have Kwame • there today by himself and I'm gonna walk him through some, uh, maintenances  
(0.4)  
John: today a proper maintenance procedure. I'm gonna call him on the phone  
(11.2 - • Static on the recording where John is using his cell phone to call Kwame. •)  
John: Okay. He should be- He's getting the call now. •  
Kwame: Hey, John.  
John: • Hey, Kwame. Just got video. We're recording  
John: and, uh, what we wanna do is, ah, locate the filter panel on that unit, first. •  
Kwame: (inaudible)  
John: Yeah, what- right, ah, by the one you're standing next to will be just fine.  
Kwame: (inaudible)  
John: and let's  
Kwame: [ kill  
(inaudible)  
Kwame: (inaudible)  
John: Yeah. You just kill the power to it. •  
John: Be - Here's something that's very important. (.)



John: Always be sure and, uh, and to, you know, to turn the, the breaker, the disconnect off when you're working on it, but also, it - what's equally important is turning it back on when you're finished with that unit.

Kwame: (inaudible)

John: Never walk off the roof with the power left off.

Kwame: (inaudible)

John: Okay. • So, let's go ahead and, uh, start, uh, uh, changing the filters on this first unit.

A little later on the same job, Kwame moved the Cam2 and his tools over to another RTU, Unit 3, which also needed maintenance. John noticed a potential safety problem and got worried so he called Kwame.

John: ((John again introduced the video to potential viewers by providing explanatory statements.))  
Okay, we're resuming now with a, uh, new unit, (2.0) Unit 3. (1.2) (Gonna) (0.9) tip the camera angle down just a little bit there. And, we're gonna zoom in a little bit.  
(8.0)

John: Here's the disconnect on the end of the unit.  
(41.3)  
((John called Kwame.))

Kwame: Hey, John.

John: Yeah, Kwame. Uh. Have you - You haven't killed the disconnect on that unit, yet.

Kwame: (inaudible)

John: Have you turned off the power yet to that unit?  
(2.1)

Kwame: No, I'm just getting the monitor set up there.

John: Oh. Okay. Okay. I'll just was- saw the nut- the, the disconnect was still on. I just wanna be sure you don't get yourself hurt. That's all.

Kwame: (inaudible)

John: Very good. Very good. Just checking.

Kwame: (inaudible)

John: Alright, I'll let you go. Bye.

Kwame: (inaudible)  
 John: ((John disconnected the call and then turned the conversation back to the potential viewers of the video.))  
 Well I was a little premature in chastising him there as he has just hadn't got that far. Here he is • he's, uh, writing down the model and serial number down on the end of the unit. Now he's gonna go down here to the other end and kill::: the disconnect. (3.0) which is right behind him. (9.5)  
 John: So, here he is. He's reached down, turned the dis- this disconnect is now off.

The technicians used objectifying (Whorf, 1956) when they discussed tons and air flow. They used specialized language styles and figurative language such as *killing the power* or *killing the disconnect*. John Thomason frequently used narratives and storytelling (Bauman, 1981) in everyday discussions and in training. The technicians, office personnel, and customers also shared instances of narratives and storytelling in their interviews and in their general conversations. Many participants enlivened conversations and built good relationships among themselves with various camaraderie and joking statements.

#### Additional Findings from the Interviews and Surveys

I discovered a number of insights from the customers, business contacts, and Metro Environmental personnel. The interviews and surveys revealed much of this information.

### *Customers and Business Contacts: Professionalism and Training*

The customers and business contacts gave a wide variety of responses to the questions on professionalism and training. One customer described the actions of a professional and trained technician, but they still did not feel confident that they had properly judged their training level. Many times their description of one overlapped with the concepts from the other one. Therefore, I merged their responses about both professionalism and training. Their descriptions included:

- Certified by the industry.
- Knew what they were doing. Did the assigned job well. Competent.  
Competent mechanically. Had the knowledge to fix a problem and get out.
- Established a good customer rapport.
- Communicated well. Talked a good story. Described the job to the customer well. Explained the customer's problem succinctly, in layman's terms, and most importantly, the customer understood them. Didn't leave a customer with unanswered questions.
- Trusted by the customer to give good information on their problems.
- Kept customer costs down by quickly identifying the problem and fixing it the first time. Efficiently and effectively did the work.
- Maintained a high standard of work ethics. Didn't goof off.
- Went above and beyond.

- Behaved politely. A gentleperson. Considerate in speaking. Respectful of the customer's home, time, and age.
- Responded timely. Seemed prompt.
- Acted confident and accurate. Maintained a good attitude.
- Appeared clean, clean-cut, neat, and presentable. Wore a uniform.  
Maintained a professional appearance - business-like. Gave a good first impression. Didn't smell of smoke. Left without leaving behind any muddy feet tracks.
- Kept a tidy work area. Cleaned up after their work.
- Maintained their vehicles so that they looked professional both interior and exterior. Left without leaving behind any oil spots on a customer's driveway from their trucks.
- Collaborated and "group solved" but not always calling to ask questions.
- Responds to phone calls.
- Carried common parts on their trucks.

#### *Technicians and Installers: Professionalism*

The technicians and installers at Metro Environmental said a lot about professionalism. I include some responses here by John Thomason since he functioned as a technician by trade and by license and he still viewed himself as a potential back-up technician. However, most of the responses came from the five active technicians/installers.

When the technicians described professional appearance, most of them responded first with a statement about clean uniforms. For Metro Environmental, this meant providing each technician with tee-shirts with Metro Environmental colors and matching baseball caps. Tee-shirts came in short and long sleeves to cover the varying seasons. Each technician wore a Metro Environmental badge with their picture prominently displayed. The technicians could choose their own style of blue jeans, shoes, and jackets. In actuality, they found it hard to maintain a clean uniform. Technicians worked in attics and outdoors where they very easily got apparel dusty and/or muddy. Clothes got snagged on HVAC units, protruding nails from attic boards, and bushes around outdoor systems. During the study, some of the technicians also wore personal shirts and caps, if they wore a cap, instead of the Metro Environmental blue colors. Technicians often carried another clean tee-shirt in their van.

The technicians and installers described many other characteristics of a professional serviceperson. They included:

- Delivered always an excellent customer service.
- Talked with respect to the customer. Didn't try to act cool even if the customer seemed young.
- Kept a nice haircut.
- Followed procedural standards.
- Did what they should do even when no one watched.
- Provided a clean and honest job.

- Did it right; did it the first time.
- Learned to use tools properly since just having tools doesn't mean anything.
- Strove always for excellent customer perception. Recognized that customers became wary after an expo in the 1990s regarding faking bad parts by certain companies and their service technicians. Overcame and/or neutralized customer mistrust of all service-oriented industries.
- Learned to talk at the customer's level of understanding. Realized that when they talked with the customer, the customer judged their level of knowledge.
- Considered bathrooms in a customer's home off limits unless absolutely necessary. (The technicians considered this as an industry suggested standard for good customer service. I observed only one use of customer bathrooms during the study. Typically, the technicians had one coffee or similar beverage in the morning and then used restaurant facilities during their lunch breaks.)
- Worked towards receiving a good customer satisfaction survey. (These were a source of pride at Metro Environmental since the surveys administered by Trane for Metro Environmental showed over 90% positive responses for most questions over the previous 5 years of records.)

*Trane Surveys: Professionalism and Training*

Trane Corporation administered surveys to all new installations (several weeks after the installs) and to specific installed customers (when Metro Environmental

requested that Trane survey them). Their surveys included multiple categories that related to professionalism and training. The categories had varying numbers of questions. The 10 categories specifically related to professionalism and training of the technicians included:

- Overall satisfaction
- Prompt
- Courteous and friendly
- Took time to understand my needs
- Knowledgeable
- Kept my home neat and clean
- Explained the operation/maintenance of system
- Explained equipment and labor warranties
- Completed the work in a timely manner
- Answered questions to my satisfaction

Trane Corporation published the results from all surveys online after they received them from the customer. Metro Environmental only gained access to their specific survey results after a mandatory login with their password. Metro Environmental never received ratings of dissatisfied or very dissatisfied. Over 5 years and 62 customers that returned the surveys, they received only one response of neutral and only one instance of a customer not answering questions in an area even though they submitted the survey. All other customers indicated either satisfied or very

satisfied. They checked the very satisfied response by an average of over 92% for 8 of the 10 questions in this area and an average of 88% for the other 2 questions.

As also noted in the Trane survey questions, Trane expected someone from Metro Environmental to explain the operation and maintenance of their system and to answer questions about it. During this study, this task usually fell to the technicians on the HVAC installations and/or HVAC system replacements/upgrades. Explanations for the warranties typically fell to the office personnel and/or the salesperson.

*Customers and Business Contacts: the SightPros-VirTechs System*

Overall, both customers and business contacts liked the concept of the SightPros-VirTechs system which included the SightPros communication tool. A few expressed some concerns or worries. For most customers and business contacts, these gave them added trust in the technicians' ability to fix their problems. However, most did not actually view the streaming video. I merged their responses from descriptions of the SightPros-VirTechs system with how they felt about the use of streaming video over secured Internet links. The list below contains the merged responses and includes some comments regarding specific situations. In summary, customers and/or business contacts indicated the following for the SightPros-VirTechs system and the SightPros communication tool:

- Described these as a great idea and a definite asset. Supported them totally if they helped the technician or the company to maintain a higher quality



service. Felt they allowed the technician to get a second opinion immediately and/or provided another source to confirm the problem.

- Stated that if they aided the situation, they seemed fine as long as the customer did not consider them an invasion of their privacy like with "Big Brother" (Orwell, 1949). (This customer expressed their own privacy concerns, not the privacy concerns, if any, by the technician.)
- Felt they had many uses beyond HVAC. (One commercial customer wished all his technicians had the SightPros communication tool.)
- Deemed they got two people for the price of one. Mentioned that they got another person that worked outside of their house but worked on their problem.
- Liked the idea of someone more senior discussing things with the technician.
- Saw the technicians using the SightPros communication tool but didn't take time to look at the streaming video.
- Saw, if they went online, what happened instead of guessing.
- Mentioned that the SightPros-VirTechs system seemed like a good means of training.
- Tried looking at the video but stated that the lighting made it impossible to see anything (This comment occurred prior to Metro Environmental adding additional lighting in attic work sites.)

- Didn't like having to add the ActiveX due to concerns with viruses and caution messages.
- Reacted with: "WOW!!!" Asked if they could see the video for 30 days. (The video stayed online only while it actually streamed. If John recorded it, he could give them a permanent DVD copy or could email them the file.)
- Suspected the video could be a liability if the company had unscrupulous motives or employees. Felt that to the bottom line, liability got determined by trustworthiness.
- Deemed that the video provided one more step to ensure that the customer got what they paid for.
- Didn't have anything to hide so they didn't care. (This response came from a commercial customer.)
- Suspected that the video didn't serve a purpose in their situation.
- Considered that it worked okay as long as they (the customers) did not get captured in the videos.
- Watched lots of pictures of the technicians "butts."
- Believed that if someone felt watched or monitored that they more likely would do the job well and not be tempted to cut corners.
- Commented: "As a consumer, I don't care. It's like watching paint dry."
- Assumed that the video expedited the service call.
- Predicted that these demonstrated the wave of the future!!!

### *Metro Environmental Personnel: Old West Attitude*

During the first pilot study, John Thomason described some HVAC technicians as independent workers with an attitude and/or demeanor that embodied the Old West hero. I included this as one of the questions on the interviews for all Metro Environmental personnel.

In the original pilot study, John described his iconic hero with one specific type of technician in mind, but he also added some generalities to it. He noted that everyone observed this iconic hero in certain technicians at any of the HVAC parts houses. He described his iconic heroic as a smartly dressed technician wearing the tool belt cocked low on one side and stuffed full of the tools of the trade. This technician then talked about and/or went to the rescue of the customers in distress. John further described this iconic hero as super polite, without an ego, and able to use excellent skills and knowledge to fix the customer problems - sometimes in unusual, creative ways.

During this study, John Thomason further clarified his description of his iconic hero - that technician with an attitude which embodied an Old West hero. He noted that technicians historically have acted as independent traveling mercenaries. They often have carried a tool belt - usually an old worn leather one - with tools. They have organized their tools in a specific pattern. The technicians have had a lot of pride but also a lot of cockiness. He still found this culture in the parts houses. He identified it by the type of van they used and the tools they used. They loved meeting lots of new

people. They had the gift of gab even at introductions. The downsides to these technicians included their temperamental nature and their frequent job changes.

Answers given to the Old West attitude question covered a wide range of impressions. Not everyone understood exactly what the Old West hero attitude epitomized, but everyone attempted to respond to the question. I present their responses below in random order.

- Billy the Kid had confidence, seemed fearless, and could "Shuck and Jive."
- Technicians did their best for their company. Their customers trusted them and liked their finished jobs.
- Technicians grew old.
- Technicians acted nice, professionally, fixed the HVAC units and left, and then felt good because they made the customer happy. From the customer perspective: "We've had no air conditioning for two days, can you please fix it?"
- Customers responded to the technicians as heroes in the hot summertime.
- People did not consider technicians as heroes in the Old West. The Old West did not have air conditioning.
- What do you mean by an Old West attitude? How did the old cowboys act?
- Technicians had an attitude of "their way or no way." If they wanted something, they got it. They didn't give a "shit", got it done, and didn't worry.

- Experienced technicians sometimes resisted change. All technicians must take classes every year for training. Metro Environmental technicians stayed more open to change.
- Technicians needed a simple way of doing things. They had to get it fixed and done right the first time, because technicians traveled many miles and a long time before they would or could return. They needed intricate knowledge. They looked at the world only in black and white. Filter changes meant prevention of problems. Things moved slowly and took time. Even blacksmiths took a day to make shoe horns without technology.

#### Additional Findings about the Guiding Research Questions

To explore the training at Metro Environmental in detail, I developed some initial guiding research questions as a starting point for discovery. I addressed many of these questions earlier in this chapter. This subsection includes some additional data, summaries, and/or clarifications about the guiding research questions that I uncovered during my research.

#### *What Constitutes Training in the SightPros-VirTechs System?*

The training in the SightPros-VirTechs system used the SightPros communication tool. Metro Environmental used this training with apprentices and/or experienced technicians and salespersons as they experienced situations in the field where an expert could remotely gather visual information and provide immediate feedback and/or training as needed.

Just-in-time training utilized the concept that training works most effectively when it occurred timely. Leveraged expertise utilized the concepts of multitasking, remote training, and individualized training. John Thomason worked effectively and efficiently from his office location regarding normal and/or critical office matters while he simultaneously addressed training and other needs in multiple remote field locations.

John patented his SightPros-VirTechs system and the associated hardware configurations. Other trainers/experts had used distant training/assistance applying radio, telephone, television, and/or hardwired Internet communications. John suggested a unique training and service system for wireless Internet connections that trainers/experts could utilize to train and/or work with multiple remote locations simultaneously.

The hardware requirements for the SightPros-VirTechs system as used at Metro Environmental included: (a) the SightPros communication tool located at the field site and (b) a streaming server and (c) an Internet-connected computer for the trainer/expert. The communication tools connected the video through the Internet via a streaming server available from a commercial vendor. John felt that the commercial vendor cost the company less and operated more conveniently than streaming it through the Metro Environmental network.

The software requirements for the SightPros-VirTechs system as used at Metro Environmental included: (a) the software associated with the D-Link network cameras in

the SightPros communication tools and (b) any Internet browser software. Additionally, the Camtasia® Studio® screen recorder software to permanently capture the streaming video remained optional but proved useful.

Due to the amount of data that the SightPros communication tools transmitted, John Thomason recommended the fastest wireless network connections available. Even with the fastest available network connections, the system experienced dropped data streams. With the anticipated Wi-Max launch, John Thomason expected that the data streams would work more reliably.

*How Does Metro Environmental Use the SightPros-VirTechs System to Train Their Personnel?*

All technicians need update training and/or assistance at times. However, apprentices need more training and/or assistance to bring them up to the same status as an experienced technician. The SightPros-VirTechs system proved effective for both.

Metro Environmental had a public Web site for general business that received significant traffic. John included a link on his public site to the private SightPros Web site. However, John protected access to the streaming media with a unique password for each customer to provide privacy and security.

Metro Environmental installed mostly Trane HVAC systems. However, they installed other brands of HVAC systems as needed or requested; they serviced multiple brands of HVAC systems. They sold and serviced various air filtration equipment and/or units. They also serviced refrigeration and freezer units by various manufacturers.

Everyone at Metro Environmental dealt with the SightPros-VirTechs system either directly through training or indirectly through scheduling, parts, dispatch, etc. John Thomason functioned as the resident expert/trainer. Kwame carried Cam2 daily. Any technician and/or the salesperson carried Cam1 as needed.

John had established a transaction log and had started collecting data including call durations, etc. However, I collected insufficient groupings of data to compare for statistical relevance during the study period due to the size of the company; the number of calls that occurred; the variability in number of technicians; the types of call; the variations in the HVAC systems; and the actual components or units that needed service, maintenance, or installation. Customer feedback for quality control historically scored high and did not change statistically during the study period.

The ability to capture and save the computer audio/visual data regarding their training and service calls helped them to produce real world examples for use in future training scenarios. Metro Environmental supplemented one-on-one apprenticeship training with training offered by Trane. Technicians talked about other off-site training at Trane and elsewhere from other HVAC training vendors. Training providers included high schools for initial training, community colleges for initial or supplemental training, training and conferences by ACCA and associates, industry certification by NATE, EPA, and state certification and classes.

Due to the beta testing phase of the SightPros communication tool and the potential this offered, John Thomason could hire top-notch candidates in the field. John



considered a candidate's comfort level with computer technology as beneficial but not essential as evidenced by the installer with minimal computer skills who still effectively used the communication tool when needed. However, early configurations of the communication equipment used during the two pilot studies required a good working knowledge of computers in general. The SightPros communication tool operated easily and it no longer connected to the Internet via a laptop computer.

The target population for the SightPros-VirTechs system included all businesses and industries that dispatched service calls and their customer, business and industry contacts. I found that target population feasible since Metro Environmental personnel, customers, and business contacts frequently suggested other industries and applications where the SightPros-VirTechs system would operate effectively.

*How Do the Training Practices in the SightPros-VirTechs System Differ From Traditional HVAC Training Practices?*

The traditional HVAC apprenticeship model used apprentice technicians working under the guidance of on-site, experienced technicians. The traditional HVAC apprenticeship model supplemented on-site training with relevant classes as needed.

Under the SightPros-VirTechs system, when the technicians could not reach John Thomason and/or when the technicians did not carry the SightPros communication tools (such as during the timeframes between the initial pilot tests and the study prototypes), then their training reverted to the traditional HVAC apprenticeship model. The dispatcher would schedule calls and technician teams accordingly. Metro Environmental

might hire additional trained technicians as required to service their customers until an apprentice grew qualified to service calls independently.

The remote expert instead of an on-site expert made Training in the SightPros-VirTechs system unique. Typically, in the traditional HVAC apprenticeship model, the expert did the significant and/or complex tasks while the apprentice did the "go for," grunt work, heavy manual labor, and/or simple tasks and then observed the expert whenever possible. With the SightPros-VirTechs system, the traditional HVAC apprenticeship model broke. The apprentice did all of the hands-on work while the remote expert supervised. This left the expert with significant free time except in the initial few weeks of field adjustment and training of the apprentice. John Thomason used a balance of traditional training with field personnel to bring Kwame up to speed doing routine tasks. Then, once Kwame knew the basic routines, John switched Kwame to work near an experienced technician as an on-site backup but had him work mainly with John through the SightPros communication tool. Finally, John switched Kwame to independent calls with the communication tool as the only backup expert. Kwame never really worked alone on those independent calls since John remained virtually co-present. Nonetheless, this incredibly rapid advancement for the traditional apprentice occurred within two months. Traditionally it took apprentices a year or more of doing installs and then assisting on calls before doing truly independent customer calls.

The traditional business model for the HVAC industry has used a licensed contractor on staff that provided expertise to all technicians employed by the business.

Younger technicians then learned from the expert and/or from the more experienced technicians. Training classes provided information about updates and new HVAC units and/or systems. Businesses sometimes utilized phone communications to remote experts for service assistance. Some businesses utilized expert systems with computerized CD/DVD service procedures and troubleshooting aids (Finholt, 1993). Sometimes businesses utilized text communications through Internet connections to internal experts (from within their company) or external experts (from another company, but usually for a fee).

The SightPros-VirTechs system worked significantly better than the traditional HVAC apprenticeship model in that the expert saw, using high-quality video, exactly what happened in real-time. The SightPros-VirTechs system also freed up most of the time required of the expert since the expert virtually, not physically, traveled to each account. Typically, technicians spend a significant portion of each day traveling to and from customer accounts or parts houses and doing routine tasks. John Thomason did not need to travel or to assist with routine tasks. He monitored activities for the unusual and for any necessary troubleshooting assistance. At first, John spent only an average of 1.5 hours a day helping Kwame as needed. He background monitored remote activities using the SightPros-VirTechs system or waited for a call from Kwame during the rest of his day. John spent significantly less time after the initial ramp-up.

Training occurred only as needed so the time that the business spent for training improved nearly 100% compared to pulling a technician from the field for outside

training. For field training, as discussed earlier, Kwame worked independently significantly sooner than in the traditional HVAC apprenticeship model. John scheduled more time at each call for Kwame since Kwame had less experience, but he also did not use or bill for two technicians unless the dispatcher sent another technician due to task requirements that actually needed an additional body. Metro Environmental tracked the timeframes, but, they had insufficient numerical data to use for reliable statistical comparisons. Since the specific call tasks varied widely for each customer, they used the SightPros-VirTechs system only as needed. We found that the now hands-on apprentices learned new information after fewer repetitions, I felt that the logged call data would be hard or impossible to compare statistically until Metro Environmental has launched the process and the prototype into a larger audience base.

*How Do People Perceive Training with the SightPros-VirTechs System?*

Customers rated their perception of the training using the SightPros-VirTechs system and SightPros communication tools as good to excellent as noted by their feedback. Most of the technicians and staff perceived the training as extremely positive. Others perceived it as well-accepted.

John Thomason envisioned the SightPros communication tool as a resource to a technician - just another tool. They might use it only as needed, but all technicians should have it available when needed.

At the time of the study, other HVAC businesses had nothing equivalent to SightPros-VirTechs system. The HVAC industry only used hardwire applications for

distance training. Medical providers (Zuiderent, Winthereik, & Berg, 2003; Nardi et al., 1993) and other industries already utilized hardwire applications and noted its effectiveness and efficiency. Studies in research lab environments used mostly hard-wired applications for training. Prior laboratory research on remote collaboration on physical tasks (Fussell et al., 2004; Gergle, Kraut, & Fussell, 2006; Gergle, Kraut, & Fussell, 2007; Ou et al., 2005; Ranjan, Birnholtz, & Balakrishnan, 2006; Wong et al., 2007) showed that experts with video worked effectively even when they used multiple workers and one expert, but usually less effectively than one-on-one assistance.

*How Does Wireless Training Impact the Business Culture, the Personal Culture, and/or Communities of Practice at Metro Environmental?*

Metro Environmental had not changed much since the two pilot studies in 2003 and 2004. They still interacted as a family-oriented business. Some of their personnel had grown older. Their technicians now included two new individuals and three individuals from the pilot studies. Their office staff now included three new individuals (two in new positions) and four individuals from the pilot studies. Their location changed, but their homey environment looked familiar to me. All of the office staff had separate offices rather than the mixed offices/open spaces in the previous two locations. All of the technicians still worked well in teams, but also worked well individually.

The most evident impact came from the rapid rise in skill level of the apprentice technician from Training in the SightPros-VirTechs system. As noted previously, users

found the SightPros communication tool as simple to operate; the streaming video interface as simple to use; and the video capture software as easy to create and save files. Technicians no longer needed laptop computers in the field with the current communication tool. John had designed and built prototypes for the new SightPros communication tools as sturdy units instead of the fragile laptops. Moreover, Internet speeds had increased.

John Thomason did not currently write articles, but he indicated a desire to start that again. He especially wanted to present the information at HVAC convention across the country.

I did not find much resistance to change as Metro Environmental had a historical record of change. I noted problems and frustrations with the new call management software and with the new networked computer systems, but I noted similar problems in the two pilot studies.

John assumed the change agent role for the SightPros-VirTechs system and within the HVAC industry; Christine assumed the change agent role for much of the office software. I suggested the purchase of the screen capture software due to my stated desire to capture the streaming video, but they picked and purchased the software.

HVAC businesses encounter a high turnover rate due to the competitive industry. Kwame created the only technician turnover during the study, but he made

the turnover choice for his own advancement opportunity. I had noted turnover between the pilot studies but not actually during the studies.

#### *What Opportunities Exist When Companies Use Wireless Technologies in Training?*

During the study, I noted opportunities for more efficient and more effective training with the SightPros-VirTechs system. Better training meant improved customer service. The video captures measured training success best because the recorded records demonstrated evidence of skill and could be compared over time for a specific individual. The captured videos also indicated language changes over time. Moreover, they revealed John's confidence or lack of confidence in the ability of a specific technician.

I observed practical knowledge retained and discussed by Kwame and others. The SightPros-VirTechs system introduced him to some of the knowledge but traditional apprenticeship training introduced him to some. Wireless technology could definitely shorten the current 3-5 year apprenticeships, because it forced the technician to be more hands-on than the traditional HVAC apprentice model.

John definitely leveraged his expertise to be multiple places concurrently. John easily handled the two SightPros communication tools and would sometimes wait impatiently for technicians to actually need his services.

John watched two places simultaneously by opening and staggering two browsers. When he recorded video, however, he preferred to stack the browsers and record whatever SightPros communication tool he wanted to record by clicking the

appropriate button on the computer taskbar. Stacking the browsers meant that he did not have to record a large screen area and he could switch rapidly between the browsers. However, I tested the setup with two browsers sized properly and sitting next to each other without interference. The size of his recorded video captures saved disk space as my files saved at approximately twice the amount. However, I captured two locations simultaneously where his arrangement captured only one of the two at any given time.

The SightPros-VirTechs system delivered just-in-time training for this study. Wireless technology enhanced learning by delivering lessons wherever and whenever needed in this study as long as the communications links worked.

The SightPros-VirTechs system offered a full range of opportunities for some underutilized employees. They could use it to share knowledge as experts without traversing the physical boundaries of field work. This technology could assist older populations and physically challenged individuals especially if they had gained prior expertise. Recently graduated apprentices could earn higher salaries by improving their skill levels faster. Three of John's five technicians were minorities. Another one of his highly experienced technician had already expressed a desire for less rigorous field work. Traditionally, the industry did not attract many females because of the physically demanding field work.

Metro Environmental and I both used customer satisfaction levels and feedback to measure training success. We noted problems with using call durations to measure



training success. I noted that each call essentially had a story with a beginning, middle, and end. Each call essentially measured training success or failure. If they fixed the problem, the technician had enough training and experience to fix it. If the customer called back for the same problem, then we looked for insufficient training, insufficient learning/experience, and/or a complex, unique, expert-level problem not necessarily resulting from a failure of training or typical experience. Customer complaints could measure success, but my interviews and surveys revealed that customer perception did not identify real skill deficiencies if the technician talked a good story.

#### *What Obstacles Exist When Companies Use Wireless Technologies in Training?*

Potential competition for training in the SightPros-VirTechs system came from Webcams and cell phone cameras, but the portable, wireless SightPros communication tool included significant improvements because of the remote controls by the expert instead of on-site adjustments by the technician and because of better video resolutions. The technicians never needed or utilized the remote control handset in the Cam2 spare case during this study. The iRobot Corporation (<http://www.iRobot.com>) has pilot tested a new home robot with a network camera designed for virtual visiting. They designed their robot for a single link to another location for viewing but they did not design it for easy portability into attics, in yards, etc.

The management issues that I noted included the high cost of the prototype SightPros communication tools, the connectivity issues, and the need to get customer

approvals. John easily got approvals to use the communication tool from most customers once he explained how and why Metro Environmental used it.

I noted a few management issues for the Training in the SightPros-VirTechs system. Management responsibilities frequently took John out of the office for business. Metro Environmental did not always use their backup expert for the SightPros-VirTechs system. When the technicians could not reach John because of his schedule conflicts, Metro Environmental often reverted to the traditional HVAC apprentice model. John planned for slightly lower service call efficiency on some calls due to the training by allowing slightly more time for service calls due to the mediated conversations. However, John expected better overall service efficiency because of lower manpower needed to service the calls. John expected improvements in effectiveness with the training since the technicians had more hands-on time.

Customers expressed mostly positive comments about the SightPros-VirTechs system, but did express initial privacy and/or network concerns. Some customers and businesses would not allow any video inside their premises. John and I specifically discussed privacy concerns and/or potential ethical or illegal uses of recorded audio/video files if the SightPros communication tool accidentally captured sensitive background chatter and video from inside a customer location and/or from inside Metro Environmental. John Thomason mentioned that recorded video of a technician's proper actions at a customer account could benefit companies if a customer submitted contrary claims.

Most employees loved the SightPros-VirTechs system even if they didn't feel they would need to use it often. No specific personnel expressed issues during this study with Training in the SightPros-VirTechs system. This study alleviated some of my initial fears of language barriers (found in the pilot studies) since the multilingual technicians realized that their language proficiency actually could open additional opportunities as multilingual experts.

John Thomason noted problems already with patent infringements. Other businesses have "stolen" his VirTechs name. Other businesses have also utilized a remote expert assistant similar to the expert assistant in the SightPros-VirTechs system. John expressed concerns with the legal difficulties and costs barriers of a small business trying to stop infringements by other small businesses.

I found no HVAC industry issues of concern with Training in the SightPros-VirTechs system. If anything, they expressed anticipations for the availability rather than expressed concerns about it.

The SightPros-VirTechs system fits within the licensing requirements for the industry. In Texas all technicians working for a HVAC contractor must register yearly (for background checks) and be EPA certified to purchase or sell refrigerants. Technicians did not have specific skill criteria that must be met other than those, but John liked the NATE certifications. The state only required one license holder per contractor business. License holders had to take continuing education courses yearly.

No one expressed any insurance issues. As long as the technicians received good training on safety and followed safe training procedures, John stated that insurance rates should stay the same with or without the SightPros-VirTechs system. If a customer made an insurance claim, a video record of a service call would have proved beneficial in resolving any issues.

The HVAC industry historically noted that technicians had a dangerous job. If an expert failed to properly monitor an apprentice in the SightPros-VirTechs system environment, ethical issues and safety issues could arise. However, those same issues could arise even with on-site training.

#### *How May Wireless Technology Impact Instructional Requirements for Apprentices?*

Wireless technology recorded world experiences, issues, and problems. Kwame taught a technology discovery class. Kwame and I discussed that those videos, if they were converted into training clips, would paint a realistic portrait of the real job of a HVAC technician. I felt that the videos would enhance the student motivation to learn. He felt that the student's also could use the videos as an effective replacement for field time working one-on-one at a customer site.

#### Summary

This study explored distance learning that used wireless technologies within apprenticeship programs. The SightPros-VirTechs system utilized leading edge developments in computers and communications technology. Adaptation in the system

at Metro Environmental remained very fluid because the technology remained very fluid.

The data collection for this qualitative study began in December 2007 and ended in March of 2008. My audio and video recordings documented the majority of the data that I presented here. I captured approximately 80 hours of digital audio and/or digital video recordings at the offices of Metro Environmental and at various customer locations. Additionally, John Thomason saved and then gave me copies of approximately 10 hours of computer-screen-capture videos showing the streaming images from the SightPros communication tool that I used for analysis.

In the study of Metro Environmental and the SightPros-VirTechs system, I discovered new information, validated information from the literature, reconfirmed information from two pilot studies, and discovered new insights relative to the company and their personnel. I gained these insights and information through both structured and unstructured interviews and participant observations of the Metro Environmental personnel. I examined the operation and usage of the SightPros communication tool. As a participant, I followed the service technicians and apprentices in their working and training environments. I prepared and used both structured and unstructured interviews and surveys regarding the use of the SightPros-VirTechs system on both customer and business contacts. Finally, technology helped me to capture and analyze the data gathered in this study.

Despite some connectivity problems, the SightPros-VirTechs system appeared very beneficial to Metro Environmental training and service. John Thomason voiced extreme pleasure with the results he achieved in being able to instruct the technicians and monitor the customer sites while sitting at his desk. Technicians voiced pleasure about instant answers to questions or concerns as they occurred. Customers voiced pleasure with essentially having two people for the price of one.

In final summation of this chapter, I have used it to present the findings from this study. First, I reviewed the purpose of this study which included my major research questions. Then, I provided a general introduction to the findings. Next, I described my findings about Metro Environmental; their Web sites; their personnel; their SightPros-VirTechs system and SightPros communication tool; their work environments; and their training. Then, I presented additional findings from the interviews and surveys and discussed more findings about some initial questions that I developed for guiding my research. Finally, I finished the chapter with a general summary of the findings from my study.

The SightPros-VirTechs system potentially could change the way that service-dispatched businesses operate in the future. In the next chapter, chapter 5, I will further discuss and analyze my findings and then draw some conclusions. I will also provide some recommendations derived from this study.

## CHAPTER 5

### DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

#### Chapter Introduction

I recently completed a study at Metro Environmental, a HVAC (heating, ventilation, and air conditioning) company. I researched the impact of training technicians using their SightPros-VirTechs system for remote, wireless, Internet video assistance.

In this chapter, I present a broad summation of my study. First I review the purpose of this study which includes my major research questions. Then, I provide a short general introduction to the discussions, conclusions, and recommendations sections. Next, I discuss my research findings. Subsequently, I draw some conclusions based on the discussion. After that, I make some recommendations. Finally, I summarize this dissertation and chapter.

#### Purpose of the Study

The purpose of my study has been to investigate the SightPros-VirTechs system and to analyze its business impact. The system addresses training and/or assistance via wireless Internet video from job site apprentices and/or technicians to a remote expert. To investigate and analyze the system, I have explored the following research questions:

- Can the SightPros-VirTechs system as used by Metro Environmental demonstrate that its concepts of just-in-time training and leveraged expertise effectively expand the capabilities of their HVAC workforce?
- Can the SightPros-VirTechs system expand the workforce capabilities in other HVAC companies and/or other service-dispatched industries to positively impact the skilled labor shortages?
- Does the SightPros-VirTechs system generate additional impacts that might influence adoption of the system in other companies or industries?

As part of my investigation of the SightPros-VirTechs system, I have studied the personnel and environment surrounding Metro Environmental. I have documented the business context with both narrative description and statistical data.

As part of my analysis of the business impact, I have compared an apprentice technician who uses the SightPros-VirTechs system frequently with other technicians who use the system occasionally. Also, I have compared this study with my two pilot studies. I have analyzed the business context to determine the impact from the system and its concepts to Metro Environmental and potentially to other businesses and industries.

#### Introduction to Discussions, Conclusions, and Recommendations

In this chapter, I discuss my research findings. I compare my findings to those from previous researchers. Subsequently, I draw some conclusions. After that, I make some recommendations.



## Discussions

### *Overview of Metro Environmental and the SightPros-VirTechs System*

I categorize Metro Environmental as a small business, a HVAC company, located in the Dallas/Fort-Worth Metroplex. John Thomason, the president/co-owner of Metro Environmental holds a license as a HVAC technician. The HVAC industry recognizes him as an expert.

John Thomason received two patents for portable, wireless audio/visual communication technology and processes. He submitted paperwork for another patent, but the status of that patent remains pending. He initially referred to the technology and processes as the VirTechs technology. He now refers to them as the SightPros technology. The SightPros-VirTechs system incorporates both the technology and the processes.

As an extension of his patents, John Thomason has begun development of a Web site <http://www.SightPros.com> as a centralized expertise portal. With the portal, anyone from around the world can contact an expert for a small fee when they need assistance. Customers can seek "professional advice without the hassle and expense of a service call" (J. A. Thomason (personal communication, August 6, 2007). At a minimum, Metro Environmental will use that Web site where mediated communications like telephone, Webcam, and/or other Internet communications might enhance the exchange.

John dreams about enhancing the expertise portal communications with the SightPros communication tools. Customers can buy and/or lease a communication tool for brief intervals. Metro Environmental will then ship the communication tool by overnight express to their remote location and then use it to allow one-on-one, just-in-time, high-quality, video-monitored instructions between the expert at one site and a customer at another site.

John Thomason built two prototype SightPros communication tools for use in the SightPros-VirTechs system. We tested the communication tools in field trials during this study. He hopes to interest potential investors in helping him take his system and/or communication tools to the commercial marketplace.

John Thomason registers each SightPros communication tool to its own unique Web site that he password protects to retain privacy. Each communication tool uses a high-quality network camera and wireless communication networks to provide real-time video capabilities. Up to ten remote users, including the expert(s) and customer(s), can view and potentially control each communication tool depending on the control rights set by the Metro Environmental software administrator. The remote user controls the network camera settings for pan, tilt, zoom, and iris (light exposure). Since a remote user controls the communication tool, the technician(s) remain free to do the on-site tasks.

### *Mediated Environments Now and in the Future*

The SightPros communication tools deliver streaming video from a remote site via Internet connections to any computer worldwide. At this time, John Thomason typically uses the streaming video communications, but to save bandwidth, he turns off the audio portion. He typically uses cell phone communications with the technicians for the audio. In the office he uses a headset microphone for narrating the recorded video. If he forgets to use the speakerphone, his conversations are audible, but the remote conversations are almost inaudible. However, the communications sounded very audible from both parties on the recorded video whenever he puts the remote user on a speakerphone. With the launch of telecommunications devices using generation 4 standards and Wi-Max capabilities, John Thomason might have the necessary bandwidth to stream both the audio and video portions of the signal through the SightPros communication tools and still achieve reliable communications.

The current configuration of the SightPros communication tool uses a third generation mobile wireless router that generates its own mobile "hot spot." EV-DO mobile computing standards, a third-generation standard, contribute to the numerous wireless connectivity issues noted earlier in this study. This third generation standard for all mobile applications supports transmission rates of up to 2 Mb/s (Banks & Fidoten, 2006). Later third generation improvements do allow higher speeds and more data. Realistically, devices available using the third generation standards accommodate these transmission speeds reliably for signal downloads, but not for data uploads (John

Thomason, recorded conversation February 2008). Fourth generation telecommunications devices may eliminate some of the wireless connectivity issues noted earlier in this study since it will use packet-switching technology, at speeds of up to 100 Mb/s which will allow more bandwidth (Banks & Fidoten, 2006).

The current design for the SightPros communication tool uses Wi-Fi® communication formats. Wi-Fi formats have a range of up to 350 feet so distance from the transmission towers proved sensitive. Wi-Max, which may test launch in the local area in the next couple of months (John Thomason, recorded conversation, February 2008), will allow wireless communications from longer distances, 25-30 miles.

Technicians can unwire themselves from their cell phones and computers with Bluetooth capable communication devices. For the SightPros-VirTechs system, this allows the technicians to work entirely hands free while communicating with the remote expert.

#### *Security Concerns*

Each SightPros communication tool has a unique Web site that John password protects for privacy. The Web site administrator can issue permission for up to ten remote users at any one time. On the first observation of the video stream, users must download and install a small ActiveX program on their computers. If the users change to a different computer on subsequent observations, they must download and install the program on that one also. Because many users install virus protection programs on their computers, the computer may display a caution flag when the users attempt to load an

ActiveX program. Several users in this study expressed concerns about the potential risk to loading that program.

Firewall software and hardware may generate issues with customers not being able to connect to the SightPros Web site particularly when they use it in work locations. As newer mobile telephone and computer devices and standards allow longer distance connections to personal networks, this should minimize most firewall problems as most customers will work within 25-30 miles from their own home network instead of needing to use a company network.

I anticipate that some users or customers will feel concern with the potential privacy invasion of streaming video. Due to those concerns and potential loss of sensitive customers, companies may deem that certain customers remain too risky to stream video from their location. Therefore, I recommend that companies limit use of the SightPros communication tool to customers who they pre-screen for acceptance of on-site streaming video. However, I only had one technician and one customer mention "Big Brother" (Orwell, 1949) as a possible concern. The low number of comments regarding customer concerns may have come from the pre-screenings. However, they probably come from the password-protected Internet connections and from the use of non-sensitive recording locations versus more sensitive living spaces. One customer with original artwork negated all video on their site for theft insurance concerns, not for invasion of privacy concerns. Since so many individuals have camera phones, Webcams,

camcorders, computers sites with photos and video, etc., the commonality of video in their lives may desensitize our culture and the customer.

John notes the expensive cost of the prototype SightPros communication tool - approximately \$2500.00 each. Of course, the final-production communication tool may benefit from quantity pricing of components and sharing of design and start-up production costs over a large number of tools. Nonetheless, the current costs of individual communication tools and components remain high. He notes high theft potential in some markets or locations. The technicians find it impractical to disconnect and secure the communication tool every time they go back to the truck for a part or move away from the communication tool for discussions with a customer, etc. Therefore, they take some risks such as leaving communication tools in outside residential locations without technicians nearby. John Thomason monitors the communication tools from the office if his activities allows. However, at times his activities leave him unavailable to watch.

#### *Participative Action Research and Collaboration*

Because I designed this study as participative action research with collaborative and iterative aspects, I collected feedback from customers, field situations, interviews with technicians and installers, etc. We generated and tested some changes as a direct result of my participation. I recommended increased lighting in the attics for easy viewing of the components by customers. Since John decided to use the technicians' cell phones for audio communications instead of the steaming audio due to bandwidth

considerations, I also recommended capture of the entire audio by using John's speakerphone capabilities whenever possible. I advised John Thomason to purchase screen capture software to permanently capture the streaming video. I also helped John with file revisions using the screen capture software and input design suggestions for the Web site lighthouse logo.

### *Training for and with New Technologies*

Nolan (1996) predicted that companies would need to adapt to new information and to acquire knowledge and skills due to the rate of technological changes. During this study, the training of the Metro Environmental sales and service staff by Trane® trainers introduced the technicians to new HVAC systems with better features. Their latest training introduces new levels of computer and technology sophistication for the technicians. This research reinforces Nolan's prediction.

Most HVAC apprentices and/or technicians learn basic mechanical and electrical principles. Their troubleshooting skills isolate some problems down to common HVAC assemblies. For instance, the technician might isolate a problem to a simple circuit board replacement, but they do not isolate problems to specific components on the circuit boards. One of installation technicians does not even consider himself as computer literate. The newest Trane HVAC systems include new hardware features that communicate status messages from one high-end unit to other units in the system and then through a computer modem and/or phone lines back to a dealer to request

maintenance. Thus, this newest Trane technology requires the technicians to potentially troubleshoot even the customers' computer network.

Currently, their coursework and experience does not train apprentices or technicians to troubleshoot complex, fully computerized systems. With the SightPros-VirTechs system, the technician can use a remote expert at the home HVAC office or at the Trane offices to help troubleshoot and direct even a computer illiterate technician to repair on-site network problems.

Using the SightPros-VirTechs system, Metro Environmental management feels comfortable sending an apprentice technician out to a job site alone much earlier than would typically occur. The technicians feel secure since the expert remains just a call away to watch, to suggest solutions, and to provide just-in-time training. The customers, not knowing the actual experience level of the apprentice or technician, express very good feeling about the home office expert monitoring the worksite. They like getting two people, one of them an expert, for the price of one.

#### *Instruction in Mediated Environments*

In this section, I discuss specific findings from the Metro Environmental study on the SightPros-VirTechs system that relate to instruction in mediated environments. Some of those findings suggest improvements for instruction in other mediated environments.

The SightPros-VirTechs system utilizes an expert who willingly shares information with others and who maintains flexibility to deal with any problems in any



sequence in which problems arise. John Thomason, in his role as the HVAC expert, sets an excellent example. Metro Environmental selects the appropriate technicians to do the assigned tasks. Everyone at Metro Environmental feels comfortable with the SightPros-VirTechs system and the SightPros communication tool. John adapts his instructions to the level of knowledge of the technician. The technicians trust John's advice. The technicians ask questions freely and exhibit their desire to learn. The SightPros-VirTechs system may prove that it works as effectively and/or as efficiently in less idealistic situations.

At Metro Environmental, technicians and experts readily share their knowledge with their co-workers via direct advice and storytelling rather than hoarding their knowledge (Argall, 2002); resisting advice (Brehm, 1966; Weaver, 1999); and/or using subtle threat statements (Weaver, 1999). This might result from the family atmosphere at Metro Environmental, the close teamwork, the emphasis on customer relationships, the levels of trust, the many independent decisions, and/or the lack of a competitive atmosphere.

The SightPros-VirTechs system recognizes that learning takes time. John Thomason, in his role as expert HVAC technician for Metro Environmental, notes that he needs to repeat and to reemphasize some tasks and information until they became routine knowledge for the remote technician. He finds that both the expert and the worker benefit from the repetition of information that facilitates the interests of either party. Especially in mediated environments, John may find some resistance to his expert

knowledge with frequent repetition of critical information so he may need to continually balance his communications skills and his concerns for safety with his current recognition of the remote technician's skill set and knowledge.

Metro Environmental finds that knowledge management tools prove invaluable to certain situations. They may discover that as they use and develop more knowledge management tools, related to the SightPros-VirTechs system, that the new tools continue to save time and benefit everyone. For example, if they establish a database for most of their key processes and instructions by creating appropriate checklists, troubleshooting aides, and/or videos, then, as needed, they can offer or retrieve the data and/or videos for use in their mediated communications.

Some Metro Environmental employees and customers express their camera shyness and/or public security concerns. Other employees and customers love the camera exposure and/or public recognition. Their current positions may change over time and familiarity with the SightPros-VirTechs system. If Metro Environmental creates additional training videos, they may continue to ask participants for their permission and/or get them to sign consent forms to establish their current preferences, to eliminate surprises, and/or to avoid legal ramifications. They may also ask the participants if they prefer pseudonyms or real names if they incorporate any names in the videos.

The SightPros communication tool utilizes a professional network camera, other components, and software to capture professional quality videos. John Thomason feels

that the communication tool works better in the SightPros-VirTechs system than the Webcam technology and software that he previously utilized. He always tests and learns the equipment and software features, their capabilities, and their limitations. As Metro Environmental continues to create training videos and improve the SightPros-VirTechs system and the SightPros communication tools, they may find that even when the technologies change over time, the user's knowledge of the features, capabilities, and limitations still determines the end quality of their communications.

As professional communicators and for better customer service, the Metro Environmental technicians quickly and instinctively learn to directly face the person or people with whom they communicate. This face-to-face communication rule yields additional customer trust. However, this communication rule sometimes extends to the expert behind the SightPros communication tool even when the expert resides outside of the technician's immediate vicinity. Especially with new users of the SightPros-VirTechs system, they often turn or start to turn and face the SightPros communication tool even when talking with John Thomason on their cell phone and even though he sits miles away at the office. But, this generates an unconscious distraction and safety concern to the technicians while they perform their tasks. Experienced communication tool users learn to ignore the communication tool and modify the face-to-face communication rule while doing tasks or talking on their cell phone with John. To capture real world events and to maintain safety, John may remind and/or encourage users when needed to act naturally and not to "talk to the camera."

With the SightPros communication tool, John Thomason utilizes many standard rules of photography and multimedia. For instance, for indoor shots, he uses sufficient lighting to get the best images. For outdoor shots, sunlight creates a problem if the network camera directly faces the sun and/or reflected sunlight. John adjusts the iris setting as needed. Occasionally, he requests the technician to move the communication tool as needed for better visuals or for sunlight interference. As the technologies, devices, and customer situations change, John may learn new rules to create even better, more effective mediated communications and/or instructional videos.

Upton (1985) suggests that tripods work best to prevent unwanted camera movement. In low light conditions or with long-focal-length lenses, Curtin (1980) suggests that tripods, clamps and/or cable releases help to eliminate blurs caused by camera movement.

The technicians sometime use a tripod or more often find some other kind of solid base to stabilize the SightPros communication tool to capture more professional videos. Like any camera, a hand-held or unsteady communication tool picks up jitter and yields shaky videos. Some video devices have automatic software controls to lessen jitter, but a steadier device still yields crisper, more professional videos. The technicians do not use HVAC components to stabilize the communication tools. Many components have inherent vibrations during operation and some have vibration due to their physical location such as attic units that hang by metal straps from the roof.

The technicians also use a tripod or some other kind of solid base to set and maintain a good viewing angle. The technicians try to situate the SightPros communication tool for natural viewing angles. They frame the shots as much as practical. They place the communication tools for side shots or over-the-shoulder shots for better videos, but they make sure that the communication tools remain out of the path of the workers. They find that if they place a communication tool directly facing the work area, the technician may block the view and/or may record too many backside and/or butt shots.

For setting and maintaining a good viewing angle with a tripod, Upton (1985) suggests that:

Camera height is adjusted by raising or lowering the tripod legs or center shaft; camera angle is adjusted by tilting or swiveling the tripod heavy. Some tripods have a center shaft that can be removed and reversed; the tripod head and camera then hang upside down and the camera can photograph from a low angle. (p. 53)

John Thomason has to watch and listen diligently so that private information stays private. He tries to record the videos in locations that cannot reveal customer or company secrets. He tries to keep background noises to a minimum so that private information such as customer phone numbers and many other conversations stay confidential. Later, he carefully reviews the files and cuts or edits all unintentional captures, as needed, before he makes any published recordings available to an outside customer. He checks to see that the audio and video meet all appropriate security standards to publish.

John Thomason tries to monitor and capture the best audio. He uses a speakerphone to capture both sides of the telephone conversations. He deletes the remote streaming audio to minimize remote ambient noises (such as hammering on sheet metal, weather, high winds, and inadvertent customer conversations). He narrates the scenes for the intended audience to produce better results when appropriate.

The SightPros communication tools, the lighting sources, the technicians' power tools, and their cell phones need power from either batteries or electrical outlets. Batteries do not last long. All HVAC work sites require local sources of power for fully functioning operation. Most work sites provide access to some local electrical power. Technicians occasionally do preliminary work in construction areas without local power and/or at other locations during power outages. Frequently, builders and owners locate electrical outlets in a convenient location for the building users, but without thought for the future convenience of the service personnel. Technicians may need to carry spare batteries and/or extension cords. They may occasionally need access to back-up power generators.

John Thomason plans for both typical and unusual situations in the SightPros-VirTechs system. For typical situations, he develops a checklist of activities to verify and develops troubleshooting branches to potential solutions if the technicians discover problems. He plans flexibility in his processes for unique results or unusual situations.

John Thomason likes to capture permanent records of the streaming media. He finds that the screen capture software works easily to capture the video. He notes that

file sizes stay reasonable. Therefore, his requirements for storage space may remain less expensive.

John Thomason recommends screen capture of work locations for a variety of reasons including legal liability. If he fails to capture video during the initial streaming, he loses his best opportunity to capture the customer site. He may find specific tasks at a specific customer location very expensive, difficult, or even impossible to simulate later.

Metro Environmental uses the screen captures as a record of progress for instructional applications. They want them for future training purposes to show real-world applications. Anderson (1983) suggests that:

Visuals representing on-the-job situations must be acceptably realistic. All instructional situations should:

- Accurately reflect company or institutional policies and practices in such matters as dress, demeanor, work and safety rules, and models of performance;
- Show views of persons using tools, instruments, and control equipment, for examples, from the point of view of the person using them on the job. Work environments and situations should, to the greatest degree possible, represent the real world (40).

The videos record historical data. Metro Environmental may use them as a selling point and/or commercial sales item if their customers want a copy. Personnel and customers may use them as mementos to share with family and friends. I have utilized them for my research purposes.

### *General Systems Theory*

General systems theory predicts that changes in one area of a system generate changes in other connected areas. Starting with my first pilot study at Metro Environmental, I have watched improvements in communications and media technologies yield improvements in the SightPros-VirTechs system, in the devices they use in the system, and in the overall operation of their business. In my pilot studies, I worried that additional use of mediated communications might negatively impact personal relationships. However, this study suggests positive outcomes from the SightPros-VirTechs system on the bonding between the Metro Environmental personnel and on the close relationships with their customers. In fact, overall, the SightPros-VirTechs system technologies and training appear to impress the customers and provide an important tool to the technicians and managers.

Customers of and the personnel at Metro Environmental all express stronger positive feedback now regarding the SightPros-VirTechs system and Metro Environmental than they expressed in the pilot studies. They still slightly joke about "Big Brother" (Orwell, 1949) lack of privacy due to the video monitoring. They still raise a few concerns regarding security risks associated with the Internet in general. Nonetheless, I rate their few concerns as minor in comparison to the overall enthusiastic comments that the Metro Environmental personnel, their customers, their business associates, and their industry associates express.



The turnover rate for personnel in the HVAC industry remains high. I knew over half of the personnel currently at Metro Environmental from my previous pilot studies in 2003 and 2004. Some of the technicians and staff who left previously have now returned to Metro Environmental because of the excellent working environment. I attribute much of the bonding at Metro Environmental to their "invested" mentality and teamwork, but I attribute some of it to the environment of willingly sharing information in their SightPros-VirTechs system.

#### *Major Research Questions*

In this section, I try to answer my three major research questions. I address the SightPros-VirTechs system at Metro Environmental, just-in-time training, leveraged expertise, and skilled labor shortages in the service-call-dispatched industries.

*Major Research Question: Can the SightPros-VirTechs system as used by Metro Environmental demonstrate that its concepts of just-in-time training and leveraged expertise effectively expand the capabilities of their HVAC workforce?*

Wong (2007) notes that as technology becomes more complex, the expertise needed to operate and repair it seems essential but scarce in many organizations. He suggests that experts use information technologies to assist novices in remote locations when they require specialized knowledge. The SightPros-VirTechs system demonstrates itself as an excellent tool that can monitor and/or assist a remote technician to provide the level of support that Wong notes.

The SightPros-VirTechs system, a new technology tool, proves itself as a partial solution to other new technologies and to the skilled labor shortages in the HVAC industry in that an individual can connect to an expert that has knowledge of a specific concern to that individual. The SightPros-VirTechs system enables expert(s) and/or customer(s) to remotely monitor one or more technician(s) and/or site(s) in real time and provides just-in-time suggestions or answers to any and/or all of the participants. It uses streaming video of real world situations to provide meaningful insights to both experts and trainees. Their high-quality, SightPros communication tools and their use of wireless communications networks give real-time video capabilities. The communication tools, under the control of the remote viewer(s), leave the technician(s) free to do the on-site tasks. The remote expert can use all of the camera controls in the communication tool: pan, tilt, zoom, iris (light exposure), frame rates, and password protections. The remote adjustment of the camera controls proves helpful in the field environments.

John Thomason effectively and efficiently leverages his expertise to multiple technicians, to the office personnel, and to the customers. Even when John Thomason in his role as the Metro Environmental HVAC expert supports multiple technicians at more than one customer site, he seldom has schedule conflicts where he monitors overlapping critical situations. He constantly interacts with office personnel regarding normal business issues - sometimes amid a conversation with a technician in need.

Moreover, he frequently interacts with customers via the SightPros communication tools, telephone conversations, and/or emails communications.

John Thomason frequently monitors the work sites with the SightPros communication tools and loves doing so, but realistically, during most days he only monitors the video for a small percentage of the day. For each site, John Thomason pans the entire site to get an overview. He then monitors only during critical segments of the call or when a technician calls him for assistance. When he examines the site he uses the pan, zoom, and tilt features extensively to look at specific conditions, and then moves back to a convenient setting where he monitors the overall activity. He accomplishes most of this without interaction from the technicians doing their job.

On multiple occasions John Thomason narrates and/or converses with others in the office about how nice it feels to sit in his office, monitor work sites, observe progress, and assist in the planning of upcoming activities. At various times, he calls the technicians and discusses work not yet complete and/or possibly overlooked and/or gives tips on how to handle a situation or a customer problem, etc.

Kwame, the apprentice technician at Metro Environmental, independently works on many service and maintenance calls. John Thomason states that he advanced to this level much earlier than other apprentice technicians. My literature reviews and my observations in this study confirm his statements. Kwame and John both feel comfortable enough to do that because of John's ability to monitor Kwame's progress at any given site and offer suggestions just-in-time while using John's leveraged expertise.

Using the SightPros-VirTechs system, technicians with some experience need minimal assistance from the expert. So, John's original ratio of 1 expert to 6 technicians seems extremely small. With 6 new, inexperienced technicians, John might stay busy and the technicians might have to wait a short time for assistance. Since the Metro Environmental technicians have a full range of experience levels, John seldom has to assist anyone other than Kwame. The ratio in the traditional HVAC apprentice model of 1 expert to 2 or more apprentices definitely might improve with this wireless technology.

Metro Environmental employed eight technicians during the initial trial study in the spring of 2003 but only four technicians during the study in the spring of 2004. By this study, in the spring of 2008, their business customers grew enough to now support five technicians. These figures suggest favorably that the use of the SightPros-VirTechs system with its just-in-time training and leveraged expertise concepts effectively expands the capabilities of their workforce. Starting with the earlier SightPros-VirTechs system implementation in 2003, the overall concepts suggest validity but the devices proved not quite ready. In 2007 and early 2008, the prototype SightPros communication tool has proved ready and easy to use. By mid-2008, the Wi-Max communications speeds may support and make the SightPros-VirTechs system more reliable, efficient, and effective.

*Major Research Question: Can the SightPros-VirTechs system expand the workforce capabilities in other HVAC companies and/or other service-dispatched industries to positively impact the skilled labor shortages?*

Orr (1996) studied the service environment at Xerox Corporation. I worked for Xerox Corporation. Many of the situations at Xerox Corporation seemed similar to those faced at Metro Environmental. Xerox® technicians also traveled from account to account working with customers in distress over their failed copier and fax equipment.

Many participants provide similar feedback regarding the impact of the SightPros-VirTechs system to other industries. Even without solicitation, the participants (technicians, office personnel, business contacts, and customers) frequently site specific company names or businesses, not necessarily their own, and describe how that company or business can use it. This feedback suggests favorably that the SightPros-VirTechs system may help with the skilled labor shortages.

John Thomason feels that once he launches the SightPros-VirTechs system nationally, business use of the system can enhance the opportunities for some under-represented population. The technicians' storytelling and feedback confirms his expectations by their mention of various customers who sit in a wheelchair and/or can no longer climb a ladder that love to monitor the work in progress. I can easily picture my own uncle, now retired after selling his own HVAC business, assisting other businesses and technicians from his home even though his frailty prevents him from servicing even his favorite customers.

*Major Research Question: Does the SightPros-VirTechs system generate additional impacts that might influence adoption of the system in other companies or industries?*

The overall consensus by customers shows that Metro Environmental sets a new industry standard that gives it a definite competitive advantage in the marketplace. With high competition and costs associated with the acquisition and retention of customers in this industry, John Thomason feels that he gets a major advantage from the SightPros-VirTechs system. He continues to invest many hours of research and significant resources in time and materials to develop the working prototypes. He shares his excitement. Everyone at Metro Environmental shares the excitement. The customers share their excitement. Metro Environmental associates at Trane, their major supplier for HVAC units and systems, share the excitement.

With the rising expenses for travel, an accessible expert that remotely travels to problem accounts remains a definite benefit. John Thomason works multitasks both as president/co-owner and as a remote expert to his technicians and apprentices. Because he can rapidly increase the learning curve of the apprentices, he can maintain fewer technicians on his payroll. The use of the SightPros-VirTechs system as a tool for even experienced technicians dramatically expands its usability.

#### *Additional Insights from the Study*

##### *Professionalism versus Well-Trained*

In the study on Metro Environmental, I found that many customers described well-trained technicians with some of the same adjectives and other descriptors that

they used for describing professional technicians. I see a distinction between well-trained and professional. I expect that a well-trained technician possesses the skills and knowledge to install, service, and repair the HVAC systems, and complete the paperwork. This includes particulars like actual hardware, software, tools use, and specific knowledge. I expect that the professional technician displays good customer service and/or customer interface skills and professional appearances. I feel a little surprise in that many customers do not distinguish those differences.

For customer interface skills, I expected actions like calling ahead to let the customer know that the technician had received the call and then calling for updates if the projected arrival time changed. I also expected that politeness, respect, and other one-on-one communications would fall into this category. For customer service skills, I expected answers like the respect for customer property such as wearing booties, laying down drop cloths to maintain clean work areas, drop cloths, and booties. For professionalism, I expected answers that addressed appearance of the technician, uniforms, the vehicles, etc.

The fact that the customers combined these two categories into essentially one, by their cross-references in one category to items in the other - both directions, indicates that training should include an emphasis on both. With poor customer skills, the customer perceives poor training, even if the technical training rates excellent. With good customer skills, the customer perceives good training, even if the technical training rates poorly. Both customer skill situations negate the reality of the technical training.

## *Status*

Orr (1996), in a major qualitative study on Xerox Corporation technicians, discussed the status criteria among the service technicians. He discussed the preservation of order and understanding in their world and related their reputations to both technical knowledge and social skills. He noted:

Technicians' discourse reveals that they value most highly those attributes that contribute to the preservation of order and understanding. Reputations are built on technical skills, memory, ability to gather information, verbal performance, and the general ability to retain control of the situation. (p. 144)

The status that Orr described highlights the status and/or reputation among the technicians. In my own experiences with technician status at Xerox, I had many customers complement me and/or other technicians when we used the service manuals instead of "flying by the seat of our pants." The older technicians did not like to use the manuals because they felt that it made them look inexperienced. I had one older technician look me up after I transferred to the International Training Center as a trainer. He came by to thank me personally for forcing the technicians to use the manuals when they were in the field before I left his branch as a product specialist. He had resisted using it at first but knew I would ask him about it when he called for help. He started using it to search for problems before he called and realized how much help the manuals included. He told me that after he started using them, his customers seemed happier and began to complement him for trying to do the job right and fixing



problems that other technicians had not fixed. Essentially, he had increased his status in his own eyes as well as in the customer's eyes.

But, what status does a HVAC technician hold in society? John Thomason feels that society views their status as blue-collar, not white collar. He wants to somehow raise the status for his technicians and the entire HVAC industry. He repeated that desire on numerous occasions. How might the technicians' status change with their newly acquired video and Internet skills? When computers first appeared, kids feared and mocked the geeks in schools. By early 2008, society awarded geeks with badges of honor for their high pay and the ability to rescue others from the whims of computers. Some of the companies with the most playful work environments and best benefits hired the geeks. If the HVAC systems and the service technicians can associate themselves with computers and high technology, the status of the technicians may rise.

I have several additional thoughts/clarifications on the status issues. The positives include the new technology which provides new awareness and the general systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993) that notes that when one item in a system changes then others have to re-stabilize. However, there exists a normal resistance to change caused by factors also mentioned in the general systems theory and by factors in society as noted by Douglas (1966) and Turner (1969). I hesitate to predict a significant change in status for the technicians due to those conflicting factors.

Douglas (1966) discussed classifications such as clean/dirty. Douglas felt that symbols worked at two different levels: individual psychology and social life. Society contained powers to reward conformity and repulse attacks. Society frequently controlled these through rituals. Rituals attempted to create and to maintain a particular culture or set of assumptions. Rituals reenacted social relationships to give them visibility and expression so that the people in the society learned their society.

For customers, HVAC systems fall into the dirty or polluted category as defined by Douglas (1966). HVAC units reside in dusty closets, attics, and outside areas. Customers dislike dirt and fear those things that they do not understand. Customers also do not want to appear stupid. Customers often fear this strange world with its new and different terminology. The world of the HVAC technician includes terminology, concepts, and equipment hidden behind the customers' walls and bushes, but critical to the technicians. The customer attempts to explain their problems so that the technicians can fix them. In the customer's viewpoint, the professional or well-trained technicians treat the customer with respect and explain to the customer the nature of the repairs in terms the customer understands. That respect and the explanation alleviate some of the customers' fears, since now they understand more about the strange world called HVAC.

Then, you have the writings by Turner (1969) who recognizes the dualism between "structure" and "communitas"(a relationship between concrete, historical, idiosyncratic individuals) which resolves in "societas." Rituals help put society back into

order by activating an orderly succession of symbols that function as both communication and efficacy. Even in the simplest societies, structure and *communitas* remain distinct and obtain symbolic expression in liminality, marginality, and inferiority.

### *Heroes*

One of my questions to the personnel at Metro Environmental concerned John Thomason's comparison of the HVAC technicians to the "Old West Heroes" (see my 2003 pilot study, Appendix A). Also, customer comments regarding rescue made that description an appropriate fit.

I find that some customers do consider the technician as a hero by solving their crises. They go into the liminal region of the customer's private spaces, initially creating different kinds of discomfort, but ultimately generating gratitude from them. As a result, the technicians feel that hero status which gives them instant feedback and gratification.

No one wants the privacy of their home invaded. Some customers want to live as a macho fix-it person; some do not care. Customer discussions range from comments such as "watching them is like watching paint dry" (denial) to watching closely so maybe they can fix it themselves next time (admission of interest but lack of knowledge). This appears as part of a territorial thing - the house or office - and it does not look picture perfect or professional for the guest, the technician. Some apologize and offer water and cake; some watch closely, but from a distance. People feel invaded and helpless when the HVAC system in their background environment, the HVAC system that

contributes as an essential part of their daily lives, now fails and they can not fix it themselves. The interview feedback in this study validates this scenario.

The techs who fix the customer problems feel good about that. For a few moments, they feel like a hero even though their societal status remains lower, blue collar. Henceforth the love of what they do. Many workers and professionals wait months and even years to see the rewards for their work. These heroes receive mental and emotional rewards daily, sometimes hourly.

#### *Unpredictability and Variety*

Orr (1996) in his qualitative study of Xerox technicians noted:

There is an existential dilemma at the heart of service: the technicians are responsible in a world in which they have very little control. Their job is to respond to trouble and to anticipate and avoid trouble when they can, but the setting in which they perform is largely constructed by other people, is inhabited by other people, and is inherently unpredictable. (p. 158)

The technicians' work days are dominated by unpredictability and variety. They valorize their ability to cope with this ongoing experience. I wonder if this difference occurs because of the disparity between those who love controlled environments with everything just right versus those who don't and successfully learn to adapt to changes.

I query if this control pattern relates to childhood learning patterns. Some students live routine lives and eat on schedule with meals at 6 p.m. every evening Some students live in home environments that society considers as constantly in flux and/or in home environments with both parents working and whose meal sometimes get

prepared by the older kids versus the parents. I wonder which students find it attractive to enter a trade versus an office work environment.

I see these two categories of students in meetings I attend elsewhere and in my own life. I wonder if that pattern hides behind the reasons that Kwame, with his business degree, finds it difficult to resist going back to a more controlled office environment. He did well at Metro Environmental. John Thomason hated to lose him. The Metro Environmental apprenticeship position offers nearly the same salary, but not the same environment or status as a management position in an office. Does this variability make a difference in the workers who survive the harsh environment of the HVAC industry?

The variability rests partially as a result of dealing with homes and buildings that vary. It rests partially as a result of always being on call and never knowing from where or when the next call comes. Even their lunchtime varies. They often control their lunch since they usually choose when, where, and if they take the time for it, but none of the technicians take lunch at a set time or place every day. They typically schedule lunches around the tasks and locations at hand.

### *Tools and Tool Bags*

The tools and tool bags seem to be, at least symbolically, an extension of the technician themselves. The gunslinger image of the cocked tool belt with the technician's tools right at hand seem very symbolic, but does not fit the reality of the technicians at Metro Environmental. The gunslinger image does, however, fit a

technician in one of the pilot studies when I accompanied a technician to the parts house. I find practicality in the technicians at Metro Environmental and in their tools and tool bags. I observe no false status, no showmanship, but just what makes the job easiest.

I feel that the people and the relationships regarding the borrowing and lending of tools suggests the importance and meaningfulness that tools play in the technicians' lives. With the proper tools, the tasks seem easier and finish faster. Without the proper tools, technicians waste time and energy. Everyone appreciates the respectful treatment of tools and respectful treatment reemphasizes their trusting relationships.

The tricks the technicians play with each other tools indicate both respect and camaraderie. The tricks help train the apprentices to remain aware of their environment, especially their tools. But, the technicians do not limit the tricks to the apprentice technicians. Tricks occur among experienced technicians when the opportunities arise and/or when they feel a need for humor. The tricks also help reinforce trust of the other technicians since in the end the other technicians remain honest about the tricks instead of trying to steal their possessions. The fact that the technicians feel comfortable about leaving the tools in the recesses of an attic while they go elsewhere gives a message of their trust about their co-workers and others. Even the tool belts that some technicians wear, with the tools always close to the body, indicate mistrust. The open buckets or tool pouches that Metro Environmental technicians wear indicates a more trusting relationship symbolically.

### *Customers, Service Calls, and Story Telling*

Orr (1996) found in a qualitative study that Xerox technicians frequently share *war stories* about various machines, accounts, customers, managers, and other technicians. The Metro Environmental personnel share many war stories, especially with Kwame and me since we recently have entered their group. Throughout this dissertation, I now share some of their stories with the reader. Like fairy tales to children and folk tales to everyone, each story presents a lesson that requires learning or advice in handling a situation. If someone experiences an event and shares it, it often elicits a memory and another tale by the listener. Frequently these stories entertain and/or discuss important topics. Metro Environmental personnel share these stories quite frequently during the morning meetings when everyone waits to see what they get assigned to do for that day, occasionally during the not so busy times throughout the day, and always during their lunches.

For Metro Environmental, every visit to a customer contains a story with a beginning, middle and conclusion, even if it does not qualify as a war story. They greet the customers, determine the problem, fix the problem, and then they explain the problem to the customer to conclude the call. Even if they take a break to retrieve parts or lunch, they connect with the customer on exit to explain why they must go and connect again on re-entry to let the customer know that they have returned. This pattern helps so that the customer does not fear any unknown noises, activity, or the absence of noises and activity, in their house or business.

Moore and Kearsley (1996), in discussing learning environments, noted the many stories told about distant learners. The HVAC industry, as well as many other service-oriented industries, now has new stories to tell about Metro Environmental and their SightPros-VirTechs system including the SightPros communication tools, the training, and the remote learners. John Thomason and Metro Environmental hope that you, the reader, will help to tell their stories.

### *Real-World versus Classroom Environments*

The captured video from the SightPros-VirTechs system offers wonderful opportunities to present real-world conditions as part of any educational or training curriculum. For example, a video clip and discussion about a technician that has to solder copper pipe next to gas lines and in cramped conditions offers a visual that students, apprentices, or technicians may not forget. It opens opportunities to make training on safety issues come alive. Discussions on the proper way to handle situations like a locked roof ladder might address issues that technicians commonly find.

Technicians can practice and/or managers can observe soft skills such as customer service skills over the SightPros communication tools. According to J. Wircenski (email communication, February 13, 2008), who manages a grant for the Texas Education Association (Texas Trade and Industrial Education <http://www.texastandi.unt.edu> that publishes online lesson plans for many of the trade classes in Texas), notes that their lesson plans seldom cover soft skills. Students need to study ethics and honesty since they might work in a stranger's home. If need to know



that if they have a criminal record, they face severe consequences, including the loss of their state registration which allows them to work for a contractor. They need to study one-on-one communication skills including telephone skills so they learn to communicate effectively with the customers. They need to study respect for customer property such as wearing booties, laying down drop cloths, etc. They need to study the benefits of clean work areas. They need to learn the importance of professional appearance like wearing uniforms and appearing clean-cut, including hair cuts.

#### *Customer Service and Silent Curriculum*

Metro Environmental considers good customer service as both a bragging right and one of the silent curriculum (Rigoni, 1995) areas. Everyone talks about it. Everyone practices it. At the end of every call, technicians perform a thorough cleanup of the customer sites. Technicians might not last very long at Metro Environmental if they get many and/or very serious customer complaints. Metro Environmental recognizes the high cost of acquiring new customers so they do not want to lose any of their current customers.

However, keeping things clean meant different things to different folks. The technicians often cluttered their work area with debris from the removed parts or the dust and dirt they scattered and left temporarily. In the attics, closet, and yards the customer might not see the problem. Inside, the drop-cloths helped with the movement from the entrance to the work areas. Whenever the technicians opened an attic, particularly as they frequently went up and down the ladder to them, insulation would

fall through the doorway onto the steps, the drop cloths, the carpets, or the floors below. Occasionally, debris fell off of the drop cloths and remained there until cleanup time. Moreover, removing ductwork usually meant dirt falling through the registers or the vents where they connected.

I noted differences in the technicians and the customer needs and desires in this area. At one location, an install, the customer worked at her computer after her 4-year-old child came home from school. The customer failed to watch the child closely, but I noticed the child wander down the hallway and start to play with the debris that had fallen from the vent. The child stepped through the debris and wandered on down the hallway. Insulation and debris might harm the child, but the technicians did not clean it up until they finished for the day - several hours later. Discussion of this situation instead of keeping silent brought the problem into open awareness for the technicians. Yes, the technicians always completed the clean-up task at the end of the day, but sometimes the call sequence needed altering for customer safety and business liability reasons.

### *Terminology Verification*

This study reinforced a lesson about the need to make terminology distinctions explicit. Explicit distinctions help students in training. They help when technicians converse with their customers in that the customer fully understands the conversation. In all three studies, I confused the terms condenser and compressor. This mistake can easily occur with any student, apprentice, or customer. Compressor and condenser both

begin with *co* and end with *r* and both involve the processes of cooling/refrigeration and changing the refrigerant from a gas to a liquid. Physically, the compressor describes a component located inside the condenser. Because I thought of the condenser whenever the technicians mentioned either, I confused the terms without realizing it.

I discovered the confusion when I asked John Thomason to review and confirm my categories and descriptions in the HVAC terminology in Appendix J. The technicians knew the distinctions, but the customers and others might misunderstand the concepts similar to my fuzzy understanding. The importance of recognizing it in training students relates back to the customer descriptions of professionalism and well-trained technicians. Customers feel that the technicians achieve both when the technicians explain the customer problems in terms that the customer understands.

#### *Real-World Experts in Remote Collaboration of Physical Tasks*

In the real world, the HVAC apprentices and technicians deal with everyday issues for their industry. They perform mostly routine tasks which they already know. Frequently, the apprentice does an installation with other technicians who provide instructions or advice. At other times a nearby technician does tasks that the apprentice watches and then learns how to perform. Nonetheless, some service calls deal with unique situations and/or problems. The apprentices and/or technicians occasionally need expert assistance.

An expert in the highly complex HVAC industry deals with complex problems that vary with each call and deals with technicians of varying expertise - none of which the

expert considers as novices - apprentices, but not novices. Nonetheless, the expert recognizes that the technicians already know key information such as component names, tasks, required tools, etc.

Essentially, little of the Metro Environmental expert's typical day follows the typical interactions that we find in much of the current research. Often researchers design with large or mid-size businesses in mind rather than small businesses and/or they design laboratory research. Users need both quantitative and qualitative studies. Both John Thomason and I appreciate and adapt to the advice and testing that comes from all studies on remote collaboration of physical tasks.

## Conclusions

### *The SightPros-VirTechs System*

The SightPros-VirTechs system constitutes a potential solution to the skilled labor shortages projected for the HVAC industry and other service-dispatched industries. The SightPros-VirTechs system lets expert(s) and/or customer(s) remotely monitor one or more people and/or sites simultaneously (leveraged expertise) and provide just-in-time suggestions or answers to them. It uses streaming video of real world situations to provide meaningful insights to both experts and trainees.

Kwame, the apprentice technician at Metro Environmental, started independently working on service and maintenance calls much earlier than other technicians observed in the original pilot study. He and the management both felt more comfortable to do so because of the ability to monitor his progress at any given site and

offer suggestions just-in-time and with leveraged expertise. Overall, Metro Environmental had 8 technicians during the initial pilot study in 2003 and 4 technicians during the study in 2004 completed at approximately the same time of year. In this study, they had 5 technicians. A part of the change may result from the fluctuations that typically occur in the HVAC industry due to seasonal fluctuations in demand. However, the rapid drop in the numbers after the 2003 pilot test of the concepts indicates how it can help with the skilled labor shortages in this and in other industries.

#### *The SightPros Communication Tool*

The SightPros communication tool constitutes a new technology tool in that the service personnel can connect to a remote expert that has knowledge of a specific concern to an individual. John Thomason and the technicians at Metro Environmental feel that other service personnel will benefit greatly from it.

#### Recommendations

In this section, I discuss recommendations regarding four different areas. First, I discuss my recommendations for improving instructional support. Next, I discuss recommendations for real-world studies versus laboratory studies. Then, I provide a summary list of recommendations for improving instructional support in mediated environments. Finally, I provide my recommendations for potential areas for additional study.

### *Improving Instructional Support*

Instructors may improve instruction of the HVAC technicians by adding training on what I refer to as customer service and/or customer interface instead of concentrating exclusively on actual hardware, software, tools use, and specific knowledge. Instructors should emphasize the importance of these soft areas including honesty, professionalism, etc.

Instructors may improve instruction of the HVAC technicians by adding real-world video examples to their lessons from applications like the SightPros-VirTechs system. They could use these videos and communications to address items like safety, installation, maintenance, and repair.

### *Laboratory versus Real World*

Researchers may need to balance their studies for more real-world communications from expert to apprentices and/or worker. For instance, instead of using simple tasks, they can use realistic tasks. Instead of using just recently trained helpers as experts for laboratory studies, they can use real experts. I have found significant differences in my field research compared to the reported studies of laboratory research. A more balanced approach may result in more meaningful and easy to adopt ideas.

### *Improving Instructional Support of Mediated Environments*

With my research, I wanted to find and recommend suggestions for improving instructional support in mediated environments. The following list briefly summarizes the suggestions that I discussed earlier in this section:

- Pick the right people to do the appropriate tasks.
- Use appropriate knowledge management tools.
- Don't surprise video participants. Always ask permission.
- Encourage participants to act naturally but not to talk to the camera.
- Use a good audio/video device. Learn the capabilities and limitations of that device.
- Use standard rules of photography and multimedia: lighting, framing, and video stability.
- Record good audio. Eliminate unintended background noises.
- Be prepared with spare batteries and/or extension cords.
- Plan for both typical and unusual situations.
- Capture permanent records. Do not reveal private information.

### *Potential Areas for Additional Study*

I examined a number of areas relevant to this study, but many areas still remain that other researchers can examine. I recommend the following topics as potential areas for additional studies:

- Repeat the study at Metro Environmental using Wi-Max communications to determine if the observed cellular communication interferences continue or diminish with improvements in the next generation of equipment. For this study I found significant service interruptions over the communication lines with the current wireless communication equipment.
- Repeat the study at Metro Environmental using launch version hardware and/or different times of the year.
- Track the ratio of expert to apprentices or trainees to see how many apprentices or trainees that a single expert can successfully support. For this, peak work loads may be a prime consideration. I completed this study during a seasonal downturn for service calls, but at a high point for system replacements. While this seems like an ideal time to test the SightPros-VirTechs system and the prototype SightPros communication tool, the service call volume remains fairly low.
- Use the SightPros Web site in a study to compare ease of use for different experts on that site and their customers.
- Duplicate the study on the SightPros-VirTechs system using additional business applications or companies either inside the HVAC industry or other service-oriented companies.



- Do a comparison study of the SightPros communication tool versus other mediated communications such as cell phones only, cell phones with cameras, cell phones with texting, etc.
- Study a multinational company to gain insights into language barriers or cultural differences.
- Take some findings from this report and adapt them to a real-world, laboratory study to verify/validate them.
- Do a cost/benefit analysis or a self-worth analysis, for individuals on welfare versus individuals continuing in the work force, to determine the benefit to society and the economy of using differently enabled individuals (due to a back injury, arthritis, some neurological disease, diabetes, or other disabling affliction) who continue working from a remote site using the SightPros-VirTechs system instead of joining the welfare population.

### Summary

This section completes my discussion of my recent study at Metro Environmental. In this summary, I review Metro Environmental and John Thomason, the president/co-owner of Metro Environmental. I review the SightPros-VirTechs system and its just-in-time training and leveraged expertise concepts. I review the impact of the SightPros-VirTechs system on personnel, customers, business contacts, and all service-dispatched industries. Finally, I review this entire chapter.

Metro Environmental ranks as a small business, a HVAC company, located in the Dallas/Fort-Worth Metroplex. The HVAC industry considers John Thomason as an expert in their industry. The U.S. Patent and Trademark Office awarded him two patents for his portable, wireless audio/visual communication tools and processes. John has a third patent pending. John Thomason built two prototype communication tools for the current field tests. As an extension of his patents, he has developed a Web site where anyone from around the world can contact an expert to seek advice when they needed assistance where mediated communications would enhance the exchange. At a minimum, they use telephone, Webcam, or other Internet communications. His dreams about enhancing those communications with the portable, wireless audio/visual SightPros communication tool that they will sell and/or lease for brief intervals, ship it overnight to remote locations as needed, and then use it to allow one-on-one, just-in-time, high-quality, video-monitored instructions between an expert at one site and a customer at a remote site.

Their battery-operated, high-quality video SightPros communication tools use wireless communications networks to provide real-time video capabilities. The communication tools controlled by the remote expert/customer(s) leave the worker(s) free to do the worker tasks. The camera controls for the communication tool include pan, tilt, zoom, iris (light exposure), and frame rates. Up to ten remote expert/customer(s) can view and potentially control each communication tool depending on the control rights provided by the software administrator for the

SightPros-VirTechs system. Each communication tool has a unique Web site that John password protects for privacy.

John Thomason and Metro Environmental successfully use the SightPros-VirTechs system to train their newest apprentice remotely. John sometimes teaches the apprentice by using the traditional HVAC apprenticeship model of watching and learning from an expert and eventually doing the tasks alone. Via the SightPros-VirTechs system, John frequently modifies the traditional HVAC apprenticeship model and reverses the expert activities. With the SightPros-VirTechs system, the expert works remote from the HVAC system and only the apprentice works local to the HVAC system. Therefore, the apprentice must do physical activities from very early in training with the expert closely watching over wireless video and instructing the apprentice exactly what to do. For the initial calls, the expert has another technician on the same site. However, the SightPros-VirTechs system works well enough that Metro Environmental sends the apprentice alone to customer accounts after just a few months.

The technicians who work at Metro Environmental express excitement about the prospects of the SightPros-VirTechs system and the SightPros communication tool. Even the experienced technicians express potential uses for the communication tool as a tool that technicians can use whenever necessary to contact a remote expert.

The customer and business contacts give good reviews of the SightPros-VirTechs system. They suggest many other businesses that may benefit from the system. This

positive feedback indicates that this may work for many of the service-dispatched industries and possibly other applications.

I conducted this study as a qualitative study so I gained additional insights. I captured the work on the screen capture software. Since I permanently captured the video, I can refer to it for many applications, but especially training.

In brief summation of this chapter, this completes an overall view of my recent study on training at Metro Environmental, a HVAC business. First, I reviewed the purpose of this study which included my major research questions. Next, I provided a short general introduction to the discussions, conclusions, and recommendations. Then, I reviewed and discussed my research findings in detail. Subsequently, I drew some conclusions. After that, I made some recommendations. Finally, I summarized this dissertation and then this chapter.

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APPENDIX A

FINAL REPORT FOR SPRING 2003 PILOT STUDY

## Introduction

I completed the following field report in spring 2003 to fulfill the requirements for an educational research course that I took on qualitative research. For that course, each student submitted a proposal, acquired the necessary UNT IRB (University of North Texas Institutional Review Board) approvals, and then completed hours of field research. I did my first pilot study on Metro Environmental and VirTechs as part of the requirements for that course. (Prior to 2007, John called the SightPros-VirTechs system as simply the VirTechs processes.) Near the end of the course, the instructor, R. W. Wilhelm, provided a field report outline with specific questions for each student to address as our final exam. The instructor returned my report with some thoughtful comments. I include those feedback comments as part of this report.

## Statement of Grand Tour Question

- A. Describe the principal social phenomenon under investigation.
1. The title to my research project provides a partial answer to this: Metro Environmental: The impact of training a HVAC technician using an Internet video conference room to connect an on-site apprentice with a remote HVAC expert.
  2. In essence, Metro Environmental has had processes they developed and patented that they have called VirTechs. I wanted to know how Metro Environmental used the streaming video to train their service personnel and



how it impacted everyone involved both inside and outside of the company. I decided to look at five different areas within that scope. Within each of those five areas, I also developed multiple sub-questions. Those five areas were:

- a. How do the Metro Environmental workers explain/understand the VirTechs training?
- b. How does Metro Environmental use VirTechs training to train their employees?
- c. How does VirTechs training differ from traditional HVAC training practice?
- d. What generates the perceptions [feedback from R. W. Wilhelm, May 12, 2003: "whose?"] of VirTechs training?
- e. What obstacles and opportunities exist [feedback from R. W. Wilhelm, May 12, 2003: "for whom?"] with the VirTechs training?

[Feedback from R. W. Wilhelm, May 12, 2003: "You didn't include a question about the impact of the introduction of VirTechs on the overall culture of the business."]

- B. How did prior research literature guide your identification or exploration of the question(s)?
  1. My studies and my work activities over the last 5 years have kept me abreast of much of the computer, learning, and distance education trends, issues,

and literature. [Feedback from R. W. Wilhelm, May 12, 2003: "What specific articles or books helped shape your questions?"]

2. I found that the Department of Labor Statistics summarized the work situation for the HVAC (heating, ventilation, and air conditioning) industry and predicted the future trends in that area. Their reports verified the labor shortages that John Thomason (president/co-owner at Metro Environmental and also an industry expert) mentioned. Their reports helped me to understand the environment and to note potential questions and concerns.
3. Prior literature on training and media research indicated that media itself should not impact the results of learning in a training environment. Therefore, I felt that I did not need to verify the effectiveness of the training or the media.
4. Literature on qualitative versus quantitative research [feedback from R. W. Wilhelm, May 12, 2003: "what?"] indicated that a qualitative study fits the design of this study more appropriately. It remains an area without much prior research, in a very fluid environment, and without enough data to fit a quantitative model.
5. I failed to find much prior research on apprenticeship training and computers. I read several dissertations in those areas and recently received seven more that I will look at this summer. From the analysis of literature so far, I believe that I found an area crying out for additional research.

- C. What steps did you undertake to focus your research question(s)?
1. To help me focus my research questions, I contacted several key individuals in fall 2002. These included my major professor, my minor professor in anthropology, John Thomason at Metro Environmental, and a local service department trainer at Xerox Corporation. I brainstormed and analyzed the input that I received against my own background as a Xerox® service technician, service trainer, and service/customer documentation specialist. In essence, I built a conceptual framework to determine what relevant questions to study.
  2. I bounded my study to one site: Metro Environmental. I did this partially to limit the study to a reasonable boundary and partially because they were the only site currently developing the VirTechs processes. I decided against a comparative study because I felt that I could not afford the resources required to study two locations in enough depth and to also accomplish my intended goals for graduation. I can always study other sites for comparison purposes after I graduate.
  3. I originally thought that my five major questions and the numerous sub-questions would have helped me to focus on specific and attainable materials. I referred back to them numerous times in the last few months. However, after I went into the field, I found that I needed to explore many additional and relevant areas as well as the areas that I originally planned.

4. When I first entered the field, I viewed the VirTechs processes as still in the prototype stage. They planned it for an early spring launch. They delayed the actual launch due to computer network and records failures. Since my questions focused on VirTechs training, this delayed research on many of my questions. With the change in situations at Metro Environmental, I explored a few areas more in depth than I originally planned.

#### Description of the Context and/or Informants

- A. What material elements did you find in the setting in which you conducted your investigation?
  1. I spent most of my research hours at the Metro Environmental office located in Carrollton. At that office, I observed the president/co-owner of the company in his daily routines. He gave me extensive access to his work as president/co-owner, network systems administrator, and trainer.
  2. I mapped most of that location including the front reception area, the marketing office, the training/kitchen area, the dispatch and accounting area, and the president/co-owner's office. I still need to map the parts area, the truck access area including an area for large parts, a central area that includes a uniform rack and various literature, and the service manager's/drafting office. [Feedback from R. W. Wilhelm, May 12, 2003:

"Would mapping a service truck be helpful in providing useful information?"]

Key items in the building were:

- a. The entire computer network that included computers, laptop setups with wireless communication links, and the network server.
- b. Cell phones with Direct Connect® features (Direct Connect operates similar to two-way radios.) used to communicate with the field personnel.
- c. The security systems that included several network cameras, televisions, window cages, locked parts room, and a loud bell that announced when anyone opened the front door.
- d. Office furniture and furnishings that included standard desks and other office equipment like file cabinets, an elaborate antique desk, flags (US, Texas, and Marine Corp), literature rack, kitchen table, overhead projector, A/V cabinet, uniform rack, and several desktop and stand-alone air filters.
- e. Wall hangings that included everything from Monet prints, rotary plaques, certificates, and HVAC promotional materials.
- f. Two parts areas, one for small parts and one for large parts. The one for large parts included a drive through area that could easily fit four 18-wheel trucks and another area adjacent to that which looked

equivalent to four more 18-wheel trucks where they stored large parts and some used and/or spare HVAC units.

3. I conducted research in another setting: inside their trucks. Their trucks, mostly service vans, had rear and side access doors. In each van, a metal mesh wall separated the passenger compartment from the rear compartment. The passenger compartment included a mounted stand for a laptop computer/printer case. The rear compartment contained the parts and supplies needed for the service calls. What they carried often depended on the specific job requirements at the location(s) assigned for that day. They used their service vans as utility vehicles and they looked the part. They purchased white vans. They put the Metro Environmental logo on the outside side panels. They labeled each truck with a three-digit fleet identification number. Some of the trucks had visible dents and dings.
4. I researched a third setting: a series of customer locations. They included:
  - a. Buildings under construction,
  - b. Offices and warehouses,
  - c. Stores and gas stations, and
  - d. Individual homes and apartments.

Each location varied in material elements and layouts. However, all of the locations needed HVAC units, maintenance, or service. At these locations,

part of the operational environment included the parts, materials, equipment, and tools like meters, metal tape, gauges, and acetylene torches.

B. What were the spatial relationships between the people and the material elements in the setting?

1. The atmosphere in most of the rooms at the Carrollton office appeared very casual and family oriented. They provided huge office spaces for each individual – the size of a typical 18-wheel truck! A few of the offices had a formal business atmosphere, but those offices rarely had anyone in them.

a. They physically occupied the reception area only about 35% of the time during my visits there. That area included two large multi-component desks, one with a computer. The staff from the back office monitored this area via a security network camera. The two workers that used this area included the two young adult children of John Thomason (president/co-owner and the sales/network systems administrator) and Christina Thomason (vice-president/co-owner and the accountant). The children only worked there on a part-time basis. The daughter (Rachael) worked as a receptionist.

b. They typically locked the office of the marketing manager (Ken). He came in the mornings and late afternoons. Other than that he typically traveled outside of the office. His computer also served as the network server so the systems administrator went into that office

on an as-need basis. That room reflected the background of its resident in that everywhere I looked I saw the Marine Corps symbols: his desk had a large logo, his office had floor mounted flags, he encased his uniform in a glass cabinet, etc.

- c. Another small area off of the reception area had about four file cabinets and the entry to the men's room which also included a shower. In the HVAC business in the heat of summer, technicians and staff sometimes shower after returning from a dirty work site.
- d. An unused office off of the reception area included an antique desk and a drafting table. I saw this office used once when we used it as a quiet room during the first VirTechs trial between Steve (lead technician/field service manager) and John (nicknamed PK to distinguish him from John Thomason) (apprentice technician/apprentice installer). A batch of business cards indicated that this might be Steve's office, but other than that one trial, I never saw him in there.
- e. Past the unused office, I stepped into another area of people interest in the building. This area served as a large entryway to all of the other rooms and to the drive-thru parts room. This room contained a built-in literature wall with many reference books and a uniform rack.



Because of its convenience and large size, people tended to gather there before and after conducting business in the other rooms.

- f. They used the kitchen for two purposes. First, it served as a kitchen. The smell of baked cookies or sausage greeted me on various occasions. Christina Thomason frequently cooked breakfast or snacks - sometimes for the whole office staff. Secondly, it served as a meeting/training room for the short classes that they often held during early mornings on Tuesday and Thursday and/or for other meetings as needed. Since I specifically wanted to observe their training, this room often served as my center of activity and attention until the service technicians got back on the road. The kitchen had access doors to the HVAC units for this building and to the ladies room.
- g. The ladies room felt like a guest bathroom in a home rather than an office bathroom. I felt pleasantly shocked the first time I stepped into the room. I saw flowery wallpaper and frilly implements. This room varied from all other rooms in the entire building in its incongruous femininity.
- h. One of the two offices located towards the back of the building incorporated the work area for Christina Thomason and Susan (service dispatcher and payroll guru). They sat facing each other.

Multitudes of stuffed animals, small figurines, family photos, plus the typical office furnishings surrounded both of their work areas. Both of them monitored the TV to watch their favorite shows or to switch to the security network cameras if they heard the doors open or heard any other unexpected activity. They used a small couch (covered by a quilt and large throw pillows) for relaxation as needed. I typically found 2 to 4 technicians gathered in this room so that they could get instructions regarding their assignments, could verify/clarify order status for needed parts, and/or could discuss billing or payroll issues.

- i. John Thomason occupied the second office towards the back of the building. He littered his office with computers, accessories, software, literature, books, and paperwork. When I visited there, he often had to move parts, equipment, or papers from the extra chair that sat on his side of the desk so that we could work together and see his computer or chat while he worked on his computer. Even though he occupied a large room, it had the least available space because of the two desks, a large credenza, and other miscellaneous stuff.
- j. The technicians typically visited the two parts rooms as the last places to stop as they started to leave for their assigned calls. They pulled their trucks into the drive-thru area and then filled them up with necessary parts, tools, and HVAC units.

2. The technicians used their trucks to transport people and materials and as a base station for the laptop computer systems. During the service calls, the technicians left their personal belonging such as drinks and food items inside the trucks. If they needed additional parts, supplies, or HVAC units, they used the trucks to fetch the needed items. Often several technicians converged on one location when they had a large job – even at a customer's home. On one HVAC system upgrade during part of the slow work season, I noticed 4 trucks parked outside the customer's home at various times during the day, but never less than 2 trucks. Technicians came and went as other calls came in or other tasks had to be done. On one of the calls, I accompanied a technician when he went to the manufacturer's parts supply warehouse/storefront.
  3. The customer locations varied widely. As explained previously, technicians came and went as needed. I watched them (through video connections) in the center of a huge warehouse where they used platform lifts to get to areas where they needed to work. In homes, I saw technicians servicing HVAC units in the attics as well as in the backyards. They used certain tools like meters and acetylene torches as necessary for portions of their work.
- C. How much time and in what configuration did you spend in the field?
1. Because of my class schedules and research requirements, I visited the Metro Environmental offices typically on Tuesday and Thursday morning. I stayed there as long as they had their training sessions or they had other activities

of interest to this study. Some visits lasted only 30 minutes; others lasted up to 5 hours. I documented those visits through notes and tape recordings. I collected 22 pages of field notes (8.5" x 11") and 14 hours of tape recordings from the office visits. Totally, I spent approximately 30 hours at their office.

2. I scheduled one full day to travel to customer locations. I spent 6 hours in the field that day and recorded most of it on tape. However, I made other field visits. I went to other customer locations via the Internet and streaming video. Totally, I spent about 15 hours on customer calls and on watching the technicians travel to and from those calls. Because I watched via video, I expanded my limits past the normal 8 a.m. to 5 p.m. work hours and my Tuesday/Thursday schedules. I watched the streaming video during the daytime, during week-ends, and during evening hours as I sat at my computer.
3. I made other visits through communications links such as telephone calls, Yahoo!® Messenger instant messages, and email. I made 12 pages of notes from telephone conversations. I archived messages from 11 Yahoo! Messenger addresses on 25 contact-dates. I estimated time for these visits at approximately 10 hours total, but that may be an underestimate. My notes showed that during the IRB permission phase of the study I spent 2 hours on the phone with John as he expounded VirTechs and discussed the study.

- D. How did you select the informants and what were their characteristics (e.g., gender, age, ethnicity, social class, role in the setting)?
1. I considered Metro Environmental as a small business so I chose to study their entire personnel (15 people) and up to 50 customers on an availability basis.
  2. The participant ages varied from 22 years old to about 55 years old. Social class encompassed middle to upper income. All participants worked full time for a living. Gender comprised three females with the rest males. Participants consisted of only 2 Hispanics with the rest Anglo. Participant roles included 8 technicians, 5 office staff, 1 marketing/sales specialist, and 4 customers.

#### Description of Methodological Approach

- A. What steps or strategies did you take to negotiate entry to the site?
1. My first contact with Metro Environmental occurred as a customer in July 2000. After their September 2002 replacement of my home HVAC system, I asked John Thomason about the possibility of this research pilot study. He expressed excitement as he felt it might help him in an application for a NIST research grant.
  2. John Thomason and I worked together to negotiate the conditions for my study. By working so closely up front, I smoothed the way for an open door into the site.

- B. What specific strategies of qualitative methodology have you employed to investigate the research question(s)?
1. I used an explorative, collaborative, ethnographic, participant-observer approach to gathering data for this study.
  2. I used observations, mapping, tape recordings, telephone, email, instant messages, surveys, and interviews as my data collection methods.
  3. I considered it as a critical case sample since Metro Environmental developed the VirTechs processes.
  4. My population included all members of the Metro Environmental personnel and up to 50 customers chosen using the convenience (availability) criteria instead of random selection. I selected this customer criteria because of several considerations:
    - a. My visits to Metro Environmental occurred infrequently.
    - b. Most customer calls randomly arose when a customer requested service instead of on a specified routine.
    - c. Customer participation required a customer agreement. Customers also had to allow the audiovisual communications on site.
    - d. John Thomason dealt with various corporate customers that had extremely high security risks.
  5. I created survey and interview forms for the customer data. I created interview forms for the Metro Environmental personnel interviews.

C. What ethical issues have you encountered in your research? How have you attempted to resolve the issues thus far?

1. My biggest ethical issue concerned the confidentiality of participants.

Because I designed my study as a collaborative study and I felt that it would be impossible to guarantee confidentiality in the small business environment at Metro Environmental, I decided that I would notify all participants up front that I could not guarantee their confidentiality within Metro Environmental. I specifically included that statement in the consent form and I discussed it with all participants. I informed customers that we could use information from this study in various publication forms. I promised each participant in the consent form that we would only use real names in public reports when the participants and management provided express permission and would use an alias for all customer names.

2. I identified a second ethical issue as one that you [R. W. Wilhelm, my instructor] suggested in January 2003. We had John Thomason send a letter to me and to the IRB board that stated:

a. No employee would be compelled to participate in the study without their freely-given and written permission.

b. If an employee preferred not to participate in the study or later withdrew from the study that they would suffer no prejudicial actions regarding their employment status with Metro Environmental.

- D. What problems have you encountered in data collection and how have you attempted to resolve them thus far?
1. Mainly, I fought time. I never had enough time. I enjoyed every minute that I spent on the research, but I wished for more. I have predicted more free time during Maymester and during Summer II, but I have predicted a busy Summer I because of the classes that I usually teach then. I have needed the income so I have not preplanned for 40 hours a week on data collection. I have considered a grant application to get more free time.
  2. I encountered problems when I concentrated on trying to take notes instead of observing. I found that I did inadequately on both. So, I used my audiotape recorder as much as possible.
  3. I experienced problems while recording the audiotapes. I sometimes failed to work the recorder properly. Once I forgot to press the record button; once I did not hear when the recorder clicked at the end of a tape; and once I failed to notice when the battery ran too low. For each of these incidents, I failed to notice the problem before I lost data. I recalled information shortly after the field visits when these happened. I found that I had fair to good recall of the events if I had any audio/visual clues. So, I listened to the recordings before and after the breaks to help me recall events and discussions. By the next morning, I usually recalled the rest – not verbatim, but as good as any notes I have taken.



4. I had a problem where I had no control. A hacker got into the Metro Environmental computer network. The hacker destroyed their files and set them back significantly on launching VirTechs.

#### Discussion of Analytical Thoughts

- A. What strategies have you employed to analyze your data?
  1. I used several of the strategies noted in our readings for this course to analyze my data.
  2. I reviewed my notes and thought about them from a variety of perspectives. I typed them up as soon after the visits as feasible - usually by the evening but always within a few days while the information remained fresh in my mind. I included reflexive remarks with my notes.
  3. I began transcribing my tape recordings so that I had easier access to that data. I indexed the tapes in 15 minute increments. [Feedback from R. W. Wilhelm, May 12, 2003: "This is an interesting strategy. What does it help you do in terms of data retrieval or analysis?"]
  4. I started the initial coding of my data into categories. I also started to tie the categories into parent/child relationships and patterns.
  5. For the class, I created memos on various aspects. I found this as a wonderful technique to rethink the areas that I wanted to explore further and to think about the environment.

- B. What problems have you encountered in data analysis and how have you attempted to resolve them thus far?
1. The transcription of the tape recordings that I made caused a big problem in my data analysis. I knew that I should finish my analysis as I proceeded, but I had very little time to transcribe even the short visits. I began the transcriptions, but I found that I transcribed them very slowly. Recording the tapes allowed me to concentrate on what happened instead of splitting my attention between recording and observing. I talked to my daughter in Colorado. She volunteered to assist me with the transcriptions. But, I hesitated to let the tapes go for that long. Moreover, I felt that I might need to get to some of the information sent to Colorado. Also, my permission forms and my IRB approval did not explicitly include an outside transcriber so if I used her I faced ethical issues.
  2. Coding took time, but it proved valuable to my analysis. When I started this study, I refused to commit to theory development. With coding, I will reconsider this as a feasible approach in my dissertation.
  3. I regarded finances as another problem. I wanted to invest in the best qualitative analysis software package. My husband recently lost his job due to a company downsizing. I have worked part-time this semester. Our budget did not justify the extra funds for it. From experience, I know that I will face a learning curve and initial time loss with any new software. I have taught

Microsoft® Office® system products and Microsoft Windows® operating system software so I used advanced features in those software programs to input my notes for now. When I can afford new software, I plan to check with my professors to see which software package they recommend as both good and inexpensive. During semester break, I also plan to check with the university computing centers to see what software they have or can order for their labs.

#### Discussion of Data Interpretation

- A. What working assumptions, generalization, or insights about the population and/or social phenomenon under investigation have you developed thus far?
1. I feel that many small businesses like most HVAC companies will slowly but reluctantly adapt to any network technology that they consider as unfriendly and/or fairly expensive. John regards himself as fairly computer literate but he admits to numerous technology problems with the current computer and communications technologies, especially when he combines them.
  2. Few businesses adopt leading edge technology because their processes and/or cost justifications typically prohibit it. Only a few businesses consider VirTechs training as a viable solution yet because of the technology requirements and the overall costs. Other businesses might consider it feasible if Metro Environmental includes technology gurus as part of the

overall marketing package. I feel that once the technologies and operating interfaces become easier and/or more commonplace, other businesses will rapidly adopt the VirTechs processes.

3. VirTechs already saves Metro Environmental money in travel time and expenses that would occur in a typical expert/apprentice scenario.
4. HVAC technicians work in a harsh environment but offset it with a strong sense of teamwork and camaraderie. [Feedback from R. W. Wilhelm, May 12, 2003: "What impact does the new technology have on this aspect of the business culture?"]

B. What questions remain unanswered and what plans do you have to investigate them?

1. I still want to investigate the overall impact of the VirTechs processes. I observed some impact in their use of new call management software. They transitioned to it after a computer virus. I witnessed potential influence in their hiring and retention processes. I noted changes in the environment with job losses for two employees due to the high cost of the technology, the importance of communications, and a loss of trust. One of the two employees, the only bilingual technician, misused a company cell phone without permission for multiple long-distance calls. They fired that technician. Then, they dismissed a non-English speaking technician due to the language communications barrier. I feel that these impacts might signal

the beginning of the system changes. Metro Environmental might experience other impacts as they continue to develop their VirTechs training and processes. Nonetheless, many of these changes and impacts did not specifically result from the VirTechs processes. [Feedback from R. W. Wilhelm, May 12, 2003: "These are important insights and findings that merit further attention throughout the study."]

2. I plan to investigate the impacts as part of my dissertation. Will VirTechs remain a bragging right? Will VirTechs impact the strong camaraderie that I witnessed in the early research?

#### Meta-Analysis of the Project

- A. What insights have you gained about yourself as a researcher who uses qualitative methodology?
  1. I think that overall I rate myself as a good qualitative researcher. I rate myself as good to excellent with analytical skills and fairly good with people skills. I think those benefit me in the long run with the type of studies that I hope to conduct. I also think that the level of professionalism that I instill in my work benefits training studies.
  2. My writing skills benefit my reports on qualitative studies. However, I discovered that I need a quite atmosphere and an intense mental state to write well and communicate with my internal Muse. My Muse frequently

ignores my schedules. My Muse likes to communicate through computers, but I personally get tired of the computer screen and need frequent breaks. Nonetheless, when the pressure gets intense and a hard deadline nears, my Muse usually humors me and we do great work together. I feel that as a team we inspire additional interest in the output from my qualitative study. [Whoops, I forgot to include my Muse on my consent forms!]

- B. In what specific ways has the project helped you to understand the process of and develop skills in qualitative research?
1. I learned so much on this project that it even amazes me. Initially, I felt comfortable after doing some very short studies in Anthropology. However, looking back over this last semester, I feel very glad that I took this course. I have received phenomenal guidance from you [R. W. Wilhelm, my instructor] and others.
  2. I feel better prepared to do a qualitative study and to develop theory from it.
  3. I feel comfortable with the IRB process.
  4. I understand and appreciate coding. I anticipate new software to facilitate it.
  5. I thank you for the great learning experiences.

APPENDIX B

FINAL REPORT FOR SPRING 2004 PILOT STUDY

## Introduction

I completed the following report in spring 2004 as my final report for an anthropology research study on Metro Environmental. For that course, each student submitted a proposal, acquired the necessary approvals, and then completed hours of field research. I used this required field study as an opportunity to do a second pilot study on Metro Environmental and VirTechs as part of the requirements for that course. (Prior to 2007, John called the SightPros-VirTechs system as simply the VirTechs processes.) I used a linguistic perspective as well as the training, educational, and culture perspectives that I had used in the first pilot study.

## Overview

For this class on language and culture, I have taken the opportunity to further study a HVAC (heating, ventilation, and air conditioning) installation and service provider in a large metropolitan area in the southwestern United States. This particular provider has expressed a high interest in computers in general and in using wireless audiovisual links between an expert technician and multiple novice technicians. One of the co-owners of this provider submitted two interesting patents (U.S. Patent No. 6,317,039, 2001 and U.S. Patent No. 6,690,273, 2004) for the VirTechs business/training processes and concepts (Thomason, 1999, 2002) relevant to the service industry. This provider has used the leading edge of technology to further audiovisual communications between remote locations and personnel while providing service to



various types of customers. This provider has broken new ground in a number of areas in the HVAC service industry.

Last summer this provider field tested the patented methods using laptop computers with wireless communications capabilities. The provider found that laptop computers were too bulky and too fragile to successfully negotiate the harsh environments covered by the HVAC service personnel. However, when the telecommunications equipment advances (they expect improvements by the end of 2004), this provider has planned to launch a series of initiatives to use the newest technology along with their patents to achieve a new service standard for the HVAC industry and potentially many additional industries.

In this report, I document the language and culture as it currently exists at this provider. As the new initiatives are launched, I will have a historical "yardstick" to measure language and culture changes due to the new initiatives.

### Background to the Study

As a doctoral student at UNT, I have planned to focus my dissertation on the current culture surrounding the training of a HVAC technician at a small, family-owned service provider business. I have planned my study as a qualitative study. My intent for this study has been to describe the VirTechs training environment – to document it with both narrative and statistical data. I have planned to use two research traditions for this study: a blended application of both the case study and the ethnography traditions. I

have wanted to show perspectives from both emic and etic orientations. This report for this language and culture class now completes the second of two pilot studies that I have planned for my doctoral dissertation.

Thomason (2002) described VirTechs as an Internet video transmission used to connect dispatched HVAC field technicians with an in-office expert using laptops with Webcams to relay two-way synchronous information. The owners/managers of the provider that I have researched started using VirTechs as a way to expand the capabilities of their workforce. As noted before, one of the co-owners holds the patents for the processes.

#### *Experiences I Brought to This Research Project*

I brought extensive experience into this project. I had:

- 2 years installing and servicing Xerox® copiers and fax machines for Xerox Corporation.
- 2 years as a branch specialist (expert) with Xerox Corporation helping their field technicians diagnose and repair complicated machine problems.
- 3 years training Xerox Corporation technicians on copiers at their Xerox International Center for Training and Management Development (XICTMD).
- 14 years writing customer manuals, service manuals, and training programs for Xerox Corporation.
- 1.5 year writing technical marketing materials for RF Monolithics, Inc. (<http://www.rfm.com>), the manufacturer of RFM® wireless components.

- 5 years training applications like Microsoft® Windows® 2003 operating system software and Microsoft Office® 2003 system products to undergraduate students at a university
- Yearly maintenance tasks on my residential HVAC system.
- M. S. degree in Computer Education and Cognitive Systems
- ABD in Applied Technology, Training, and Development with a minor in Anthropology
- 1 year as editor of a national newsletter for the International Platform Association

*My Expectations/Assumptions for This Research Project*

I had a lot of expectations/assumptions coming into this study. Some were based on my previous study; some were forecast due to the nature of this study. My past experience with a major corporation gave me insights that I could share with the HVAC provider. I assumed that I would get full co-operation from the providers since the owners/managers wanted this study accomplished. I expected that this project would be an exploratory study for a 2-year, grant-funded study using VirTechs. I expected that my background in computer technology and service maintenance/training would benefit the HVAC provider. I anticipated that I would not have any personality difficulties with the research participants. I expected to effectively document the VirTechs training environment. I anticipated that the patent holder, one of the co-owners, might publish

parts of the study in their industry magazine. I expected that this project would be part of a book that the co-owners want to publish about their patent and their company.

#### *My Concerns for This Research Project*

I have had a number of concerns regarding this study. To assist the provider at his request, I have worked on a new proposal to meet a pending deadline for a NIST grant. I have addressed potential confidentiality issues of employee information when dealing with the entire company. I have worried about smoking by others since I have had breathing problems aggravated by cigarette smoke. I also have known that my schedule would be busy this semester since I have taken this class on language and culture (which included this qualitative and time-consuming study) while teaching two CECS 1100 classes (that historically have been very grading intensive).

#### *Prior Connections to the Topics, People, or Setting*

I already discussed some of the prior connections to this topic, the people, and the setting. My experiences (see previous listing) included various connections to the overriding service maintenance industry. Moreover, my uncle has owned a HVAC business in Houston so I have hoped that he could give me some input/insights. Although I have met him at family reunions, I seldom have discussed his business with him.

As a homeowner, I have used the services of this HVAC provider over the last 2 years. First, I had them help me with a fan motor problem at my house and then later they installed an entirely new HVAC system to upgrade my home. I have held several

meetings with and have had various other communications with one of the owners in regards to this study and the pending grant application.

*How I Thought and Felt About Any Prior Connections to the Topics, People, or Settings*

I worked in the service departments at Xerox Corporation for over 19 years. Throughout my career, I typically worked as one of a very few females in a mostly male-dominated service environment.

In my first 2 years, some of the local technicians saw me as an affirmative action hire and didn't necessarily respect me until I had the chance to work with them as individuals. Once I worked directly with the technicians, I gained instant respect. Moreover, customers and management quickly identified my advanced skills and promoted me.

My next 2 years as an expert troubleshooter in Xerox Corporation were among the best times of my life. I had a wonderful time communicating with experts at the national level and peers across the nation at various training events and other meetings. My peers and the national experts very quickly noted my expertise and treated me with kindness and respect. Nonetheless, the last few months as a branch specialist, three levels of management changed due to a sexual harassment charge by another female employee. The new management team made a series of poor assumptions and incorrect judgments regarding my own qualifications. My world fell into instant turmoil. After several months of intense scrutiny, they recognized their mistakes but by then I no

longer trusted the new management. They offered and I quickly accepted a promotion to the Xerox International Training Center.

Even 24 years later, that turmoil at Xerox Corporation generated personal concerns about returning to a field service environment, but in the final analysis, I believe that it has not impacted this study. I have felt that I related well to the technicians and management at this HVAC provider. My field and training experiences have added to the positive rapport that I have established in this study. The female vice-president/co-owner has worked as part of the office staff and also has been intimately familiar with the life of a HVAC field technician. We both shared stories of working in non-traditional roles. She totally related to my experiences of life as a female in a mostly male environment.

This HVAC provider has been a successful small business. I have looked forward to seeing what has made it successful and to working with positive, forward-thinking individuals.

#### *Why I Chose This Topic and Setting*

I have chosen this topic and setting for a number of reasons. One consideration addressed timing. Several years ago, VirTechs had not developed enough to study. However, another planned topic, use of three dimensional (3-D) graphics in training, interested me and my major professor. But, that major professor left the university and my new major professor did not support my original topic. As I searched for a new topic, I had the opportunity to contact this provider again and everything seem to gel. I liked

the people I met at this provider. The president/co-owner appeared very computer literate, wrote for an industry magazine, and we seemed to connect at an intellectual as well as a business level. I have loved both computers and research. I have believed that computers work as great tools for learning. I have felt that VirTechs represented a fascinating application of streaming video and in a fascinating educational setting. This HVAC provider has functioned as the only company currently using VirTechs and they held the patent for it. Moreover, this provider seems convenient to my home and to my schedule.

*How Did All of the Above Impact the Way I Approached My Research*

I felt that I brought my experiences and knowledge to the HVAC provider and this project. My experience and the HVAC setting seemed ideal for a collaborative research study. I loved the people contact and the deeper understanding of the data that seem inherent in a qualitative study.

My mother worked as a chemistry teacher and loved scientific research and analysis. She always encouraged my WHY questions. Mother taught me how to maintain our home furnace and encouraged me in science and math courses. This gave me the technical knowledge to get hired at Xerox Corporation as a technician. Throughout my life, I have continued to ask the WHY questions and to seek answers to them. This search for new answers has been how I have approached my research in this study.

### *Field Site Visits for Anthropology 5910.705*

Prior to the study, I planned for two field site visits to videotape sessions with the technicians. I planned to attend a training session on safety with the president/co-owner and the 4 current technicians as my first session. I planned either a field visit or another training session as the second session. I wanted to begin to examine their language usage as relative to their expertise in the HVAC field. I completed one customer visit and one demonstration of the VirTechs application.

### *Description of the Group*

The HVAC technicians at this provider were typical service personnel. They had served a minimum of 2 years in training/apprenticeship positions before being considered for promotions as their skill levels increased. Some were certified using various industry level testing. All of the technicians were male Caucasians. During the study, the office included the president/co-owner, the vice-president/co-owner, the dispatcher, and the salesman. The office staff changed shortly after my study due to a major cutback in a large corporate contract.

### *The HVAC Provider Culture*

The culture at a typical HVAC provider has been influenced by many variables. A few major influences have been the:

- Service industry work and social environment,
- HVAC work and social environment,



- On-the-job apprenticeship training,
- Small-business environments,
- Knowledge management trends,
- Communities of practice (Lave & Wenger, 1991),
- Expert and novice interactions and levels of expertise,
- Knowledge hoarding, and
- General systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et al., 1999; Smith & Ragan, 1993).

In the rest of this section, I will briefly address each of these issues and provide quotes about each from some of the current literature.

#### *Electronic Service Industry Work and Social Environment*

The broad electro-mechanical service industry sets up a number of expectations regarding anyone in that industrial environment. Orr (1996) in a major qualitative study found that Xerox Corporation technicians shared "war stories" about various machines, accounts, customers, managers, and other technicians. He noted:

Technicians' discourse reveals that they value most highly those attributes that contribute to the preservation of order and understanding. Reputations are built on technical skills, memory, ability to gather information, verbal performance, and the general ability to retain control of the situation. (p. 144)

There is an existential dilemma at the heart of service: the technicians are responsible in a world in which they have very little control. Their job is to respond to trouble and to anticipate and avoid trouble when they can, but the setting in which they perform is largely constructed by other people, is inhabited by other people, and is inherently unpredictable. (p. 158)

In my previous experiences at Xerox Corporation and my recent study at this HVAC provider, I witnessed similar behavior in similar situations.

### *HVAC Work and Social Environment*

The Bureau of Labor Statistics at the Department of Labor (2003a) researched and wrote extensively on the HVAC industry. They noted that the work environment for the HVAC industry:

- Required lifting and moving heavy equipment
- Felt physically uncomfortable
- Included possibly dangers
- Required frequent overtime or irregular hours
- Required continuous training and licensing
- Interfaced directly with the public and possibly aggravated customers
- Required certification if working with refrigerants

Along with this tough work environment, the service trades technicians faced a poor public image of their social environment:

It appears that here, a stigma is being cast upon construction trades as low paying, manual, thankless, outdoor work rampant with drug and alcohol abuse. . . . The term “construction worker,” embodied as the unskilled manual laborer, has negative connotations for young people. To youngsters, “construction workers” are ditch diggers they see calling obscenities to passers-by, loafing on the job. Most commonly associated with dirt, sweat, and a gruff demeanor, the construction worker lacks prestige, class, and respectability. (Rosenthal, 1990)

### *On-the-Job Apprenticeship Training*

The Bureau of Labor Statistics (2003a) also noted that many HVAC employees still learned through informal, on-the-job training. But, HVAC units had become so sophisticated that employers preferred to hire technicians who had either attended technical school or had previous apprenticeship training. Training came from a variety of organizations and affiliations. Typically it took from 3 to 5 years to complete most formal apprenticeship training. The technicians' wages increased as they increased their skills. Advancement opportunities included supervisory or management positions, crossover positions such as sales and marketing, teaching, small business ownership, etc.

Nolan (1996) noted that apprenticeship training for skilled crafts and trades ranks as probably the earliest documented training methods. He distinguished apprenticeship training as allowing the apprentice to become skilled in one of many areas instead of learning specific tasks within one job. Nolan gave 4-7 years as the typical apprenticeship "contract for training" made between the employers and the worker during which time the apprentice made only about half the salary of a skilled craftsman/journeyman in exchange for the learning experiences. The typical scenario depicted an apprentice as receiving shop instruction from a craftsman and supplemental, formal classroom instruction from a technical school. Nolan noted that in some instances automation and changing technology made some apprenticeships obsolete by the time they completed their training. However, he also stated that a good

apprenticeship program seemed like an excellent way to acquire highly complex skills and that apprenticeship training had many useful years ahead.

### *Small-Business Environments*

Like this service provider, most HVAC service providers have functioned as small, independently-owned businesses. Broadwell (1996) noted that small business owners/managers often had the same training needs found in larger businesses, but they lacked the trained or dedicated staff to make it happen. Moreover, the owners found it hard to spare employees long enough to send them away to a formal training class. In a small-business environment, the typical trainer had many other job responsibilities on top of the training tasks so their instructional skills might be weak. Broadwell wrote that generic training programs seldom addressed specific tasks needed within their business. Nonetheless, Broadwell summarized that training must occur for the business to survive well and the training that occurred needed evaluation.

### *Knowledge Management Trends*

Efficient knowledge management has helped the typical HVAC provider get critical information on an as-needed basis. Effectively using knowledge management has increased customer satisfaction and employee satisfaction. Hoefling (2001) in describing knowledge management summarized that:

Knowledge management goes beyond the capture, storage, and retrieval of information. It is a way of helping the organization unbury the hidden treasure of knowledge that lie in people's minds (tacit knowledge), and make that knowledge accessible to a larger group of individuals who are responsible for acting and deciding in the best interest of the

organization. The virtual environment provides an incredible opportunity to capture knowledge through informal exchange among team members because much of the exchange is captured through email, web conferencing, bulletin boards, and chat rooms and other discussion forums. . . . As more organizations are at least partially virtual, the virtual manager's ability to manage the relationship between knowledge management and virtual team collaboration becomes even more critical. (p. 166)

In discussing technology, Hoefling (2001) noted that organizations that wanted to maximize the work use of virtual teams should make the most of relationship tools such as "web conferencing and other groupware tools ( that) build trust, relationships, and interdependence among team members in ways that are - or soon will be - indispensable tools in any organization" (p. 54).

### *Communities of Practice*

Lesser, Fontaine, and Slusher (2000) wrote that organizations "have begun to recognize that knowledge critical to business success is often created and shared by informal groups of individuals with common work practices and interests. . . . These communities . . . [have preserved] valuable insights that can be easily lost in an age of employee mobility and early retirement." (p. vii)

HVAC providers have been most successful when they have formed strong communities of practice (Lave & Wenger, 1991) among their personnel. Wenger, McDermott, and Snyder (2002) discussed community of practice as follows:

[They are] groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis. . . . As they spend time together, they typically share information, insight, and advice. They help

each other solve problems. They discuss their situations, their aspirations, and their needs. They ponder common issues, explore ideas, and act as sounding boards. They may create tools, standards, generic designs, manuals, and other documents--or they may simply develop a tacit understanding that they share. However they accumulate knowledge, they become informally bound by the value that they find in learning together. The value is not merely instrumental for their work. It also accrues in the personal satisfaction of knowing colleagues who understand each other's perspectives and of belonging to an interesting group of people. Over time, they develop a unique perspective on their topic as well as a body of common knowledge, practices, and approaches. They also develop personal relationships and established ways of interacting. They may even develop a common sense of identity. They become a community of practice. (p. 4-5)

#### *Expert and Novice Interactions and Levels of Expertise*

Like this HVAC provider, apprentice training in the typical HVAC provider has consisted of a highly experienced individual (considered an expert) who has trained a less experienced individual (considered a novice). Trainers and/or other associates who have ranked a person as an expert or as a novice have often judged their expertise on experience with specific tasks or situations. Sternberg discussed these differences and how they have related to intelligence as follows:

Each of us faces tasks and situations with which we have varying levels of experience, ranging from a completely novel task, with which we have no previous experience, to a completely familiar task, with which we have vast, extensive experience. As a task becomes increasingly familiar, many aspects of the task may become automatic, requiring little conscious effort for determining what step to take next and how to implement that next step. A novel task makes demands on intelligence different from those of a task for which automatic procedures have been developed.

According to the triarchic theory, relatively novel tasks – such as visiting a foreign country, mastering a new subject, or acquiring a foreign language – demand more of a person's intelligence. On the other hand, a

completely unfamiliar task may demand so much of the person as to be overwhelming. (1996, p. 480)

In the HVAC industry, various organizations have provided testing and certification to help discriminate a technician's level of expertise on various HVAC required tasks.

### *Knowledge Hoarding*

Argall (2002) in a discussion forum on knowledge management noted some reasons why experts might resist sharing their knowledge:

One reason why people hoard knowledge is because it makes them important and a valuable asset to a company. They are reluctant to share the information because it reduces their power and importance within the company. Although they receive compensation for their consulting work, they do not receive rewards directly tied to sharing their knowledge. Unless experts feel that they are compensated for their knowledge, they will always be reluctant to share it. This is where the performance evaluation criteria come into play. If you want to be promoted, you must share your knowledge. (¶ 4)

The successful HVAC provider has wanted to find experts willing to share their knowledge. By building strong communities of practice (Lave & Wenger, 1991; Lesser, Fontaine, & Slusher, 2000; Wenger, McDermott, & Snyder, 2002) within their organizations, the owners/managers should find that the problem of knowledge hoarding should diminish.

### *General Systems Theory*

Smith and Ragan (1993) discussed the general systems theory proposed by Bertalanffy (1968). They noted that when any element in any system changed, the change also impacted the interdependent components of the system.

Moore and Kearsley (1996) categorized five of the elements of a distance education system as:

- Content experts and other sources of knowledge,
- Course design expertise,
- Communication of information,
- Interaction and management via technology, and
- Learning environments.

They agreed with Smith and Ragan (1993) when they stated:

Changes in one component of a distance education system have immediate effects on all of the other components. . . . Distance education should be conceived of and developed as a total system, giving equal attention to all the above interacting components if it is to be practiced successfully. Paying attention to one of the components without regard to the others is a recipe for disaster. (p. 13-14)

Therefore, I have hypothesized that when this provider and/or any other HVAC provider have planned to use new computerized training scenarios then anyone and anything connected to the provider could experience additional impacts. I have predicted that the impacts should be most pronounced on the people closest to the training - the managers, the experts and the trainees, but that any person in the



company could feel an effect. For instance, the dispatcher might need more awareness of trainee problems or customer complaints. The accounting personnel might need procedures that accommodate the less experienced trainees doing more “expert” tasks. Recognizing those potential impacts, I have felt that even my presence could impact their overall system.

### *Summary*

In summary, I have found many variables of interest as I have studied the culture surrounding this HVAC provider. Those variables have become especially interesting due to changes in the overall business and culture at this HVAC provider.

### *Field Visits*

As part of the language and culture class assignments, I spent a half-day at this service provider on each of two different dates. On the first half day I visited multiple sites. On the second half-day, I full scrutinized the home office location while I observed a VirTechs demonstration. For each visit, I took a digital MiniDV camcorder for video recording and a small audiotape recorder for capturing additional audio. At both visits, I used the camcorder to help map the sites and to take notes.

### *Field Visit 1*

My first field visit occurred on February 12, 2004 between 8:00 a.m. and 1:00 p.m. I observed work related activities by the service department of this small HVAC provider such as the startup for the replacement of a residential split system.

### *Description of the Location(s)/Setting(s)*

The entire field visit included four significant location(s)/setting(s). I started at the headquarters of this service provider. Then, the president/co-owner drove us to the customer's location. On the way back to the office, we stopped at a local retailer.

Headquarters (see Figure B1): Metro Environmental located their headquarters in a small business strip with about ten businesses located in two parallel buildings that faced each other. They had picked a location just off of a major highway and about half a mile from a major interstate in the suburbs of a large metroplex. The buildings looked like tilt-concrete wall construction. The headquarters contained:

- Central office: This area was a large room that housed both the vice-president/co-owner and the dispatcher. It provided access to a warehouse with a drive-in storage area. Everyone used it as a meeting spot. Decorations ranged from stuffed animals and plants to Van Gough prints. The room contained a large refrigerator, standard office equipment including a copier, a fax machine, two large desks and chairs, two desktop computers, storage cabinets, and bookshelves.

Warehouse storage with a drive-in entry: This area had an outside entryway with an automatic garage door and two entrances to the offices. The room was large and empty enough for the service trucks to drive in. This provided a convenient loading facility especially during bad weather. The provider stored parts needed for service and for training in this area.

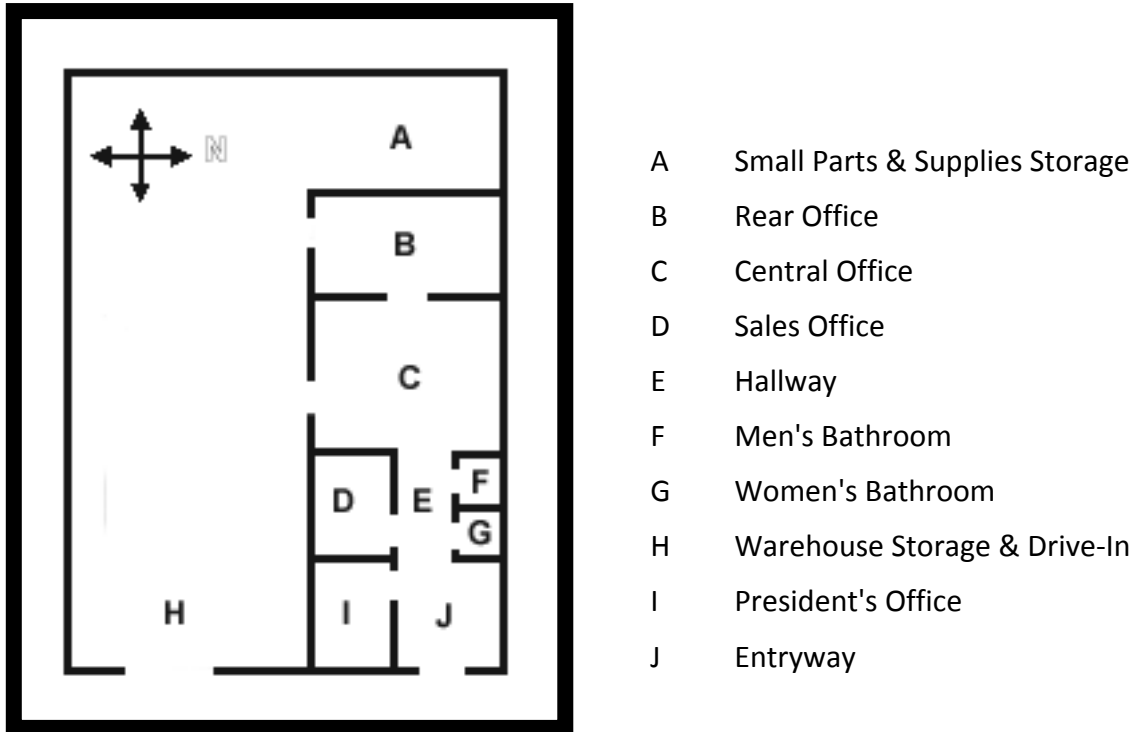


Figure B1. Map of the business headquarters in the 2004 study.

Company car: This vehicle was a Ford Thunderbird that belonged to the vice-president/co-owner. The car was a comfortable, but sporty model. The interior and exterior were black. The seats were leather. The president/co-owner borrowed it from his wife to drive us to the customer's location and then to a local business for copies.

Trucks: The technicians for the HVAC business parked their trucks in front of the customer's house. I noticed four company trucks, one with a trailer, parked out front when we arrived at the house.

Customer's home (see Figures B2 and B3): This home was a nice home in a local suburb. I noted several important areas connected with this home:



*Figure B2.* Photograph of the customer home in the 2004 study.

- Dining room: The entry way of the home essentially opened into a dining room. This room contained a large formal table and a buffet. The customer offered the table top to us for use as needed. The rear of the dining room gave access to an atrium and the backyard.
- Hallway: The hallway was long and essentially void except for a thermostat, some wall hangings, and the doorways to the children's bedrooms and bathrooms. The technicians gained access to the attic from a pull-down stairway in the hall ceiling.

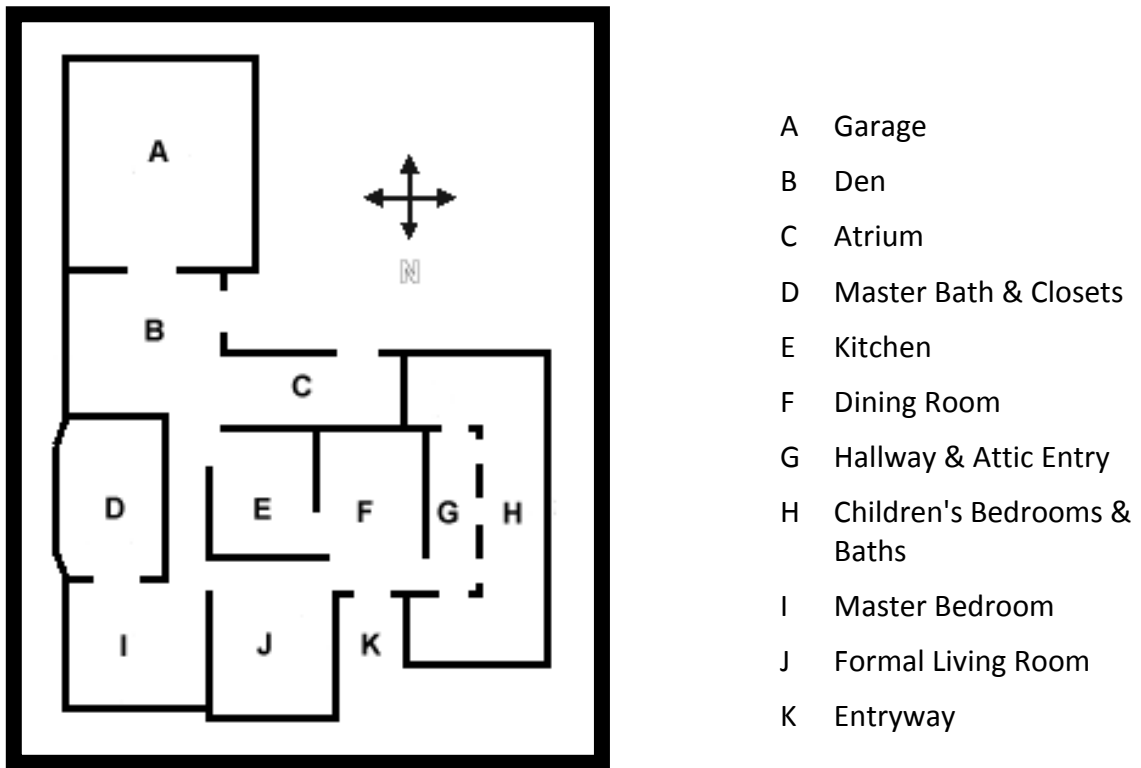


Figure B3. Map of the customer home in the 2004 study.

- Attic: The attic appeared as a large area, but without any walkways or flooring. The technicians installed some wooden plywood so that they could comfortably move and work in the area. The HVAC unit hung sideways but loosely by metal strips from the roof. I calculated the space between the bottom of the HVAC unit and the ceiling joists at approximately 2 feet.

- Living room: The customers had decorated their living room as a formal area. They used the windows in it to observe the service personnel as they unloaded and unpacked the new HVAC units.
- Master bedroom and bath: We accessed the master bath through the master bedroom. The master bath had a problematic air vent in the ceiling.
- Den: The den was used for the customer's home office area. It also served as the TV room and had a nice fireplace.
- Garage: The entry to the garage was at the rear of the den.
- Outside condenser: The condenser, located on the right side of the house behind a wooden fence with a large gate, seemed like a large unit because of its size.

Office Depot: This office supply firm contained a copy center. We used it to run copies of several journal articles that I shared with the president/co-owner and for which he indicated an interest. The layout looked typical of other Office Depot locations. It had two self-serve copiers and a work area to sort, stack, staple, etc.

#### *Description of the Participants*

I met many participants throughout this field visit. In the descriptions below, I include the personnel and the customers associated with the HVAC provider. I do not include the Office Depot personnel. The participants included:

- President/co-owner: The president/co-owner looked like a Caucasian male approximately 50 years old. His attire looked business professional. He acted

pleasant. His personality seemed friendly and outgoing. He talked about himself as a strict disciplinarian with his employees regarding certain matters since he needed to run a professional business. He talked about working one year as a high school teacher educating students enrolled in trades and industrial classes so he felt comfortable about teaching/training his employees, his customers, and me. He worked as a HVAC technician before starting his own business. He later moved his business to this area of the state. He seemed highly computer literate and obviously loved to keep his business on the leading edge of technology. His inventiveness earned him two patents for using wireless technology to train field employees from a remote location.

- Vice-president/co-owner: The vice-president/co-owner looked like a Caucasian female approximately 50 years old. She dressed in business casual. She seemed pleasant but not quite as outgoing as her husband, the president/co-owner. She managed numerous tasks including the bookkeeping for the company. She talked about her children: a boy and a girl in their late adolescence. On an earlier visit, I observed her baking cookies for the personnel and visitors.
- Dispatcher: The dispatcher looked like a Caucasian female approximately 55 years old. She dressed in business casual. She seemed pleasant but somewhat shy or reserved. She acted very protective of both owners. Her

husband worked there as the corporate salesman for the company. She smoked cigarettes.

- Tech 1: This technician looked like a Caucasian male approximately 25 years old. He had a slight build. He wore a baseball cap with his uniform. He seemed friendly and pleasant. He still worked as their apprentice but had several years experience. His father worked there as a HVAC technician and so did his father's good friend (Tech 2).
- Tech 2: This technician looked like a Caucasian male approximately 40 years old. He had a heavier build than Tech 1, but muscular, not heavy set. Tech 2 also seemed pleasant. He had a lot of experience as a HVAC technician. He had worked for this company for many of those years.
- Tech 3 and Tech 4: These technicians looked like Caucasian males approximately 30 years old. They had slender builds. They had years of experience as technicians. They had worked for this HVAC business for about 7 months. They were brothers.
- Customer 1: This customer looked like a Caucasian male approximately 40 years old. He dressed casually. He seemed friendly, helpful, and offered to assist as needed, but he stayed out of the way of the work in progress. He worked from this location, his home.
- Customer 2: Customer 1 introduced this customer as his wife. She looked like a Caucasian female approximately 40 years old. She dressed in business



attire. Her communications seemed well organized like that of a business professional or teacher.

- Customer 3: Customer 1 and Customer 2 introduced this customer as their child. He wore pajamas when we first arrived but later changed into play clothes for his preschool. He seemed like a friendly 3-year old.

### *What Happened*

When I arrived at the business at 8:00 a.m., I found all of the personnel in the central office except the salesman. The salesman had left already for the day's business calls. The president/co-owner had just finished going over the plans with the technicians and the office staff. He seemed ready to get out to the customer location to manage the replacement of an existing, but non-functional HVAC system. The office staff confirmed that the customer expected their arrival.

The president/co-owner introduced me to the two technicians whom I had not met during my previous study. He briefly discussed the study with them and we got verbal permission from them. He also reintroduced me to the technicians I already knew since I had not seen them in the last 9 months and he did not know if I would recall their names. He clarified the plans for the next few hours with the office staff. He then took the service technicians to the storage/loading area of the building. They organized the materials and tools they needed for the day and discussed work plans for the customer account. Then, we all departed for the customer location.

The president/co-owner suggested that I ride with him so that we could discuss the pending call on the way. He told me that he had not yet covered the study with the customer, so he would need to discuss it with them first and if they felt o.k. with the study, then I could do my thing. He clarified that he did not want to mention actual training of the technicians at the customer site as it might give a poor impression of his personnel and his business.

At the customer location, the technicians unpacked their tools and HVAC units from their trucks. They had not contacted the customer yet. The president/co-owner and I knocked on the front door while the technicians stayed around the trucks. Customer 1 answered the door and then invited us to join him in the dining area as he supervised Customer 3 as the boy finished his breakfast of cereal and milk. The president/co-owner discussed the study as part of my initial introduction to the Customer 1.

The president/co-owner summarized to Customer 1 the planned activities that would occur. Customer 1 questioned whether he should remove the rug at the entryway. They agreed that it would be a good idea, but that the technicians would also use drop cloths on any carpeted areas to keep the traffic areas clean.

Customer 3 finished breakfast about the time Customer 2 entered and welcomed us. After a brief discussion of the study and after signing the permission form, she mentioned her concern about the master bathroom area and the air flow into that area. We all went that direction to look at the problem. The president/co-owner

clarified that because of the new ductwork they planned to install, the technicians could balance the airflow throughout the house. Therefore, she could expect improvement for that problem. She then discussed her concern about the new thermostat for the new system. She asked whether it could be preprogrammed to adjust for automatic change in operation for different time frames. She also asked if someone could show Customer 1 how to program it. The president/co-owner clarified that the technicians would set it for them, but they would also teach him how to modify it as needed. Within about 15 minutes she left to take her Customer 3 to preschool.

The president/co-owner of the HVAC business basically knew the layout of this house and the accesses to the HVAC system since previously he had bid the job with the adult customers. The president/co-owner typically bid all of the residential accounts and used the company salesman only for their corporate customers.

The technicians entered and began placement of the drop cloths and checked out the access to the attic. The president/co-owner helped me to place my digital camcorder in the attic. The technicians discussed the removal of the old attic unit and then quickly removed it. The president/co-owner brought the camcorder down and then we took video of the outside condenser. The president/co-owner and I left the customer location and headed back towards the office.

On the way back to the office, the president/co-owner showed me the location of his planned meeting the next week with a vice president of the wireless division of a local telephone company. We discussed making copies of some articles that I had

brought and that I felt might seem relevant knowledge prior to his meeting. He had a copier at his office but it copied slowly. I preferred a quick, two-sided copy job. We stopped at Office Depot on the way back to the office so that I could quickly make copies of the articles for him.

When we returned to the office, the president/co-owner made copies of the job site location and a map for me to use for my return that afternoon. He called the technicians and told them I needed to come back so that I could get them to sign some paperwork.

I returned to the job site, discussed the study in more detail with the new technicians including the concerns for their protection and then got their written permissions. I noticed that they already had installed some plywood flooring on top of the attic joists so that they had better footing to work. They continued to work while I discussed the study and answered their questions. They seemed quite adept at switching between work conversations and casual/friendly conversations. I departed shortly after I received the written permissions.

*Relevant Feelings, Intuitions, Ideas, or Analyses I Had During My Observations*

I felt very awkward about recording technicians with just their verbal permissions. I should have had the permissions slips signed well before they started working at the site. However, I knew that I could always trash the data that I had collected if they did not sign the permission forms and/or if they felt uncomfortable with the study.

Much of the communications between sites and even on-site occurred over the cell phones with Direct Connect® features (Direct Connect operates similar to two-way radios.). I needed to find a way to hear and tape their full conversations.

The technicians appeared to work well together with minimum negotiations on which tasks to accomplish. The communications and teamwork seemed friendly. However, I had minimal one-on-one contact with the technicians at the early morning visit because the president/co-owner was such a dominant presence. I felt tired and didn't have time to stay after getting the signatures on the second trip so I did not observe them at work for very long.

I wanted to observe the technicians more so that I could analyze their level of knowledge as it related to the VirTechs environment of experts training apprentices. I noted that all of the technicians on this job seemed fairly skilled. However, my findings came mostly from the reported skill levels and only slightly from the actual skill levels that I observed. I hoped that through the linguistic study of their taped conversations, that I could clarify/confirm my limited observations.

I realized that the arthritis in my knees made access to their work sites much more difficult for me. My arthritic pain has increased over the last year. For this study, I bought a small portable camp stool so that I could sit and take some of my body weight off of my knees. At Xerox Corporation we had called this condition "tech rep knees" because over the years almost all technicians developed pain due to the extra weight of the tool bags and the frequent need for stooping, squatting, and bending.

I now had observed two installations over my two studies. Some of the same personnel did both installations but I also met with some new team members. I felt that this team seemed quieter with less joking than during my previous observations. I wondered whether it indicated a difference in personalities or whether it indicated a difference in attitude, relaxation, and/or teamwork. I felt more familiar with the technicians involved during the first installation which might have given them more confidence in my presence. For this second installation, I had no previous relationship with two members of this team. If I had more of a prior relationship with them, it might have allowed all of the participants to relax and open up.

The president/co-owner seemed excited about the articles we copied for him. Nonetheless, he misplaced them by the time we discussed them back at his office. I left my original copies overnight and then picked them up the next day. By then he had found the missing copies above the visor in the car.

The president/co-owner felt discouraged that the NIST grant opportunity might not open up this year. He had expected it to open already and expressed concerns about it because of the national deficit and the cost of the war with Iraq and Afghanistan.

My usage of both the audiotape recorder and the camcorder proved beneficial in that I recorded data from multiple locations at one time. However, it also proved difficult in that I recorded data that I did not observe directly. That increased the

probability of problems at the end of the tapes and delayed my analysis after the actual field visits.

### *Field Visit 2*

I made a second field visit on February 18, 2004 between 10:30 a.m. and 11:45 p.m. and then later that same day between 3:00 p.m. and 5:15 p.m. My planned activity included an attempt to capture a demonstration using streaming video communications for a meeting between the president/co-owner of the service provider and a vice-president at a major communications provider. For the demonstration, the HVAC provider simulated a home or office setup with a dummy condenser repair. I had extra time to observe so I also mapped more of this location.

### *Description of the Location(s)/Setting(s)*

Headquarters (see Figure B1): This second field visit mostly occurred at the headquarters location. I also made a quick trip to a local retailer, but I do not describe that setting in any detail. Also, I described some of the headquarters in the first field visit so I include here only my additions to those earlier descriptions. The entrance to the headquarters was located on the west side of the complex, but on the east side of the building. The headquarters consisted of the following areas:

- **Entryway:** This was a small area with a glass door; two chairs; a coffee table with plants and potpourri; an end table with a plant; several tall plants and trees; pictures; two certificates; and entrances to the hallway and to the president/co-owner's office. The entrance wall had a window of the same

size as the door. The common wall with the president/co-owner's office had a 6-ft wide x 3-ft. high chest-level opening (not a window). Today, there was a condenser positioned on the floor towards the northwest corner.

- President/co-owner's office: This office appeared as a small, crowded office. A large credenza with a bookshelf decorated the South wall. The president/co-owner had placed his desk and chair directly in front of that. The president/co-owner had positioned them so that they faced away from the credenza and towards the entryway. He had set his computer monitor on top of the desk directly in front of him. The systems unit of his computer laid on the floor to the east of the desk. A guest chair embellished the east side of the room between his desk and the entryway. That day, a tripod with a Hi-8 camcorder blocked the pathway to the chair. The camcorder pointed towards a condenser that the technician had placed in the entryway. Behind the guest chair, vertical mini-blinds covered a large glass window. Predominantly, an 18-inch stuffed gorilla adorned the top of the bookshelf.
- Sales office: The salesman's desk, credenza, and chair sat in approximately the same locations as in the president/co-owner's office. However, the credenda did not include the additional bookcase. Instead, he had placed a short bookcase on the west wall next to his chair. His had put his computer on top of the credenza, essentially behind him when he sat at the desk. He also had put an electronic air filter on the credenza. He had positioned a



guest chair on the northwest side of the room. He had set a silk Ficus tree behind the guest chair. He had placed a coat stand in the southeast corner of the office. He had situated a dominant, flowing-haired bust of Nostradamus in the southwest corner of the office. He had displayed several Marine Corps memorabilia such as a marble pen holder with an eagle, a Marine Corps plaque, and a world globe around the office. His office opened into the hallway.

- Hallway: The hallway was a short pathway to the central and rear offices. There were also two additional doorways to two bathrooms: the ladies' room and the men's room. Mounted on the wall between the bathroom doors were a coat and hat rack (wooden with a heart design) and a motivational cloth hanging of a frog.
- Central office: I described much of the central office in the first field visit so I include here only my additions to those earlier descriptions. The vice-president/co-owner and the dispatcher sat towards the west wall, but faced the east wall. They sometimes watched a television that they had mounted on the east wall. Today they had the television turned off. On other visits, they turned on the television and listened to it as they did their work. Other items that I noticed this time, but failed to mention in the first field visit included a bottled water dispenser, a smaller desk without a chair, 2 guest

chairs; file cabinets, a coffee maker, computer networking equipment, and telephone switching equipment.

- Rear office: This office was a large office. It had two doorways, one to the central office, and one to the drive-in storage area. It was as wide as the central office, but not as deep. This office stored a lot of the current business records. It also contained a storage cabinet, 8 file cabinets of various sizes, a sofa, an electronic air filter, a desk, a long work table, a computer, a calculator, etc. Nobody used this office during this site visit.
- Warehouse storage with a drive-in entry: I described some of this area in the first field visit so I include here only my additions to those earlier descriptions. In this area, they stored disposable filters for a wide variety of HVAC units. It contained a huge table for shaping ductwork. It housed a hydraulic lift for moving heavy items. It had a commercial icemaker that provided ice for the technicians during the hot weather. They connected and used it during the summer season, but it was not connected now.
- Small parts and supplies storage: This area housed four large metal racks that contained the smaller parts and supplies needed for their business and customers. Also, it contained several work benches and approximately 12 years worth of historical company paperwork.

### *Description of the Participants*

The entire field visit involved multiple participants. I described most of the participants in the first field visit so I include here only my additions to those earlier descriptions:

- President/co-owner: I described this individual in the first field visit so I include here only my additions to those earlier descriptions. The president/co-owner was mostly pleasant, but slightly nervous today because of a pending meeting with the vice-president of a major telecommunications corporation. His attire was CEO business attire: expensive black suit and vest, white shirt with cuff links, and a conservative tie.
- Vice-president/co-owner: I described this individual in the first field visit so I include here only my additions to those earlier descriptions. The vice-president/co-owner dressed in business casual again today.
- Dispatcher: I described this individual in the first field visit so I include here only my additions to those earlier descriptions. The dispatcher smoked, but not during this visit. She also dressed in business casual today.
- Salesman: The salesman was a Caucasian male approximately 55 years old. His customers were corporate CEOs so he walked and talked the part. He had both a country club personality and attire in that he sported a better-than-the-rest attitude and stature plus an air of posh elegance. He dressed with a

lot of expensive, gold jewelry such as rings, a masculine bracelet, cuff links, tie bar, etc.

- Tech 1: I described this individual in the first field visit so I include here only my additions to those earlier descriptions. Tech 1 acted camera shy since he didn't talk much when he noticed or remembered the camcorder.
- Tech 2, Tech 3, and Tech 4: I described these individuals in the first field visit so I include here only my additions to those earlier descriptions. My only contact with these technicians on this visit was listening to them through their two-way communications with the staff.

### *What Happened*

When I arrived at the business at 10:30 a.m., the president/co-owner was in his office. The vice-president/co-owner and the dispatcher were at their desks. Tech 1 was in the central office. The salesman and the rest of the technicians were in the field (out of the office).

After everyone exchanged greetings, the president/co-owner and I talked about the camcorder setup. The president/co-owner had positioned his Hi-8 camcorder in his office, but he did not know where to find his Hi-8 tapes after their recent move to this location. I had brought tapes for my MiniDV camcorder, but I didn't have any Hi-8 tapes. Since I wanted to tape both the situation and the VirTechs training, I made a quick trip to a nearby store so that we could get both camcorders loaded and operating before the

president/co-owner had to leave for his appointment. He planned to leave at 11:00 for an 11:30 meeting.

By the time I got back from the store, the demo had been delayed until 3:30 due to a crisis with the schedule of the customer - the vice president of a major telecommunications corporation. I stayed and talked briefly with the president/co-owner long enough to set up the Hi-8 tape and go over the tape operation. Then I left with the intention to come back by 3:00.

I arrived back about 2:45 p.m. and exchanged greetings with everyone in the office. I brought in my camcorder and audiotape recorder. I left the audiotape recorder running and set it on an open area next to the Hi-8 camcorder.

I went to see when the president/co-owner planned to leave. His allergies had flared up so we discussed his medication for them. Tech 1 entered from outside. I then questioned the president/co-owner on whether he wanted to kill some time by giving me a tour of his warehouse/storage area. He opted to do the tour.

I used the tour and some extra time a little later to take video of the following areas. This gave me an accurate map of the premises. It also captured the office attire and posture of the participants.

- Office complex
- Entry way
- President/co-owner's office
- President/co-owner's computer setup

- The Hi-8 camcorder setup
- Salesman's office
- Hallway and bathrooms
- Central office
- Telephone and network connections
- Rear office
- Warehouse
- Small parts and supplies storage
- Outside lighting and telecommunications towers

At the end of the tour, there was a brief office conversation regarding appointment cancellations and then the president exited the building. Outside, he talked briefly about his daughter before leaving for his appointment.

While everyone waited for the phone call from the appointment, the staff and Tech 1 talked about the owners' daughter, her Motocross biker friends – one who had recently died, and the Motocross dangers.

The refrigerator compressor started and sounded so loud that I commented about it. We held a brief discussion about refrigerator and icemaker noises.

The conversations continued, but now turned to a mustang owned by Tech 1. Then, Tech 1 moved back into the entryway and I followed. We discussed the strength of various cell phone signals and various "dead zones." I videotaped the certificates hanging on the wall there and a little more of the salesman's office.

The call came in to turn on the Hi-8 camcorder in preparation for the demo. We checked the camcorder and started the Hi-8 tape.

I recorded the telephone/Internet connections in detail. I also recorded some more details in the president/co-owner's office such as a license for business operations which showed the office address. I wanted that detailed address to help me find building plans on the Internet.

I utilized my MiniDV camcorder throughout most of the visit with only short pauses to change tapes or as requested to stop the video. I took additional shots of the computer screen and recorded the demo. I also recorded the telecommunication satellite antenna which operated outside the front entryway. Tech 1 and I talked about getting paid for standing around. A cold-call salesperson (an oriental male about 40 years old) stepped into the office, but the vice-president/co-owner turned him away.

*Relevant Feelings, Intuitions, Ideas, or Analyses I Had During My Observations*

My camcorder did not have a date and time setting so I recorded my own watch several times during the taping process. I liked that and felt that I should do it more. That helped me later to document the exact times.

Much of the communications between sites and even on-site occurred over the cell phones. I still needed to find a way to hear and tape both sides of the cell phone conversations.

The technician's communications remained brief – probably due to the remote, wireless connections. Moreover, I had only minimal one-on-one contact with one

technician at this visit and because they staged the work situation for the demonstration, I did not have much observation of the technicians at work in their natural environment.

I still felt that I needed to observe the technicians more so that I could analyze their level of knowledge as it related to the VirTechs environment of experts training apprentices. At this time of the year, it appeared that the company employed fairly skilled technicians. However, this was mostly their reported level of skills and not the actually observed skills. I still hoped that through the linguistic study of their conversations, that I could clarify/confirm this.

I still felt that the arthritis in my knees was going to make accessing their work sites much more difficult for me. I dreaded the customer site visits during the hot summer. Since I was in their office location with available chairs, I left my portable stool in the car. As I watched Tech 1 setting up the demonstration, I remembered that the technicians did most of their working either standing, kneeling, or squatting. I had noticed on the first site visit that stairs also become a problem for me.

The president/co-owner was suffering with a severe allergy problem. I remembered a slight allergic condition on my last visit, also. I wondered if the allergies were a by-product of working in the dusty and moldy environments of the HVAC industry.

I was familiar with the Tech 1 which gave him confidence in my presence. However, he acted camera shy since he didn't want to talk when we operated the



camcorders. He did relax some during the office chat about the daughter and the funeral, but he frequently looked my direction with a cautious glance.

My usage of the audiotape recorder and both camcorders proved beneficial in that I recorded data from multiple locations at one time. However, it also proved difficult in that I recorded data that I did not directly observe. That opened up the probability of problems at the end of tapes and of slow documentation and follow-up after the actual field visits.

I worried that the Hi-8 videotape would generate a mpg conversion problem. I did not have access to the computer hardware and software needed to convert it.

I realized that I needed to start a list or dictionary of HVAC terminology. Much of their terminology was HVAC specific.

#### Analysis of the Linguistic Practices and Ideologies

As a researcher, I observed and documented a number of linguistic practices and ideologies. Classroom discussions highlighted some of the practices and ideologies. I identified others through additional readings or by observations related to the visits. For instance, I observed chunking of information as one of the practices. I gave it that name because it was a term I have used in teaching design issues for a class on visual design using presentation software.

### *HVAC Vocabulary/Terminology*

Whorf (1956) noted that the structure of particular languages partly conditions our concepts of time, space, and matter. In talking about physical quantities, he stated that "Our language patterns often require us to name a physical thing by a binomial that splits the reference into a formless item plus a form. . . .It is part of our whole scheme of OBJECTIFYING — imaginatively spatializing qualities and potentials that are quite nonspatial."

On my first site visit, the customer asked how much the condenser weighed so the president/co-owner took the time to go out and find the exact weight as listed on the condenser specifications. To the HVAC salesperson, the term *ton* referred to a unit of measurement for determining cooling capacity, not physical weight. For instance, the manufacturer rated this condenser model at 3 tons. The customer felt the need to ask about the 3-ton condenser in their HVAC system. It did not weigh 3 tons; it weighed about 200 pounds. They probably asked about the weight to help them clarify their misconception.

Earlier the same customer and the president/co-owner talked about air quantities and volumes as I note in Example 1. I identified objectifying in the "push the air," "more air," and "no air" comments.

*Example 1*

Customer 1: Let me ask you a question? Do you think that (.) the (.) the (piped tons) (.) is going to be (.) strong enough to push the air (.) (yep) to this part of the house. Cause this is about the farthest part of the house and that duct (.) right there (.) you get no air coming out at all.

President: Yup. One thing it's, it's fairly small. But, this is the thing, we got, uh, we've got more air to deal with now. And, so what we're going to do is, we're going to put balancing dampers on every one of the major duct runs up there as part of this.

Customer 1: What does that do?

President: What it lets me do is it let's me send the air where I want to send it instead of it just following the path of least resistance which it's doing right now. We're going to make it, we're going to put our dampers in so that we, oh we've got too much air going down this run, we'll pinch that down and force it to overcome the static pressure (.) of that (.) register right there and send more air down into this area.

Form deals with the *poetic function of language*. It describes one characteristic of verbal art and performance. The communications at the company seemed rampant with forms such as specialized language styles and figurative language as discussed in the handout for our class. I provide one of many instances in Example 2 as Tech 3 defined a term that he liked to use.

*Example 2*

Tech 3: ((The technician spun the squirrel cage in the blower assembly.))  
That's walking the farmer.

President: Doesn't take long to get this stuff ripped out when you've got plenty of hands on it.

Tech 3: Yeah::

I noted many other examples in the discussions between the technician and the dispatcher during their mediated conversations. They had special introductory and closing formulas such as "K. Go ahead guy. . . ." and "Yeah, I'm over here. . . ." and "Well, then, uh take it home." Like in Irvine (1974), the greetings were typical. The closings were also forced by what Irvine quotes in the same article as "the 'set of rules for the socially appropriate constructions and interpretation of messages' (Frake 1964:132) which enables one to behave appropriately in this situation." The participants illustrated several rules, as I show in Example 3, where the dispatcher called the technicians by the generic term guy, then introduced what she needed, then described what she needed, and finally closed the conversation with her second guy statement.

*Example 3*

Dispatcher:	Hey, guy, let me ask you a question. You went back to 900 North Center in Arlington today (.) to replace the filters.
Tech 2:	( )
Dispatcher:	That's what I need to know, guy. ( )

*Expertness and Power Relationships*

The correct and/or incorrect use of specialized vocabulary and/or terminology can help to determine expertness. The president/co-owner ideologically was more expert than the employee/technicians or the customer. But, I observed in Example 2 when Tech 3 defined a term to the president/co-owner that they had temporarily

switched roles. The technician displayed a higher, more expert level of knowledge about one topic than the president/co-owner.

The customer, although they might not have realized it, held a lot of power in their relationship with any customer service organization. The president/co-owner and his staff expressed this in Example 4.

*Example 4*

President: Uh. People do not understand how much (.) trouble it causes when they don't keep an appointment. Especially for something like this. You got a whole stage full of actors (.) here trying to <perform> that -

Vice-President: Yeah, he didn't have a clue about that.

Ellen: You'd think they care about it, right?

Vice-President: Well-

Dispatcher: It's a big business.

President: It's like uh Ellen told me. They've got a whole different set of priorities than we got

Dispatcher: ( )  
He He.

Vice-President: There:::  
you go!

Dispatcher: This is the truth.

Ellen: Yep. (.) But I - I think (.) as I told John, it's going to hit in two areas. Now, this guy may not have the focus for anything but (.) the presentation today, but they could do it- (.) for their service people.

Tech 1: No they ain't gonna do it.

President: Thing is, we all feel (.) <wonderfully upbeat> about the prospects of this, but try to

Ellen: get -  
Uh huh.

President: give them ah - to pay attention long enough to tell my story is the key here.  
*((The president/co-owner moved out of the office, into the hallway towards his office.))*

I also saw power relationships within the mediated example that I provide in Example 7. In that example, the vice-president/co-owner, through her comments, directed the dispatcher who in turn directed the technicians. As an interesting aside, the dispatcher would typically be paid much less than any technician because of the expert knowledge of the technician. In our society where salary has been very important this switch in power roles has been intriguing. Ideologically in a salary hierarchy, the dispatcher would have less power and the technician more. However, the dispatcher had power because the dispatcher coordinated the technicians actual work contacts and schedules.

### *Narratives or Storytelling*

Bauman (1981) talked about the importance of story telling and truth-in-dog-trading activities at Canton, Texas. Example 5 shows how comfortable the HVAC provider was at story telling and truth.

#### *Example 5*

Dispatcher: L (Alright)  
You don't like that cheating stuff.  
Vice-President: That's right.  
President: (Obviously.)  
((The president/co-owner walked towards the hallway.))  
Dispatcher: Cheating. We don't like it.  
Vice-President: That's  
right. ( )

President: [ ((The warehouse door slammed.))  
I'm going to  
head that way guy::s

Vice-President: [ and uh (.)  
(We just don't know.)

President: I'll be- (.) If the guy should call and says he late or  
whatever the heck

Vice-President: [ he's::  
I'll tell him.  
You know it's unexcusable. He better sit tight at his  
desk. If I were you, I'd stick right where you are at.  
Ha. Ha. Ha. Ha. Ha. Ha. Ha.

President: ((*The president/co-owner sniffed loudly.*))  
Well, we'll be going to Nextel® next week.

Ellen: ((At first I tried to stifle a laugh and then laughed  
freely with the vice-president/co-owner.))

Vice-President: Well, why

President: [ not.  
We  
Sprint® and Nextel-

Vice-President: And that's just what I'll tell him.  
((*Everyone laughed.*)).  
We've got a meeting next week with Nextel and all  
of that.

Ellen: [ ( )  
AT&T® or Cingular®.  
Which one

President: [ bought 'em out?  
It's Cingular-

Vice-President: [ Cingular bought  
out AT&T.

Ellen: Ah, O.K.

Vice-President: [ So,-  
(I'll)  
(tell him we're) meeting with Nextel (.) tomorrow  
and uh Cingular next week and if he can't meet ( )  
if he wants to get in on the edge he better get in it  
now.

*Politeness, "Old West Cowboys" or "At Your Service, Madam"*

As in the article by Keenan (1974), several linguistic ideologies became apparent for this service industry. If service personnel made their customers uncomfortable, they could cause their business to quickly fail. So some of the linguistic ideologies were:

- Service personnel avoided direct affronts.
- Service personnel did not make a customer feel uncomfortable or unpleasant since that could cause a loss of face and that would go against the community norms.
- The community admired the service personnel for their sophisticated but indirect verbal art skills. The service personnel used those skills to build and maintain relationships.
- The service personnel seldom confronted anyone to the extent that even a typical request of someone was only alluded to or presented through a third party.

In Example 6, I show an instance where the president/co-owner expressed a concern for an upcoming meeting with the vice-president at a major communications provider. That meeting involved an extremely important set of negotiations.

*Example 6*

Ellen: Er (.) How are you feeling about this meeting, other than your allergies?



President: I::I, I wished it was less uh straining on time for my party's sake there because I feel a little (.) (verbal click) I think it would be better received if it were - (sniffle) = he wasn't feeling like he was to watch his watch the whole time, so I, I'm hopeful that his - he'll be a little more relaxed than he was earlier at noon. huh (sniffle)

### *Mediated Conversations*

The participants used cell phones with Direct Connect features (Direct Connect operates similar to two-way radios.) to communicate with remote personnel from the home office and also from one technician to another. For instance I recorded a conversation between the dispatcher and one of the field technicians. In both directions, the participants experienced problems with understanding the communications because of signal loss. Moreover, the technicians only heard conversations when the dispatcher keyed the microphone during those conversations. Example 7 illustrates this variation of the back-channel talking we discussed in class. The technician usually did not hear the comments of the president/co-owner and the vice-president/co-owner because the dispatcher did not key the microphone during most of those moments so the microphone did not transmit those conversations for the technician to hear.

#### *Example 7*

Dispatcher: 'K. Go ahead guy.  
Vice-President: Sweet

Tech 2: ((Audio came from the cell phone.))  
Yeah, I'm over here. Uh. They got a meeting in one  
of the offices that we have to be in and so  
Salesman advised  
President: [ if I's ready to the (bank)  
((The president/co-owner, suffering from allergies,  
blew his nose loudly.))  
Vice-President: ((The vice-president/co-owner spoke softly.))  
Gee:s::!  
Tech 2: [ ((The vice-president/co-owner typed on her  
computer keyboard while she listened.))  
L Salesman thought I should hang out  
and get it finished up  
Vice-President: [ or (.) -  
No!  
Tech 2: ( )  
Dispatcher: You don't have anything else going on do yah?  
Tech 2: ((The vice-president/co-owner still typed on the  
computer keyboard while she listened.))  
(Having inference.)  
Dispatcher: I said you don't have anything else that you could  
be <doing> (.) while you're waiting, do you?  
Tech 2: Not really. We've pretty much wrapped it up.  
Vice-President: Adios::  
Dispatcher: Well, then, uh take it home.  
Tech 2: (3.0)  
All righty!  
President: ((The president/co-owner spoke from the front  
office.))  
Tech 2 can't work?  
Vice-President: Evidently.

Mediated conversations occurred even when the technicians were at the same customer site. I observed technicians in the attic using the cell phones to save themselves travel up and down the stairs while communicating with another technician located anywhere outside of hearing range.

### *Chunking of Information*

I have defined the phenomenon of chunking of information as a series of very short statements or directives containing key ideas with very little detail. Example 8 demonstrates this practice. This example occurred in a dark attic with a lot of background noise. I was not sufficiently adept at recognizing their voices to determine which technicians said what, but the chunking of information was clear.

#### *Example 8*

Tech 2: Is the box ready to come down?  
((Demolition noises discouraged conversations for 11.3 seconds.))

Tech 2: Where yah at?

Tech 2: Stand back.  
((Demolition noises discouraged conversations for 1.3 seconds.))

Tech 2: Hold that on each side!  
((Demolition noises discouraged conversations for 3.1 seconds.))

Tech 2: (Ba:::ck)  
((Demolition noises discouraged conversations for 2.7 seconds.))

Tech 2: Here's on::e!  
((Demolition noises discouraged conversations for 10.6 seconds.))

Tech 2: <You better hold this.>  
((Demolition noises discouraged conversations for 10.2 seconds.))

Tech 1: Should I hit that?  
((Demolition noises discouraged conversations for 0.8 seconds.))

Tech 2: Watch your leg.  
((Demolition noises discouraged conversations for 6.4 seconds.))

Tech 2: Truce, Sir Roy. Will you cut that?  
((No one in the attic way was actually named Roy.))  
(1.1)

As a researcher, I have felt that further explorations of this conversational practice could prove fruitful. My initial thoughts regarding this practice have fallen into the following categories.

- Their mediated cell phone conversations might favor chunking. The communications companies often charged users of wireless communications by the total minutes of air time. Fewer words meant fewer minutes and lower costs. If they practiced chunking even when the technicians were not on the cell phones, they would increase their skill levels with this linguistic practice.
- Time was money. Even if they did not use the cell phone, a talkative technician would be less likely to get in, get the work done, get back out, and get on to the next service call. If a 30-minute service call dragged on to 45 minutes, then over the span of a full day's time and considering travel time, this might mean the difference between 6-8 service calls a day versus 4-5 service calls. At approximately \$60.00 a service call, that could mean a make-or-break financial situation for a small business.
- Talk was a distraction. This was an industry where technicians were frequently in danger of something going wrong. It was harder to think or

observe closely when their conversations distracted their attention from the current situation.

- The technicians might be men of few words. In the American culture, the ideology has been that men did not talk much and women have had to do the work to keep conversations flowing. Did this just indicate their macho behavior?
- The skill levels of the technicians might have influenced communications if the technicians were all fairly experienced (expert) at the tasks and the tasks were routine. In that situation, they wouldn't have needed instructions to tell them what to do nor would they have needed to tell others what the other workers needed to do. This possibility would relate back to expertness as discussed by Sternberg (1996).
- This phenomenon might have resulted from a noisy work environment. When I first noticed it, the technicians were in the demolition stage of removing the non-working heating assembly and ductwork in the attic. The space was crowded and the noise was loud.
- My last possible suspect has been the frequent use of non-verbal communications. Nods of the head, pointed fingers, and/or raised arms typically have relayed distinct messages. The physical location of participants in a situation also has relayed information. If a worker picked up one end of a very long or heavy object that needed relocation, a co-worker could have

assumed that the worker would need the co-worker to pick up the other end.

For many non-linguistic actions, a co-worker might have anticipated a needed reaction.

### *Camaraderie and Joking*

All of the individuals at the HVAC provider had a strong sense of community as evidenced in their camaraderie and joking. I present examples of their constant use of camaraderie and joking in Example 9, Example 10, and Example 11.

#### *Example 9*

Tech 3:	That's not the Sony with the x-ray vision is it?
President:	Uh, yeah, so, watch your clothes, man.
Tech 3:	[ ((Tech 3 laughed for 1.1 seconds.)) (Careful! Powerful zone!)
Tech 2:	

#### *Example 10*

Tech 3:	Hey, I found an Internet site where somebody was walking around a beach with one of those things man. I was trying ((Tech 3 added emphasis with a loud clang on a nearby HVAC duct.)) to forget that.
President:	They covered my face didn't they before they showed that on -

*Example 11*

President: Hey, you guys are going to be movie stars.  
((No one spoke for the next 3.4 seconds. Then, the recorder captured various background noises such as scraping and dragging of a large HVAC system component.))

Tech 3: Can I change my name?

President: [ Yep, we'll change your name.

Everyone: ((laughter))

Tech 3: Mike Homeless.

President: Call you Rock Something.

Tech 3: There you go!

Everyone: ((laughter))

Summary

The HVAC industry had many similar ideological practices and ideologies as those we studied in class. This report, although long, only began to touch on the patterns and examples listed above. And, I saw those patterns and examples within only 8 hours of field study. I look forward to future studies on this service provider and this industry. This HVAC provider had colorful language practices in this study. Hopefully, in a future dominated by more mediated conversations and interactions, the HVAC culture that I saw in this report will have survived and flourished. My greatest trepidation has been the potential loss of camaraderie that I witnessed in this study. If the chunking has expanded because of mediated conversations and the war stories have lessened due to mediated apprenticeship training and poor knowledge management, the culture for the HVAC industry will potentially have undergone dramatic shifts as predicted by the general systems theory (Bertalanffy, 1968; see also Moore & Kearsley, 1996; Senge, et

al., 1999; Smith & Ragan, 1993). Hopefully, owners and managers will have continued to realize the importance of the communities of practices (Lave & Wenger, 1991; Lesser, Fontaine, & Slusher, 2000; Wenger, McDermott, & Snyder, 2002) that have developed through past interactions and ensure that the communities have stayed solid through these and/or other types of future activities.



APPENDIX C

LETTER TO IRB FROM: JOHN THOMASON AT METRO ENVIRONMENTAL

Once suggested (R. W. Wilhelm, personal communication, 2003), I used similar letters for each study. J. Thomason agreed, signed, and mailed each one to the UNT IRB.



November 9, 2007

To Whom It May Concern:

Metro Environmental functions as a heating and air conditioning business with headquarters in Lewisville, Texas. As co-owner and president of Metro Environmental, I give permission to Ellen Daily to conduct a qualitative and/or quantitative, exploratory, collaborative, study regarding Metro Environmental, our training, and any of our customers directly related to the research study activities. This study will occur during November 2007 - March 2008.

I understand that the researcher will study the Metro Environmental processes to determine the impact of the training on the overall operation of the company, the personnel, and our customers.

We may use the information retrieved for:

- A dissertation for the researcher,
- A grant application for Metro Environmental,
- Business offerings for Metro Environmental, and
- Publication in books, professional magazines, and/or journals

I further understand that Metro Environmental may also use any findings from the study for their internal and/or publication purposes.

The researcher and I have discussed research methodology and concerns about confidentiality regarding any participants, both personnel and customers. Customers will remain anonymous by using pseudonyms and modifying or eliminating any identifying information in any public reports. We will only use names for specific personnel in public reports when both the staff and management provide express permission. Because of:

- ❑ The collaborative nature of the study,
- ❑ The small business operation of Metro Environmental which engenders a close relationship between the personnel,
- ❑ The potential for future licensing of the processes and technologies, and
- ❑ The possibility of using the information for company benefit, marketing, and/or history,

I understand that the researcher cannot keep the identity of the participants fully confidential as might normally occur during a research study. Therefore, we will compel no one to participate in the study without their freely-given and written permission. Any employee who prefers not to participate in the study or later withdraws from participation will suffer no prejudicial actions regarding their employment status with Metro Environmental.

We will inform each person of the purposes of the study and give them the opportunity to participate. Moreover, other than the full confidentiality limitations, we will strictly follow all other ethical research recommendations regarding a typical research study so that no harm will come to any participants as a result of this study.

Sincerely,

John Thomason

President, Metro Environmental

APPENDIX D

METRO ENVIRONMENTAL CONSENT FORM

## *Metro Environmental: Training*

### *General Instructions*

You should read and fully understand this consent form before agreeing to participate in this research study. No guarantees or assurances can be made as to the results of the study.

### *Purpose of the Study*

The purpose of this study is to analyze the training at Metro Environmental (ME).

### *Description of the Study*

This study is one of several planned studies researching the training. Since the SightPros communication tool has revolutionized the way Metro Environmental conducts their business, the training could impact all personnel at Metro Environmental and their customers. An outside researcher is working with ME from December 2007 through May 2008 to analyze the overall company operations to explore the full impact of the training. Because the events the researcher is studying are normal events in their natural environment, all participants should experience very little inconvenience and no discomfort.

Some of the results may be included in a business proposal for additional funding on technology applications in businesses. Some of the results may be used by John Thomason as he tries to license the Metro Environmental training and technology to other companies.

### *Procedures for the Study*

The researcher will be using observations, interviews, surveys, video recordings, tape recordings, etc. of ME personnel who agree to participate in this study (ME participants) and approximately 50 ME customers who agree to participate in this study (ME customer participants).

The researcher will be observing and recording all participants in the course of their normal ME work activities. The researcher will be observing ME office participants in 2-4 hour sessions. The researcher will be observing ME field participants in 1-8 hour sessions both in the office and during their field visits. The researcher will be observing some participants one-on-one, some more than once, and some simultaneously as members of a team. The researcher will be assisting in some work activities but she will be unobtrusive in any of these activities. Sometimes the researcher will be collecting items directly related to the work activities.

The researcher will also be interviewing all ME participants. The interviews will last between 30 minutes and 2 hours. Some ME participants will be interviewed multiple times. The researcher will conduct these interviews during normal work hours but when work activity is at a minimum.

The researcher will be interviewing approximately 25 ME customers participants during ME field visits. The site interviews should last approximately 20 minutes.

The researcher and ME will also be conducting approximately 50 customer satisfaction surveys with customer participants. The survey will be through either a 10-minute mail survey or a 20-minute telephone interview scheduled approximately 2 weeks after the time of a ME field visit.

ME uses cell phones and video communications to coordinate their activities with other ME personnel. Typically, neither the audio or video communications are saved. For this study, the researcher will be saving some of these communications so that typical activities, interactions, communications, and skills can be analyzed. The researcher is also taking notes of personal observations.

The researcher will coordinate scheduling of all her activities through John Thomason or his designee on a weekly, daily, and sometimes hourly basis depending on the level of activities and the opportunities that arise. Both the study and the planned discussions may change as the study develops.

*Procedures for Maintaining Confidentiality of Research Records*

The data collected in this study and the results of this study may be used in a variety of ways. You may review and add comments to any data collected from you.

To maintain confidentiality in any public reports we will:

- ❑ Keep all customers anonymous by using pseudonyms and modifying or eliminating any identifying information and
- ❑ Use names for specific personnel only under expressed permission of the personnel involved and with permission of the ME management. Otherwise, pseudonyms will be used and any identifying information will be modified or omitted.

Because of:

- ❑ The planned sharing of data and results of the study with Metro Environmental management,
- ❑ The small business operation of Metro Environmental which engenders a close relationship between the personnel,
- ❑ The potential for future licensing of the processes and technologies, and
- ❑ The possibility of using the information for company benefit, marketing, and/or history,

the researcher cannot guarantee full confidentiality of study participants. Metro Environmental management and other key personnel will know the identity of all participants, their participation or non-participation, and many of their responses. However, you will not be compelled to participate in this study without your freely given and written permission. John Thomason has signed an agreement that anyone who prefers not to participate in the study or later withdraws from participation will suffer no prejudicial actions regarding their employment status with Metro Environmental.

The researcher is maintaining any raw data (such as interviews, surveys, computer files, items, etc.) that the researcher collects for this study secured in the researcher's home. The researcher may give access to it to Metro Environmental management and to other researchers (to validate results or analyze further), but not to the public.

*Anticipated Risks*

Overall, a study like this one presents a very low level of risk. No physical or psychological risks are anticipated due to this study.

Because some site visits include live video, it is possible that some audio/video transmissions will be recorded that unintentionally include more than the ME personnel and the HVAC system at your customers' premises. Although we are studying and recording this audio/video, we will only use the data directly involved with the study.

Because of (1) the small size of ME that engenders a close relationship between all personnel, (2) the future license potential, and (3) the teamwork design of this study, full confidentiality of research participants cannot be guaranteed. Any information that impacts ME may be divulged to other personnel within ME or to other researchers. Nonetheless, you should be at no more risk in this study than you would be during normal contact with ME personnel.

*Benefits to You*

The benefit of participating in this study is that you can voice your opinions in this important study. ME management will review all of your comments. This study may make Metro Environmental training work more efficiently and effectively. By increasing the effectiveness and efficiency of training, you should become better skilled in shorter time frames. You could find that you are better prepared for industry exams sooner in your career. Moreover, you should feel good in that your opinions could have national benefits for training and service operations in a variety of service-dispatched industries.

*Review for the Protection of Participants*

This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). Contact the UNT IRB at (940) 565-3940 with any questions regarding your rights as a research subject.

---

*Research Subject's Rights*

I have read or have had read to me all of the previous information. The researcher has explained the study to me and answered all of my questions. I have been told the risks and/or discomforts as well as the possible benefits of the study.

I understand that I do not have to take part in this study and my refusal to participate or to withdraw will involve no penalty, loss of rights, loss of benefits, or legal recourse to which I am entitled. The study personnel may choose to stop my participation at any time.

In case problems or questions arise, I have been told I can contact the researcher at (972) 492-4443 or Dr. Michelle Wircenski, UNT Learning Technologies Department, at (940) 369-7704.

I understand my rights as a research participant and I voluntarily consent to participate in this study. I understand what the study is about, how the study is conducted, and why it is being performed. I have been told I will receive a signed copy of this consent form.

Participant Name (Print) \_\_\_\_\_

Signature of Participant \_\_\_\_\_ Date \_\_\_\_\_

---

*For the Investigator:*

I certify that I have reviewed the contents of this form with the subject signing above. I have explained the known benefits and risks of the research. It is my opinion that the subject understood the explanation.

Principal Investigator: Ellen Daily

Co-Investigator: Dr. Michelle Wircenski

Signature of Investigator \_\_\_\_\_ Date \_\_\_\_\_

*APPROVED BY THE UNT IRB  
FROM 12/5/07 TO 12/4/08  
SB*

---

APPENDIX E  
CUSTOMER CONSENT FORM



## *Metro Environmental: VirTechs and/or SightPros*

### *General Instructions*

You should read and fully understand this consent form before agreeing to participate in this research study.

### *Purpose of the Study*

The purpose of this study is to analyze VirTechs and/or SightPros at Metro Environmental (ME).

### *Description of the Study*

This study is researching the impact of VirTechs and/or SightPros on ME and on their customers. An outside researcher is working with ME from December 2007 through May 2008 to analyze their use of wireless technology. Because the events the researcher is studying are normal events in their natural environment, all participants should experience very little inconvenience and no discomfort.

### *Procedures for the Study*

The researcher is using observations, interviews, surveys, video recordings, tape recordings, etc. of ME personnel who agree to participate in this study (ME participants) and many ME customers who agree to participate in this study (ME customer participants).

The researcher is observing and recording all participants in the course of their normal ME work activities. The researcher is assisting in some work activities but she will be unobtrusive in any of these activities. Sometimes the researcher is collecting items directly related to the work activities.

The researcher is interviewing ME customer participants during ME field visits. The site interviews should last approximately 20 minutes.

The researcher and ME are also conducting customer satisfaction surveys with ME customer participants. The survey is through either a 10-minute mail survey or a 20-minute telephone interview scheduled approximately 2 weeks after the time of a ME site visit.

ME uses cell phones and video communications to coordinate their activities with other ME personnel. Typically, neither the audio or video communications are saved. For this study, the researcher is saving some of these communications so that typical activities, interactions, communications, and skills can be analyzed. The researcher is also taking notes of personal observations.

### *Benefits to You*

The benefit of participating in this study is that you can voice your opinions in this important study. ME management will review all of your comments. Moreover, you should feel good in that your opinions could have national benefits on training in a variety of service-dispatched industries.

### *Anticipated Risks*

Overall, a study like this one presents a very low level of risk. No physical or psychological risks are anticipated due to this study. Because some site visits include live video, it is possible that some audio/video transmissions will be recorded that unintentionally include more than the technicians and the HVAC system at your premises. Although we are studying and recording this audio/video, we will only use the data directly involved with the study.

To protect you or anyone at your site from any harm due to this study, the researcher and ME are carefully maintaining normal precautions so that any specific customer information will not become public information. Nonetheless, any information that impacts ME may be divulged to other personnel within ME or to other researchers. Overall, you should be at no more risk in this study than you would be during normal contact with ME personnel.

*Procedures for Maintaining Confidentiality of Research Records*

The data collected in this study and the results of this study may be used in a variety of ways. You may review and add comments to any data collected from you. Your full confidentiality will be protected in any public use of this data. We are keeping you anonymous to the public by modifying or eliminating any identifying information.

The researcher is maintaining any raw data (such as interviews, surveys, computer files, items, etc.) collected for this study at her home under lock and key or password protected. However, your confidentiality cannot be assured between the researcher and other ME personnel or other researchers due to the planned sharing of raw data and results. Nonetheless, raw data will not be publicly available.

*Review for the Protection of Participants*

This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). Contact the UNT IRB at (940) 565-3940 with any questions regarding your rights as a research subject.

---

*Research Subject's Rights*

I have read or have had read to me all of the previous information. The researcher has explained the study to me and answered all of my questions. I have been told the risks and/or discomforts as well as the possible benefits of the study.

I understand that I do not have to take part in this study and my refusal to participate or to withdraw will involve no penalty, loss of rights, loss of benefits, or legal recourse to which I am entitled. The study personnel may choose to stop my participation at any time.

In case problems or questions arise, I have been told I can contact the researcher at (972) 492-4443 or Dr. Michelle Wircenski, UNT Learning Technologies Department, at (940) 369-7704.

I understand my rights as a research participant and I voluntarily consent to participate in this study. I understand what the study is about, how the study is conducted, and why it is being performed. I have been told I will receive a signed copy of this consent form.

Participant Name (Print) \_\_\_\_\_

Signature of Participant \_\_\_\_\_ Date \_\_\_\_\_

---

*For the Investigator:*

I certify that I have reviewed the contents of this form with the subject signing above. I have explained the known benefits and risks of the research. It is my opinion that the subject understood the explanation.

Principal Investigator: Ellen Daily       Co-Investigator: Dr. Michelle Wircenski

Signature of Investigator \_\_\_\_\_ Date \_\_\_\_\_

APPROVED BY THE UNT IRB  
FROM 12/5/07 TO 12/4/08 SB  
SB

APPENDIX F

CUSTOMER INTERVIEW FORMS

*Metro Environmental: Customer Cover Sheet*

➤ Customer name(s):

Initial Contact: \_\_\_\_\_

\_\_\_\_\_

Follow-up Contact: \_\_\_\_\_

\_\_\_\_\_

➤ Contact information: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

➤ Preferred follow-up method:

Telephone

E-mail

USPS® (United States Postal Service®) mail

➤ Paperwork completed:

Initial Contact

Follow-up

*Metro Environmental: On-Site Customer Interview*

**NOTE: Please get the customer consent form signed. Please ask for permission to record the interview.**

1. Date and time: \_\_\_\_\_
2. Interviewed by: \_\_\_\_\_
3. How long have you been a customer of Metro Environmental? \_\_\_\_\_
4. Do you have a maintenance agreement or do you pay for each service call? \_\_\_\_\_
5. Please describe why you chose Metro Environmental as your HVAC provider. (ad, customer recommendation, warranty, other)
6. Please describe how you felt about Metro Environmental before you placed the service call.
7. Did you seek a second opinion or quote for this job? If so, please describe why you selected Metro Environmental.
8. Please describe a well-trained service technician / expert. (Example: Use of equipment, tools, literature, communication skills, work habits, experience, etc.)
9. Please describe your perception of the training quality of the Metro Environmental personnel.
10. Please describe a "professional: service technician / expert. (Example: Dress, demeanor, equipment, tools, trucks, communication skills, work habits, experience, etc.)
11. Please describe the professionalism of the Metro Environmental personnel.
12. Are you aware of VirTechs and/or SightPros? If so, please describe it.
13. Please describe how you feel about services that use streaming video over secured Internet links.
14. Please describe your perception of the job satisfaction of the Metro Environmental personnel.
15. Do you have any other input or comment?

**NOTE: Please thank the customer(s) for his and/or her time.**

APPENDIX G  
TECHNICIAN INTERVIEW FORMS

*Metro Environmental: Personnel Cover Sheet*

➤ Participant name: \_\_\_\_\_

➤ Position: \_\_\_\_\_

➤ Contact Information: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Consent form completed

Interview completed

*Metro Environmental: Technician Interview*

**NOTE: Please verify that the technician has signed the Research Consent Form for Metro Environmental Personnel. Please ask for permission to record the interview.**

1. Date and time: \_\_\_\_\_
2. Interviewed by: \_\_\_\_\_
3. Please tell me your job title?
4. Please describe all tasks that you actually perform on the job.
5. Please describe any additional tasks that can be assigned to you.
6. Please describe the tools that you use on the job.
7. What degrees, licenses, or certificates (if any) do you hold?
8. Please describe the HVAC industry. (Example: job security, safety, salary, advancement, etc.)
9. Please describe Metro Environmental. (Example: working environment, communications patterns, relationship with managers and peers, etc.)
10. Please describe some of your experiences in both Metro Environmental and in the HVAC industry.



11. Please describe how you feel about technology in general and computers in specific.
12. Please describe VirTechs and/or SightPros.
13. Please describe your use of VirTechs and/or SightPros. (Example: How the SightPros communication tool operates, how often you use it, etc.)
14. Please define the terms: expert and apprentices.
15. Please describe your training. (Example: Use of equipment, tools, literature, etc.)
16. Please compare your training now to any prior training.
17. Please describe your professionalism? (Example: Dress, demeanor, equipment, tools, trucks, etc.)
18. John describes the service technicians as having an Old West attitude. Can you give me some examples of that?
19. Please describe your career goals.
20. What impact might VirTechs and/or SightPros have on achieving your career goals?

**NOTE: Please thank the technician for his or her time.**

APPENDIX H

OFFICE PERSONNEL INTERVIEW FORMS

*Metro Environmental: Personnel Cover Sheet*

- Participant name: \_\_\_\_\_
- Position: \_\_\_\_\_
- Contact Information: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Consent form completed

Interview completed

*Metro Environmental: Office Personnel Interview*

**NOTE: Please verify that the interviewee has signed the Research Consent Form for Metro Environmental Personnel. Please ask for permission to record the interview.**

1. Date and time: \_\_\_\_\_
2. Interviewed by: \_\_\_\_\_
3. Please tell me your job title?
4. Please describe all tasks that you actually perform on the job.
5. Please describe any additional tasks that can be assigned to you.
6. Please describe some of your experiences in both Metro Environmental and in the HVAC industry.
7. Please describe the HVAC industry. (Example: job security, safety, salary, advancement, etc.)
8. Please describe Metro Environmental. (Example: working environment, communications patterns, relationship with managers and peers, etc.)
9. Please describe how you feel about technology in general and computers in specific?

10. Please describe the various communications used in Metro Environmental.

11. Please describe VirTechs and/or SightPros.

12. Please describe the usability of VirTechs and/or SightPros in Metro Environmental.

13. Please describe the effectiveness of VirTechs and/or SightPros training in Metro Environmental?

14. John describes the service technicians as having an Old West attitude. Can you give me some examples of that?

**NOTE: Please thank the participant for his or her time.**

APPENDIX I

THE INTERACTION LOG TESTED IN THE SIGHTPROS-VIRTECHS SYSTEM

*Metro Environmental: Interaction Log*

Date: \_\_\_\_\_ Technician Name: \_\_\_\_\_  
Customer: \_\_\_\_\_ Address: \_\_\_\_\_  
Service Order #: \_\_\_\_\_ Arrival Time: \_\_\_\_\_ Departure: \_\_\_\_\_  
Video Mentor: \_\_\_\_\_

*A/C- Heating Service & Troubleshooting Procedures*

1. Ask customer what they consider the problem to be: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. Go to the thermostat and check current setting: mode: \_\_\_\_\_ temp: \_\_\_\_\_  
stat type: programmable or manual?
3. Does the home have more than one unit? \_\_\_\_\_ Y/N how many? \_\_\_\_\_
4. Home square footage: \_\_\_\_\_  
Two story? \_\_\_\_\_ Y/N approximate sq. ft. up: \_\_\_\_\_ down: \_\_\_\_\_
5. Get model number of condenser: \_\_\_\_\_ serial #: \_\_\_\_\_
6. Get model number of evaporator: \_\_\_\_\_ serial #: \_\_\_\_\_
7. Get model number of furnace-a/h: \_\_\_\_\_ serial #: \_\_\_\_\_
8. Set video unit near work area and activate.
9. Does video function: \_\_\_\_\_ workable frame rate: \_\_\_\_\_ artificial lighting required? \_\_\_\_\_

*A/C condenser data gathering steps:*

- A. Check voltage at disconnect: \_\_\_\_\_
- B. Check voltage at contactor: \_\_\_\_\_
- C. Is thermostat calling for cooling? \_\_\_\_\_ Y/N
- D. Is the condenser running? \_\_\_\_\_ Y/N
- E. Is the condenser fan motor running? \_\_\_\_\_ Y/N  
cond. run amps: \_\_\_\_\_ cond. fan FLA: \_\_\_\_\_
- F. Is the compressor running? \_\_\_\_\_ Y/N comp run amps: \_\_\_\_\_ comp (FLA): \_\_\_\_\_
- G. Check condenser head pressure: \_\_\_\_\_ suction pressure: \_\_\_\_\_
- H. What is the refrigerant type? R-22 \_\_\_\_\_ R-410A \_\_\_\_\_
- I. Does condenser coil appear clean/dirty: \_\_\_\_\_

*A/C furnace/air handler data gathering steps:*

- A. Check voltage at the furnace-a/h terminal board: \_\_\_\_\_
- B. Is the thermostat calling for fan manual operation? \_\_\_\_\_ Y/N Cooling? \_\_\_\_\_ Y/N
- C. Is the furnace-a/h blower running? \_\_\_\_\_ Y/N blower run amps: \_\_\_\_\_ blower FLA: \_\_\_\_\_
- D. What is the Delta T across the evaporator: \_\_\_\_\_ across the return/supply: \_\_\_\_\_
- E. What is the condition of the system drain? \_\_\_\_\_

- F. What is the condition of the primary drain pan? \_\_\_\_\_  
emergency pan: \_\_\_\_\_
- G. Did you check the filter? \_\_\_\_\_ Y/N was it dirty? \_\_\_\_\_ Y/N replace? \_\_\_\_\_ Y/N  
filter(s) size: \_\_\_\_\_
- H. Did you check ductwork & plenums for air leaks? Y/N  
Describe general duct condition: \_\_\_\_\_  
\_\_\_\_\_

*Heating system data gathering steps:*

- A. Go to the thermostat and check current setting: mode: \_\_\_\_\_ temp: \_\_\_\_\_  
stat type: programmable or manual?
- B. Check the voltage at the furnace-a/h circuit board: \_\_\_\_\_  
Low voltage present? \_\_\_\_\_ Y/N
- C. Is the thermostat calling for heating? \_\_\_\_\_ Y/N
- D. Is the system: 1.) Gas heat 2.) Electric heat 3.) Heat pump?
- E. Is the furnace blower functioning? \_\_\_\_\_ Y/N  
blower amps: \_\_\_\_\_ blower FLA: \_\_\_\_\_
- F. Are the gas-furnace burners clean? \_\_\_\_\_ Y/N  
Describe condition: \_\_\_\_\_
- G. Did you pull and clean burners? \_\_\_\_\_ Y/N
- H. Does the flame light properly? \_\_\_\_\_ Y/N  
Describe flame color and characteristics: \_\_\_\_\_
- I. Did you check the heat exchanger for rust holes or cracks? \_\_\_\_\_ Y/N  
Describe findings: \_\_\_\_\_  
\_\_\_\_\_
- J. Did you check for gas leaks? \_\_\_\_\_ Y/N
- K. Did you check flue stack & cap for rust holes and/or water leaks? \_\_\_\_\_ Y/N
- L. Did you check ductwork & plenums for air leaks? \_\_\_\_\_ Y/N  
Describe general duct condition: \_\_\_\_\_  
\_\_\_\_\_
- M. If electric heat type A/H, did you check voltage to each heat strip? \_\_\_\_\_ Y/N  
amperage thru each strip? \_\_\_\_\_ Y/N
- N. If heat pump, was the outside condenser running? \_\_\_\_\_ Y/N  
if not, did you check the voltage at the condenser? \_\_\_\_\_ Y/N
- O. If heat pump, did you check the low voltage at the condenser? \_\_\_\_\_ Y/N
- P. If heat pump, did you check the refrigerant level? \_\_\_\_\_ Y/N
- Q. What is the Delta T across the air handler? \_\_\_\_\_ Y/N
- R. Did you check the filter? \_\_\_\_\_ Y/N was it dirty? \_\_\_\_\_ Y/N replace? \_\_\_\_\_ Y/N  
filter(s) size: \_\_\_\_\_



10. What repair solution(s) does the data suggest?

11. Did the suggested repair correct the problem? Y/N

Explain: \_\_\_\_\_

12. What parts and materials were used on this job:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

13. Do we need to come back and follow up? Y/N

What is required: \_\_\_\_\_

\_\_\_\_\_

Job Total: \_\_\_\_\_

A. How important to the outcome was the use of video mentoring: 1 2 3 4 5

(1: not at all 2: somewhat useful 3: useful 4: very useful  
5: could not have reached a successful conclusion without)

B. Was the video shared with a homeowner not present at the jobsite? Y/N

Did they enjoy the experience? Y/N

C. How did they rate the video sharing experience: 1 2 3 4 5

(1. did like it at all 2: that it was somewhat helpful 3: thought it was helpful

4: enjoyed the capability a lot 5: were ecstatic to the point where it led to a referral

D. Were any snap shots taken at the jobsite? Y/N

Why? \_\_\_\_\_

E. Did the use of video mentoring speed up the diagnostic process? Y/N

minutes/hours saved: \_\_\_\_\_

F. Did the video hardware function during the entire process? Y/N

G. Time when video was turned off or ceased to function: \_\_\_\_\_

total video run time: \_\_\_\_\_

Video Mentor signature: \_\_\_\_\_

Witness: \_\_\_\_\_

Date: \_\_\_\_\_

APPENDIX J  
CODING AND ANALYSIS OF DATA

This list reflects some of the coding and analysis that I completed throughout my three studies on Metro Environmental. I have created and maintained this list as a working document to code, to categorize, and/or to clarify important HVAC terms and concepts related to this dissertation. I did not try to list and/or define everything here. Earlier versions of my qualitative data analysis software contained limited space to add information so I often used or added just simple explanations or clarifications there and then transferred my entries and groups to this document. My dissertation expands on some of this information. Likewise, I include some details and information here that I do not cover in the final dissertation. Nonetheless, I feel that this list may provide additional insights and validation to my conclusions and/or benefit others so I include it here.

#### Communication Devices

##### *Blue tooth*

A blue-tooth device allows wireless communications between a headset and a device like a cell phone. They allow hands free operation.

##### *Camera phones*

This refers to a cell phone with a camera feature.

##### *Cell phone*

The technicians, management, and sales personnel used these extensively for communications. They frequently used the speaker phone capabilities. They found that blue tooth capabilities benefited them as they could easily work or write while talking due to its hands-free operation.

##### *Cell phone camera*

This refers to the camera option on a camera phone.

*Direct Connect® wireless telecommunications*

The technicians, the sales personnel, and John Thomason used cell phones with Direct Connect features to communicate with remote personnel from the home office and also from one technician to another. Direct Connect operates similar to two-way radios in that you push a button to talk. If they release the button, their discussion remains local.

*Laptop computers*

Metro Environmental used Webcams and laptop computers for communications in the early development and testing of the VirTechs processes. The laptop computers did not do well in the rigors of the hot and cold weather.

*Office phone*

This refers to a hard-wired telephone, usually with multiple phone lines capabilities. Companies usually make the same telephones lines available in multiple offices. As such, the office phones usually have or can work as an intercom system.

*Pager*

Prior to cell phones, many companies used these devices to send beeps to indicate the need for a remote employee to call the office and/or to send short text messages.

*Public radio stations*

This refers to public AM and FM radio stations. Locally, they transmit both English-speaking and Spanish-speaking stations.

*SightPros communication tool*

This refers to the Metro Environmental portable, wireless audio/visual units.

See the *SightPros Communication Tool* section.

*Speaker phone*

This refers to a telephone or a cell phone with speaker capabilities that allows public communications on one end of a telephone call. It also allows hands-free operation of a telephone.

*Webcam*

Metro Environmental used Webcams and laptop computers for communications in the early development and testing of the VirTechs processes. The Webcams had difficulty with sharp focus on small components. Occasionally, the customers, especially commercial customers, would not give permission to use the Webcams on their site.

### *Yahoo!® Messenger instant messages*

During the pilot studies, Metro Environmental sent text messages using Yahoo! Messenger instant messages.

## Communications

### *Backchannel (back-channel) talk*

Victor Yngve first coined this term in 1970 for the field of linguistics to describe listeners' behaviors during verbal communication. The backchannel can be verbal and/or non-verbal behaviors. The term implies two channels during conversations, the speaker directs the first channel and the listener directs the second one. They include sentence completions, requests for clarification, brief statements, and non-verbal responses. They can fall into three categories: vocalized sounds that denote attention by the listener, phrases that denote acknowledgement or assessment of the speaker comments, and substantial turn taking that repeats comments and/or asks for clarification.

All cultures and languages include backchannel, but the frequency and use may vary. Confusion and distraction may result from unfamiliar responses in intercultural exchanges.

Backchannel also refers to the practice of using communications to maintain real-time online conversations alongside live spoken remarks. Teleconferences, public speaking, and education use backchannel via Wi-Fi® connections with laptop computers and/or Twitter to allow participants to actively communicate. Speakers and/or the audience can dynamically modify presentations by electronically passing notes and giving or getting immediate feedback to or from the audience.

In business, back-channeling involves bypassing official communication channels, usually by anonymous sharing of information up at least two levels in the reporting structure to create vulnerability at a skipped level. It lets workers impact power differentials in an organization. Similarly, in diplomacy and political relationships, officials use unofficial back channel communications to discuss highly sensitive issues.

### *Background noise*

This refers to unintentional noise or conversations that occur, usually in the background (not as part of the intended communications). People can inadvertently reveal private information when conversing with others, talking on cell phones, recording videos, and/or using the SightPros communication tools.

### *Business call*

This refers to a telephone call that directly relates to the business of a company. A business call may involve some personal chatting to help build the business rapport.

### *Camaraderie*

See *Camaraderie* in the *Teams* section.

### *Chunking*

I define the phenomenon of chunking of information as a series of very short statements or directives containing key ideas with very little detail. As a researcher, I feel that further explorations of this conversational practice may prove fruitful. My initial thoughts regarding this practice have fallen into the following categories.

- Their mediated telephone conversations might favor chunking. The communications companies often charge users of wireless communications by the total minutes of air time. Fewer words mean fewer minutes and lower costs. If they practice chunking even when they speak in person, they increase their skill levels with this linguistic practice.
- Time equals money. A talkative technician spends more time to get in, get the work done, get back out, and get on to the next service call. If a 30-minute service call drags on to 45 minutes, then over the span of a full day's time and considering travel time, this may mean the difference between 6-8 service calls a day versus 4-5 service calls. At approximately \$75.00 a service call, that can mean a make-or-break financial situation for a small business.
- Talk distracts. Technicians face danger of something going wrong. People find it harder to think or observe closely when their conversation distracts their attention from the current tasks.
- The male technicians might follow the American cultural ideology that men do not talk much and women have had to do the work to keep conversations flowing. A female technician may take on the role of less talk to fit in with her peers or assume the cultural role of carrying the conversation.
- The skill levels of the technicians may influence communications. With fairly experienced technicians and /or routine tasks, they may not need instructions to tell them what to do nor would they need to tell others what the other workers need to do. This possibility would relate back to expertness as discussed by Sternberg (1996).

- This phenomenon may result from a noisy work environment. When I first noticed it, the technicians worked in the demolition stage of removing the non-working heating assembly and ductwork in the attic. They worked in crowded space with lots of loud noises.
- My last possible suspect involves the frequent use of non-verbal communications. Nods of the head, pointed fingers, and/or raised arms typically relay distinct messages. The physical location of participants in a situation also relays information. If a worker picks up one end of a very long or heavy object that needs relocation, a co-worker may assume that the worker needs the co-worker to pick up the other end. For many non-linguistic actions, a co-worker may anticipate a needed reaction.

#### *Closing scripts*

See *Opening and/or closing scripts* in this section.

#### *Expertness*

The correct and/or incorrect use of specialized vocabulary and/or terminology can help to determine expertness. The president/co-owner ideologically was more expert than the employee/technicians or the customer. But, frequently the technician and the president/co-owner temporarily switch roles. The technician displays higher, more expert level of knowledge about their work sites than the president/co-owner even though the president/co-owner remains the HVAC expert.

#### *Figurative language*

See *Form* in this section.

#### *Form*

Form deals with the *poetic function of language*. It describes one characteristic of verbal art and performance. Metro Environmental communications contained forms such as specialized language styles and figurative language. For instance, a technician might say "walking the farmer" when discussing a blower squirrel cage.

#### *Hand signals*

Technicians use their hands to signal others, especially in high noise situations.

See also *Chunking* in this section.

#### *Hook up*

This means to get together with another person.

### *Introductory and closing formulas*

See *Opening and closing scripts* in this section.

### *Jokes*

This refers to conversations and/or actions that include humor and/or teasing.

Also, see *Camaraderie* in the *Teams* section.

### *Man of few words*

I use this term to refer to a person, often male, who speaks infrequently, mostly when addressed with questions, and/or in brief response statements. This can occur due to shyness, power relationships, habit, language barriers, etc. Most times the technicians talked very little while on the jobs, but often opened up during conversations with friends, during short breaks, or at lunch.

### *Mediated conversations*

The participants use many different media when communicating: telephone, wireless cell phones, the SightPros communication tool, email, Web sites, etc. They communicate with remote personnel from the customers, the home office, or the work sites. They communicate between customers, office personnel, and technicians.

They often mediate the communication from one technician to another even at the same work site. Technicians in the attic may use the cell phone to save themselves travel up and down the stairs while communicating with another technician located anywhere outside of hearing range.

In both directions, the participants experience problems with understanding the communications because of signal loss. Moreover, with the Direct Connect feature, the technicians only hear conversations when the talk button on the cell phone remains activated. Participants sometimes block conversations by inactivating the button which then puts them on hold or covering the microphone.

Also, see *Direct Connect wireless telecommunications* in the Communication Devices section.

### *Narratives*

See *Storytelling* in this section.



### *Nuisance call*

Christine cited two examples of what she considered as nuisance calls: (a) Salesmen from other companies calling the office for something their office already handled. (b) Callers who dialed incorrect numbers.

### *Objectifying*

Whorf (1956) noted that the structure of particular languages partly conditions our concepts of time, space, and matter. In talking about physical quantities, he stated that "Our language patterns often require us to name a physical thing by a binomial that splits the reference into a formless item plus a form. . . . It is part of our whole scheme of OBJECTIFYING — imaginatively spatializing qualities and potentials that are quite nonspatial."

Technicians use statements like "push the air" and "no air."

### *Opening and/or closing scripts*

They had special introductory and closing formulas as also noted in the second pilot study such as "K. Go ahead guy. . . ." and "Yeah, I'm over here. . . ." and "Well, then, uh take it home." Like in Irvine (1974), they used typical greetings. Their closings followed their "set of rules for the socially appropriate constructions and interpretation of messages" (Frake 1964, p. 132; Irvine 1974). Irving notes that these help us to appropriately behave in situations.

Formulas and scripts include the words and/or actions used to open and close a communication or any subset of that. For instance, they include the way the telephone gets answered or the way the telephone conversation typically signals an end. Examples: (a) Hello, Goodbye, (b) Okay. Thanks, man. Bye, bye. They can occur at any transitions within each communication. For instance, a call might start with a greeting, transition into a personal exchange, and then transaction into a business exchange. In that instance the entire personal exchange has its own open and close, as does the entire personal and the entire business exchange.

### *Personal phone call*

This refers to a telephone call that does not relate to the business of a company.

### *Politeness*

This refers to statement and actions that conform to the politeness or respect norms for a culture. As in Keenan (1974), several linguistic ideologies seem apparent for this service industry. If service personnel made their customers uncomfortable, they can cause their business to quickly fail. So some of the linguistic ideologies were:

- Service personnel avoid direct affronts.
- Service personnel do not make a customer feel uncomfortable or unpleasant since that can cause a loss of face and that will go against the community norms.
- The community admires the service personnel for their sophisticated but indirect verbal art skills. The service personnel use those skills to build and maintain relationships.
- The service personnel seldom confront anyone to the extent that they only allude to or present through a third party even a typical request of someone.

In one pilot study (see Appendix B), I show an instance where the president/co-owner expresses a concern for an upcoming meeting with the vice-president at a major communications provider because that meeting involves an extremely important set of negotiations.

Also, see *Opening and closing scripts* in this section.

#### *Power relationships*

The customer, even when they may not realize it, holds a lot of power in their relationship with any customer service organization.

The vice-president/co-owner, through her comments, often directs the dispatcher who in turn directs the technicians. As an interesting aside, companies often pay a dispatcher much less than a technician because of the expert knowledge of the technician. In our society where salary seems very important this switch in power roles intrigues me. Ideologically in a salary hierarchy, the dispatcher will have less power and the technician more. However, the dispatcher has implied power because the dispatcher coordinates the technicians actual work contacts and schedules.

#### *Quiet time*

This refers to the gaps of time within and between any communications.

#### *Specialized language styles*

See *Form* in this section.

### *Storytelling*

Bauman (1981) talked about the importance of story telling and truth-in-dog-trading activities at Canton, Texas. Storytelling refers to the telling of stories, narratives, or tales, either personal or business, in order to highlight or convey a point. Sometimes storytellers will stretch the truth to add emphasis to the point.

Also, see *War stories* in the *Training* section.

### *Talking to the camera*

This term incorporates a natural tendency to turn towards a camera when someone takes a picture. This also extends to movies or video taken with camcorders, network cameras, Webcams, etc. with the actors turning towards and trying to talk directly to whoever may view them.

### *Texting*

This refers to send text messages via telephone and/or computers.

### *Truth*

See *Storytelling* in this section.

### *Verbal art and performance*

See *Form* in this section.

## Cooling

### *Ambient charge*

Ambient charge refers to the measurement reading of the refrigerant charge at ambient air temperature. According to Webster's New World (1964), ambient means "surrounding; on all sides" (p. 46). So, ambient temperature refers to the temperature surrounding an object. Some discussions suggest that, in HVAC systems, ambient temperature can refer to interior room temperatures as well as exterior building temperatures. For example, outside the ambient temperature can be 85 while inside it can be 72. Other discussions suggest that ambient temperature refers only to the air temperature at a location external to a building.

### *Charge*

See *Refrigerant charge* in this section.

### *Coil*

This refers to the refrigerant lines as they run and wrap through the compressor, the AHU, or the furnace.

### *Compressor*

This term refers to a part within the condenser. The condenser uses it to change refrigerant from a gas to a liquid state.

The compressor, a mechanical device, acts on the refrigerant. The refrigerant works like a fluid that can change between a gas state and a liquid state. The compressor increases or decreases pressure on the fluid by changing its volume in a manner similar to a pump. With enough pressure, the fluid changes from a warmer gas state into a cooler liquid state.

### *Condenser*

See *Condenser* in the *HVAC Systems* section.

### *Drum*

Technicians carry the refrigerants in high pressure drums.

### *Dryer*

This term refers to a device that technicians weld or solder onto the suction line and/or liquid line to remove any water, moisture, or contaminants in the refrigerant lines. Alternate spelling: Drier.

### *Fan*

A fan pushes air through the condenser and past the coil.

### *Fan motor*

This refers to the motor installed in the condenser. Some motors have oil ports and oil caps to oil the motor bearings. Some bearing self lubricate.

### *Liquid line*

This refers to the line coming out of the compressor. This line contains refrigerant in a liquid state. This line has a smaller diameter copper than the suction line. Dryer can go on this line.

### *O-ring*

### *R-22 (Freon®)*

This refers to one of the refrigerants used in HVAC systems. Most of the older residential condensers contain the standard R-22 refrigerant called Freon.

### *R-410A*

This refers to one of the refrigerants. This chlorine-free refrigerant meets the newest, more stringent EPA (Environmental Protection Agency) environmental guidelines. Several manufacturers make the R-410A refrigerant. Some technicians and/or customers refer to one popular brand name, Puron<sup>®</sup> refrigerant, when discussing this refrigerant.

### *Refrigerant*

This refers to the working fluid in an air conditioner or a heat pump. The chemical fluid creates a cooling effect when expanding or vaporizing. Common types include R-22 (Freon) and R-410A (a more eco-friendly Freon blend). Technicians carry these in pressurized tanks.

The refrigerant cycles/recycles throughout the HVAC system fully contained within copper pipes. Warm refrigerant gas enters the condenser at the compressor. The compressor pressurizes the refrigerant to a warm liquid. The warm liquid refrigerant then gets cooled in the condenser coils and flows as a cool liquid to the evaporator. At the evaporator, the cool liquid gets released through the expansion valve or other metering device into the evaporator coils. When the warm interior air flows across the coils in the evaporator, the refrigerant cools the interior air while the interior air warms the refrigerant. The refrigerant expands into a warm gas which then gets cycled back to the compressor in the condenser. The now cooler interior air gets recycled back into the building.

On HVAC unit change outs and on some repairs, the technicians remove and capture the old refrigerants rather than releasing them and polluting the air. Moreover, recovered Freon has a high value in today's market so technicians typically recycle it and/or reclaim it.

Recycling it involves removing, cleaning, and reusing it. Reclaiming it involves returning used refrigerant to the manufacturer for disposal/reuse.

### *Refrigerant charge*

This term refers to both an action and an amount. Technicians charge a system by adding refrigerants to it. Charge, as in check the charge, also refers to the amount of refrigerant contained in a sealed air conditioner or heat pump system or in the sensing bulb on a thermostatic expansion valve (TXV).

On HVAC unit installations, change outs, and on some repairs, the technicians must install refrigerants in the HVAC units and then check for the proper charging.

For proper charging of refrigerant lines, the system requires temperatures of over 70 degrees. Technicians can use a charging chart to help determine the proper amount of charge to set for temperatures under 70 degrees, but they must recheck the charge later and recharge the system, if needed.

When an air conditioner or heat pump has too much refrigerant, the overcharging may damage the compressor. When an air conditioner or heat pump has too little refrigerant, the undercharging reduces the efficiency of the unit. A thermostatic expansion valve (TXV) can mitigate the impact of improper refrigerant charge.

#### *Rubber seals*

Technicians use rubber seals on components such as valves.

#### *Schrader valve core*

This refers to the plastic seat for valves on refrigerant lines. Technicians must remove them using a Schrader valve core removal tool when soldering nearby lines due to their plastic composition.

Also, see *Schrader valve core removal tool* in the *Tools* section.

#### *SEER (Seasonal energy efficiency ratio)*

This term refers to a cooling efficiency ratio of a central air conditioner or heat pump over one year so that it averages across seasonal variations. A higher SEER equates to better energy efficiency, lower electricity bills, and higher purchase prices. The ratio comes from measuring the cooling in BTUs (British thermal units) during 12 months and then dividing that by the total electric energy input in watt-hours during the same 12-month period.

Older residential air conditioning units have SEER ratios of 8-10. The Department of Energy (DOE) set a minimum SEER ratio for all residential units (except window units) manufactured after 2005 and/or sold in the United States after January 2006 at 13.00. ENERGY STAR® qualified central air conditioners and heat pumps must meet a minimum SEER of 14. Manufacturers now make equipment with SEER ratios as high as 20.

#### *Suction line*

This refers to the line coming into the compressor. That line contains refrigerant in a gas state. This line has a larger diameter copper than the liquid line. Dryer can go on this line.

### *Ton and/or tonnage*

Ton refers to a unit of measurement for the cooling capacity of air conditioning units. The HVAC industry in North America established this measurement from the amount of heat energy in BTUs that it takes to melt one ton of ice to one ton of water in a 24-hour period at 32° F. One ton equates to 12,000 BTUs per hour or 288,000 BTUs per day.

Metro Environmental uses this unit of measurement to determine the cooling capacity and therefore the size of the HVAC unit that a customer needs.

### *TXV (thermostatic expansion valve)*

See *Refrigerant charge* in this section.

### *Valves*

See *Schrader valve core* in this section.

## Customer Location

### *Arrival*

On arrival, the technicians greet the customer then check for updates to any site plans. For the study, I used this time for introductions and signing of the permission forms.

### *Attic and roof structures*

House and business structures often have attics or crawl spaces just under the roof structures. The attics and crawl spaces contain the HVAC ductwork and sometimes the HVAC units. Structures with varying heights often have multiple attics.

A framed roof structure consists of an assembly of rafters and wall-ties supported by the walls of the building structure below.

Rafters refer to the beams that support the roof of a building. Traditional roof styles use exposed rafters. In home construction, builders typically use wood rafters. A simple ridged roof has angled rafters. The bottoms of the rafters sit on wall plates on top of each wall. The tops of the rafters meet at the horizontal ridge plate or ridge beam.

Attics consist of trusses built from sloping rafters and horizontal ceiling joists. Builders often use manufactured pre-fabricated roof trusses.

Truss refers to a framework of wood, metal, etc. used by a builder to support a roof. A truss often looks like one or more triangular units consisting of straight boards connected by wall joint on the ends.

Joists refer to parallel boards/beams that run from wall to wall to support either the ceiling or the flooring of a building. They also allow running space for HVAC ducts, plumbing, etc. Builders space the joists at 12-inches, 16-inches, or 24-inches on center and sometimes cover them with plywood to form a floor.

Floors consist of joists that sit atop supporting walls, beams or girders. Floor platforms contain the joists within long headers, often the full length of the floor. Wall structures sit on floor platforms. The floor platforms support the weight of the wall and any platform structures that sit above them, including the next story and/or the roof. They provide lateral strength along a wall and lateral support against wind. They hold the studs and walls square and true.

#### *Attic flooring*

During HVAC unit installations in attics, the installation crew may install plywood flooring for safety if no attic flooring exists. This prevents their crew members and/or the technicians from falling off of the attic joists and through the ceilings.

Also, see *Attic and roof structures* in this section.

#### *Brace board*

John Thomason mentions this term regarding an attic structure. Attics have both brace boards and trusses. Trusses are triangles running from walls to the top peak of the roof. Brace boards run perpendicular to the trusses and support multiple trusses.

#### *Builder and builder problems*

Builders often use standard floor plans but so many builders and new styles occur throughout the years that it yields many different floor plans. Builders typically design homes and facilities for customer needs, enhancements, and desires, but usually not for future service concerns.

#### *Clearances*

Often, builders install HVAC units in very tight spaces. On outside units, builders locate units close to the main structures to minimize the cost of wiring and pipelines. Customers often hide view of the units behind walls and shrubs. In attics, technicians face many space issues due to customer storage, wiring runs, ductwork, etc.



### *Climbing*

Technicians climb many stairs and ladders in getting to buildings, upper floors, attics, roofs, etc.

### *Commercial and business customers*

Technicians often face different situations in residential locations than at commercial and business locations.

### *Concrete pads or slabs*

Builders place these underneath the outside HVAC unit to provide a stable base instead of putting them on bare ground. This minimizes corrosion that may increase if the units touch bare ground. On a systems replacement, the installation team may replace the original concrete pad if the new condenser measures larger or weighs more.

### *Curb*

On roof installations, this refers to the lip built around the roof openings to keep roofs watertight.

### *Customer storage*

Customers use attics and utility closets for storage. Technicians must adapt to the customer use of their attic and/or closet spaces. Technicians can move items, but they usually try to put them back in their original location.

### *Customers*

Technicians deal with a variety of customers and contacts. They range in age from babies to the very elderly. They range in ethnicity. They range in language skills. They range from the very wealthy to very poor. They range from professionals to unemployed adults or even students and children. They have a wide variety of knowledge about HVAC systems and maintenance. Technicians learn to interact appropriately with all of their customers and contacts.

### *Drywall*

This refers to an inexpensive wall covering that the builders often texture and then paint. Technicians find it easy to drill. But, it does not support much weight.

### *Flexibility*

Attics often involve tight spaces so technicians need flexibility to move and manipulate in these spaces.

### *Insulation*

Builders use itchy fiberglass insulation and/or old hazardous asbestos insulation for energy efficiency in attics and walls. Loose insulation often falls through ceiling access doors during HVAC maintenance. Technicians use drop cloths to catch it and then they remove it during call wrap-up.

### *Ladder cage*

See *Rooftop* in this section.

### *Location of HVAC units*

Builders install HVAC units in various locations - closets, roofs, attics, side yards, etc. Installers sometimes move these locations if they install larger HVAC units, especially when the original builders put them inside small closets.

### *Locks*

Technicians sometimes face locked access to customer locations. Locked gates and doors may cause problems.

Also, see *Rooftop* in this section.

### *Pets*

Technicians deal with pets in many customer homes. They must watch that pets do not get loose from yards and houses or into their work areas.

### *Residential customers*

Technicians often face different situations in residential locations than at commercial and business locations.

### *Rooftop*

Metro Environmental uses cranes or helicopters, as needed, to deliver large RTUs to rooftops. Cranes cost a lot for the crane and the crane operator, but Metro Environmental can easily schedule them as needed. Helicopters cost even more for the helicopter and the pilot, but Metro Environmental can also schedule them as needed.

Technicians carry 30-foot ladders on their truck to get up on rooftops as needed. But, some buildings stand taller than portable ladders can reach. For tall buildings, builders may add a ladder cage for outside access to the rooftop. Technicians face inconvenience and/or safety issues when building managers lock the ladder cages to minimize theft and vandalism problems.

## *Walls*

For building structures, walls support roofs and ceilings as their main purpose. They usually have structural elements (like wood or steel studs, headers, and wall plates) and surface elements (both interior and exterior like drywall, wood paneling, brick, stucco, etc.). Walls may house HVAC ductwork, insulation, electrical wiring, or plumbing. They mount electrical outlets, thermostats, grilles, and louvers. Technicians sometimes drill holes in the walls to run new thermostats and wiring.

Walls sit on floor platforms. The floor platforms support the weight of the wall and any platform structures that sit above them, including the next story and/or the roof. Floor platforms provide lateral strength to the wall and lateral support against wind. They hold the studs and walls both square and true.

Studs provide vertical support to building structures. Traditionally, wood studs come in 2×4 or 2×6 inch timbers. In North America, builders typically separate studs at 16 inches (400 mm) from each other's center, but sometimes at 12 inches (300 mm) or 24 inches (600 mm).

Headers, also called lintels, refer to the horizontal beams used in the construction of buildings. They usually support brick, tile, stone, glass brick or concrete block masonry in a load-bearing wall above a window, door, or fireplace opening.

The lateral structures including the headers and floor platforms hold the outward forces in check, keep the walls in parallel, and keep the walls from bulging.

The studs and wall plates sit at right angles to one another. They provide vertical support to the upper floor/attic structures.

Fire safety officials deem wall plates and platforms much safer since they provide an automatic fire stop inside walls.

Wall plates include three types of lateral structures located at the top and bottom of wall sections. Each type continues in a piecewise fashion around the whole perimeter of the structure.

- Sill plates refer to the bottom wall plates. Builders bolt or strap these plates securely to the top of a foundation or a concrete slab. They hold the building down during heavy winds.

- Lower wall, base, or floor plates refer to the wall plates attached to the bottom of the wall studs. These also refer to the bottom of a wall section if a wall gets built as an assembly. On upper floors, these get nailed to the platform of the supporting floor.
- Upper wall, top plate, or ceiling plates refer to the wall plates attached to the top of the wall studs. These also refer to the top of a wall section if a wall gets built as an assembly. These support the platform of the next story or the ceiling and roof assembly.

Wall plates sit at right angles to the vertical load-bearing part of a building. They structurally serve as localized headers. Builders use the upper and lower wall plates to set and hold the correct interval between parallel wall studs.

Builders use wall assemblies to expedite wall construction. They create the wall assemblies using studs and wall plates. They build the wall assemblies flat on the ground then tip them up into a vertical position to form the base for the wall coverings.

## Customer Service

### *Billing*

Metro Environmental uses three types of billings. Some customers pay for time and materials when they call for maintenance and service. Some customers pay a flat rate for yearly maintenance and service. Some customers get free warranty service, but Metro Environmental gets reimbursed by the manufacturer.

### *Call duration*

This refers to the amount of time that a technician spends at a customer account.

### *Customer records*

Metro Environmental maintains historical records of all customers, including addresses, service and installation dates, equipment serial numbers, equipment type, maintenance and service calls, etc.

### *Mailings/advertising*

### *Sales*

*Screen recorder software*

See *Screen recorder software* in the *SightPros-VirTechs System* section.

*Support staff*

*Surveys*

Trane® Inc. conducts most of the formal customer surveys for Metro Environmental, usually after installation of new HVAC units. However, Metro Environmental can request customer surveys for any services related to the Trane units. Trane reports show that Metro Environmental receives excellent customer survey results.

*Warranty*

HVAC warranties often range significantly depending on the equipment, the manufacturer, the installation, the method of registration, and any additional charges paid by the customer for extended warranties.

Diary

*Arrival/departure time at ME*

I used this category to code my arrival and departure time comments in my diary entries or other recordings.

*Confirmation*

I used this category to code potential confirmations of ideas in my diary entries or other recordings.

*Expectations*

I used this category to code my stated expectations in my diary entries or other recordings.

*Impressions*

I used this category to code my impressions, both initial and secondary, in my diary entries or other recordings.

*New area to explore*

I used this category to code new areas to explore in my diary entries or other recordings.

*Personal/private information*

I used this category to code personal or private information, especially those unrelated to this study, in my diary entries or other recordings.

*Plans*

I used this category to code statements regarding my plans in my diary entries or other recordings.

*Prejudice*

I used this category to code potential instances of prejudice in my diary entries or other recordings.

Drainage

*Double-trap*

This refers to two p-traps in a drain line. Standards suggest a single p-trap for the ideal drain line. Technicians prevent a double-trap by installing the line so that it slopes down and away from the first p-trap.

*Drain line*

Technicians build a drain line from the evaporator coil to the drain lines in a building (those usually connect to the main drain for the sewer) to remove condensate (water pulled from the air). They create a p-trap somewhere along their drain line to prevent bad odors and trap fallen items.

*Overflow safety switch*

This switch detects water buildup and shuts off the HVAC system to prevent water overflow and possible flooding or damage to the customer location.

*P-trap*

This refers to a desirable water trap on a drain line that prevents bad odors from escaping and traps fallen items, like screws or rings, so that they don't get lost in the sewer.

*Vent*

This refers to a pipe that allows air into a drain system. It balances the air pressure. This prevents the water in the p-trap from getting siphoned off. Its engineered location puts it on the side of the p-trap opposite from the evaporator.

## Ductwork

### *Curb adapter*

This mechanical component connects a RTU to the lip of the curb on the roof.

### *Damper*

Technicians use this device to restrict and/or adjust the air flow in ductwork so that each room receives a balanced air flow. Alternate name: air balancing damper.

### *Duct*

Webster's New World (1964) defines this as "a tube, channel, or canal through which a gas, liquid, etc. moves . . . a pipe or conduit with wires or cables running through it" (p. 448).

### *Duct board metal boxes*

This refers to the old style ductwork built from sheet metal components. During an AHU or furnace upgrade, technicians often replace these with the newer flex duct.

### *Flex duct*

This refers to the new style ductworks that look like metallic cloth wrapped around a metal spring coil. The coil gives it an extremely flexible shape. The technicians commonly use 14-inch flex duct.

### *Flue stack reducer*

See *Flue and flue stack* in this section.

See *Reducer* in the *Mechanical* section.

### *Flue and flue stack*

Any tube, pipe, vent, or shaft that carries smoke, gas, hot air, etc. from a furnace to the outdoors. The flue gets very hot when the furnace runs so the stack must have clearance where the flue goes through walls, the ceilings, or the roof. For safety and fire prevention, technicians install them with a smaller pipe, the flue, inside a larger pipe to create the flue stack. They also describe this as a double wall stack.

### *Grille*

Grilles function as decorative wall, floor, or ceiling faceplates for duct openings. Many come in rectangular shapes with multiple parallel slots. Ducts deliver or withdraw air from ventilated spaces. The grilles can direct the flow of delivered air from the ducts as needed within the ventilated spaces. Grilles also prevent entry of large items from the ventilated spaces into the ducts that might block the flow of withdrawn air.

### *Louver*

Louvers contain multiple small blades that will adjust in some styles. Builders can place them in HVAC ducts or at duct openings to help control the air flow. They can control the air flow volume like a damper, but they can fit larger openings than dampers. At duct openings, builders frequently place them just behind the grilles. A louver placed behind a grille usually has a handle that extends through the grille for easy adjustment of the louver. Also, builders add louvers to doors and/or walls for better air flow.

### *Mastic*

Webster's New World (1964) defines mastic as "any of various quick-drying pasty cements used for cementing tiles to a wall, etc. "(p. 905). Technicians use mastic as a liquid sealant. They apply it like a thick paint using a mastic brush. They try to make the HVAC units and the ductwork air tight for energy efficiency.

### *Mastic brush*

Technicians use these disposal paintbrushes to apply mastic sealant.

### *Metal tape*

Technicians use this to seal the ducts to prevent air leaks. It looks like metallic duct tape, but works better than duct tape.

### *Plenum*

Technicians use these rectangular sheet metal boxes to link the supply ductwork as well as the return ductwork with the furnace or the AHU. Technically, this term describes any contained space with separate air.



### *Plenum space*

[http://en.wikipedia.org/wiki/Glossary\\_of\\_HVAC](http://en.wikipedia.org/wiki/Glossary_of_HVAC) notes that this term describes "an enclosed space inside a building or other structure, used for airflow. Often refers to the space between a dropped ceiling and the structural ceiling or a raised floor and the hard floor. Distinct from ductwork as a plenum is part of the structure itself. Cable and piping within a plenum must be properly rated for its fire and smoke indices."

By California standards, HVAC installers may not use the building cavities as a duct or plenum unless they use a sealed duct board or metal liner.  
(<http://www.energy.ca.gov/efficiency/qualityhomes/procedures.html>).

### *Register*

This refers to a metal grate that covers the output air end of each duct as it ends at the ceilings, floors, or walls.

### *Return*

The metal grate that covers the input air end of each duct or HVAC unit as it begins at the floor, wall, or ceilings.

### *Sealants*

See *Mastic* in this section.

### *Start collar*

This term refers to a metal form that ties each duct into the plenum. It typically looks like a circular sheet metal form with metal tabs that the technicians can bend to lock it into place on the hole that they cut out of the plenum.

## Electrical - Electronics

### *A/C power*

See *Power* in this section.

### *Blower motor*

See *Blower motor* in the *Heating* section.

### *Conduit*

See *Electrical conduit* in this section.

### *D/C power*

See *Power* in this section.

*Damper switches*

See *VAV (variable air volume)* in the *HVAC Systems* section.

*Disconnects for power*

This refers to a metal box where technicians can connect or disconnect power to furnaces, AHUs, and/or compressors. The power disconnects may contain hardwire connections or a power switch for easy turning on and off of power.

*Electrical conduit*

Technicians use electrical conduit to protect electrical wiring from impact, moisture, and chemicals. They vary in types, sizes, and lengths. Some are flexible; some are rigid. They simplify design and construction since multiple wires and wire sizes can run together in the same conduit. They aid in wiring change outs since technicians can easily slide old wires out and new wires in.

PVC conduit and connectors cost less and weigh less than other types. Metal conduits shield sensitive circuits from electromagnetic interference. Rules and regulations restrict the use of certain conduits in some applications.

*Electrical panel*

This term refers to a metal box device that centralizes the electrical fuses for a building, an area, or a home.

*Electrostatic filters*

This refers to electronic filters.

Also, see *Filters* in the *Mechanical* section.

*Fuse*

A fuse provides protection for electrical spikes and/or shorts.

*Humidifier*

If installed, installers usually place it in the supply plenum.

*Ignition switch*

See *Ignition switch* in the *Heating* section.

*Kill the power*

See *Power* in this section.

### *Outlet*

This refers to the electrical components that conveniently deliver power to the customer. Most wall outlets have grounded connections and contain room for two power connections.

### *Power*

A/C power refers to alternating current power such as from an electric company transformer, a wall outlet, or from a transformer inside a HVAC unit. In the United States, the two common power connections include 120 VAC or 240 VAC.

D/C power refers to direct current power such as from a battery or from a transformer inside a HVAC unit. In the United States, common D/C power components use 12 VDC, 9 VDC, 5 VDC, 3 VDC, and 1.5 VDC.

*Kill the power* refers to a statement that the HVAC technicians use. It describes an action that turns off power to a HVAC unit either by accident or on purpose. For instance, John told Kwame to kill the power. However, a blown fuse can also kill the power.

See also *Disconnects for power* in this section.

### *Power bank*

This term refers to a string of power boxes and power meters used in some commercial sites to distinguish power usage. For instance, a building with 4 apartments or condos may want to have 4 meters conveniently located in a power bank close to 4 adjacent outside condensers.

### *Power switch*

A power switch provides for easy turning on and off of power to HVAC units. Power switches include wall switches and switches located either inside or outside of the units.

### *Stat*

See *Thermostat* in the *Temperature Control* section.

### *Thermostat*

See *Thermostat* in the *Temperature Control* section.

### *Wall outlet*

See *Outlet* in this section.

### *Wire guides*

## *Wiring*

## Heating

### *230V 3-phase gas pack*

#### *Blower*

The blower pushes air into the furnace or AHU. The industry rates blower capacity in CFM (cubic feet per minute).

#### *Blower motor*

This refers to the motor installed in the blower. It rotates the blower wheel or fan for air circulation. Some motors have an oil port and/or an oil cap to oil the motor bearings. Some bearing self lubricate. Alternate name: Combustion motor.

#### *Blower wheel*

This refers to a large mechanical wheel with multiple scoops that help to direct air into the furnace or AHU area. Alternate name: squirrel cage.

#### *Burner rack*

A burner rack contains a set of burners in a furnace.

#### *Burners*

The burners control the combustion of gases in a furnace.

#### *Coil*

See *Evaporator coil* in this section.

#### *Combustion motor*

See *Blower motor* in this section.

#### *Convertible*

This refers to a furnace that technicians can install either vertically or horizontally.

#### *Disconnect*

See *Disconnects for Power* in the *Electrical - Electronics* section.

*Evaporator coil*

This mechanical device includes the refrigerant lines as they wrap through the indoor HVAC unit. It functions on the refrigerant lines to condition air inside of a home or business by absorbing the heat and moisture from that air. These get rated in tons of refrigeration. For instance, they come in 2-ton, 3-ton, 5-ton, etc. units.

*Furnace*

A furnace uses fuel (natural gas, propane, butane, oil, or another flammable substance) to heat air or an intermediate fluid in a HVAC system. Technicians can install them either horizontally or vertically.

*Gas line*

*Gas valve*

*Heat exchanger*

*Heater*

A heater uses an electric heating coil to heat air. Technicians can install them either horizontally or vertically. The industry rates heaters in BTUs.

*Heater rack*

A heater rack contains a set of electric heating coils in an AHU.

*Heating coil*

A heating coil uses electricity to heat air.

*Ignition switch*

This refers to an electronic device that ignites the pilot light in a furnace.

*Pilot light*

This refers to a mechanical device that ignites the gas in a furnace.

Home Office

*Cam1*

See *Cam1* in the *SightPros Communication Tool* section.

### *Company policies*

Christine developed a set of company policies.

### *Decorations*

Decorations included normal office type decorations. They included lots of personal items like stuffed animals, pictures, candles, etc. The ladies bathroom included elegant, but feminine decor.

### *Dogs*

Susan brought a small dog to the office everyday. John Thomason, Christine, and/or Rachael brought their large dogs occasionally.

### *Fixtures*

Fixtures include normal office type fixtures. Additionally, several bathrooms include showers.

### *Furniture*

Most furniture looks like standard office furniture. They have a few antique pieces in some offices.

### *Horizontal marketing software*

This term describes software packages, such as Microsoft® PowerPoint® presentation software, that many different industries (education, finance, insurance, etc.) use. Some call this productivity software. Metro Environmental uses the Microsoft software products for many general applications.

### *Loading dock*

The western wall of the building opened into a loading dock (high bay) towards the front of the warehouse.

### *Locations and moves*

Metro Environmental had their offices in Coppell, TX for the first pilot study, in Lewisville, TX west of I-35 in the second pilot study, and in Lewisville, TX east of I-35 in the dissertation study.

They owned and sold the Coppell property. They leased both Lewisville properties. However, they want to purchase their current location.

Technicians and office personnel assisted in each move. They personalized the offices and office spaces as requested or desired.

### *Maps*

The office has a large map of the Dallas/Fort-Worth Metroplex on the wall. The personnel have access to MAPSCO® maps and/or use the computers to obtain directions as needed.

Also, see *MAPSCO maps* in the *Travel* section.

### *Office space expansion*

Metro Environmental expanded their offices when they went from leasing just the bottom floor in December 2007 at their current location to leasing the entire building in the spring of 2008.

### *Parking lot*

Metro Environmental has a 4-car parking area in front of their building. They have a partially concrete, partially turf parking area aside their building, outside of a locked fence area that will park approximately 6 vehicles. They park the box truck at their loading dock next to that area of parking. Inside the fenced area, a large number of vehicles can park since it is totally paved. They keep a small trailer in this area.

### *Parts and supplies*

Metro Environmental maintains a full range of common, low-priced parts and supplies at their offices. Representatives from various manufacturers help them maintain a good stock level; some even visit the home office to check on usage levels.

Also, see the *Electrical - Electronics* section.

Also, see the *Mechanical* section.

Also, see the *Supplies* section.

### *Regulations: Local and state*

See *Regulations: Local and state* in the *Working Conditions* section.

### *Rooms*

### *Vertical marketing software*

This term describes software packages that a particular industry such as banking, government, insurance or manufacturing uses. Service dispatched industries use a software package that helps with customer records, scheduling, service calls, inventory, payroll, etc.

## HVAC Systems

### *AHU (air handler unit)*

This refers to HVAC equipment that moves and/or mixes air. It can include the blower, fan, heating coil, cooling coil, expansion device, controls, condensate drain pan, air filter, etc. It does not include the ductwork, registers, grilles, boilers, and/or chillers.

An AHU always heats with electricity. Technicians also call these fan coil units since they contain the evaporator coil, the heat strip, and the blower. AHUs basically work as glorified toasters.

### *Condenser*

This refers to the outdoors HVAC unit that includes the compressor, fan, etc. Central heating and cooling systems and heat pump systems include a condenser.

### *Electric heating/electric cooling*

This refers to HVAC systems that use both electric heating and cooling. Approximately 20% of the systems in the Dallas/Fort-Worth Metroplex use this combination. John Thomason ranked these as energy inefficient.

### *Energy management systems*

Energy management systems often include computerized software systems for HVAC and/or lighting controls. They use sensors to monitor conditions in various areas or zones and then adjust the temperature and/or lights to minimize overall energy use.

### *Freezer unit*

For my study, this refers to commercial, glass-front freezers frequently found in grocery stores and convenience stores.

### *Gas heating/electric cooling*

This refers to HVAC systems that use gas heating and electric cooling. Approximately 50% of the HVAC systems in the Dallas/Fort-Worth Metroplex use this combination.



### *Heat pump*

This refers to HVAC systems that use a heat pump for heating and cooling. Approximately 30% of the HVAC systems in the Dallas/Fort-Worth Metroplex use heat pumps. John Thomason ranked these as the second most common HVAC systems in this area.

A heat pump heats or cools by moving heat. In the winter, it draws heat from outdoor air and circulates it indoors. In the summer, it reverses the process and removes heat from indoor air and releases it outdoors.

### *Ice maker*

For my study, this refers to commercial ice making equipment that can make either ice cubes or shaved ice.

### *Packaged system*

This refers to a HVAC system in a single cabinet that usually houses both the heating and cooling components found in split systems: evaporator, condenser, compressor, etc. Customers typically install them outside, either on the roof or at ground level.

### *Packaged unit*

See *Packaged system* in this section.

### *Refrigeration unit*

For my study, this refers to commercial, glass-front refrigerators frequently found in grocery stores and convenience stores.

### *RTU (roof top unit)*

This refers to a HVAC system that sits on the roof at a commercial site. Most RTUs use packaged systems with both heating and cooling components.

Also, see *Packaged system* in this section.

### *Split systems*

Split systems, primarily found in residential installations, refer to a HVAC system with a heating unit inside a home or building and a cooling unit outside.

### *Transition*

This metal box connects the furnace or heater to the evaporator coil.

### *VAV (variable air volume)*

Most new and/or renovated commercial HVAC systems use VAV boxes. Older homes and business use constant air volume systems which work less efficiently.

HVAC systems use VAV boxes in ductwork in conjunction with an energy management system. They conserve energy by allowing lower fan speeds when the temperature demands remain low. Some control heat, some just a blower box. Typically these systems utilize a stable temperature on the air supply side then vary the air flow rate to achieve the desired temperature. A VAV-controlled system uses either electrically-controlled (an automatic damper with a motorized arm) or pneumatically-controlled mechanical dampers to adjust the air flow rate.

## Mechanical

### *Bearings*

Bearings, mechanical parts, look like either hollow cylinders or cylinders with one end flared. Manufacturers use bearings to allow efficient rotation of components in devices. They diminish friction and therefore reduce wear on the components. Bearings usually come in self-lubricating brass or in stainless-steel ball-bearing assemblies.

### *Bolts*

Technicians use screws, nuts, and/or bolts to secure devices together or to secure them into specific places. They carry a variety of these in case they lose one when working on a HVAC unit. Like many technicians, extras always seem to appear at the end of some jobs either from finding ones lost during previous visits or gathering some during system or unit removals and/or replacements.

### *Copper tubing*

Technicians carry an abundance of copper tubing for use in the refrigerant lines.

### *Covers*

All HVAC units have covers. Technicians remove some of these regularly for installation, maintenance and troubleshooting activities.

### *Damper switches*

See *VAV (variable air volume)* in the *HVAC Systems* section.

### *Filters*

Both customers and technicians frequently install and/or replace filters in HVAC systems. The systems usually have an access door for easy replacements. Technicians usually recommend replacement intervals of 1-3 months.

Filters in HVAC systems remove dust, pet dander, smoke, tobacco, pollen, mold, and bacteria from the air. Some air filters with absorbents or catalysts remove organic compounds and ozone.

Filters come in various sizes, depths, and types. Some HVAC units use filters as small as 12 x 12 inches. Common sizes range from 12 x 24 inches to 25 x 25 inches. Common depths include 1 inch residential and commercial, 2 inch commercial, 4 in residential, and 5 inch residential. Common types include foam, pleated paper, and spun fiberglass.

HEPA (high efficiency particulate air) filters, remove at least 99.97% of 0.3-micrometer or larger particles. A minimum efficiency reporting value (MERV) 14 filter captures at least 75% of the particles between 0.3 to 1.0 micrometers. Higher efficiency MERV filters increase energy costs since their density increases air resistance.

Other devices that assist air purification include electrostatic or liquid ionizers, activated carbon, ultraviolet germicidal irradiation (UVGI), photo catalytic oxidation (PCO), and ozone generators.

### *Insulation*

Technicians use insulation on outside and attic lines and pipes to protect them from weather conditions. Metro Environmental uses the Armaflex® brand pipe insulation for this. They creatively use pieces of fiberglass insulation underneath a thermostat to block air leaks.

### *Labels*

Technicians see caution and warning labels on equipment and supplies.

They create their own labels to identify items, as needed. I noticed on one maintenance service that they had labeled with a permanent marker each of the 16 customer RTUs. They labeled each with a number from 1 to 16 to distinguish each RTU for easier record keeping.

### *Metal straps*

Technicians use these to suspend furnaces, air handlers, ductwork, etc. from rafters.

*Nuts*

See *Bolts* in this section.

*Oil cap and oil port*

This describes a mechanical set used on some motors but not on all. Some motors have an oil port usually covered by an oil cap where a technician can add oil for the bearings. Some bearing self lubricate so those motors do not need an oil port or oil cap.

*PVC (Polyvinyl chloride)*

This describes a type of rigid white or cream-colored plastic pipe. Technicians use PVC pipes in non-pressure situations to create systems for drainage, waste, vents, electrical conduits, etc.

Also, see *Electrical conduit* in the *Electrical - Electronics* section.

*Quick connect couplings*

Technicians can use quick connect couplings as an alternative to the use of solder for connecting copper lines in low pressure conditions.

*Reducer*

This refers to a pipe fitting that connects pipes of different sizes together.

*Screws*

See *Bolts* in this section.

*Sleeve bearing*

This refers to a bearing that has one end that flares.

*Wire guides*

## Participants

*Christine*

She co-owned the business, but functioned as the vice-president and bookkeeper.

*Coby*

She worked as an office staff worker.

*Greg*

He worked as the lead technician. He had years of HVAC experience. He functioned as their main refrigeration technician.

*John or PK*

He worked as a HVAC technician. Since his first name matched the president's first name, the owner had nicknamed him as PK. He preferred that I also call him John in our conversations, but he also responded to PK if I forgot.

*John Thomason*

He co-owned the business, but functioned as the president and the licensed HVAC expert.

*Josh*

His peers called him by this nickname instead of Joshua. He worked as the front office greeter and the parts specialist.

*Kwame*

He worked as the new-hire, apprentice technician.

*Luis*

He worked as the lead installer because of his excellent bilingual skills. He wanted to advance to technician status.

*Oscar*

He worked as a helper on the installation team because of his limited English, but his experience exceeded that of the lead installer.

*Rachael*

She occasionally worked as an office worker as available and as needed since her parents owned the business. Near the end of the study, they brought her on full-time to work as the corporate salesperson.

*Ray*

He worked mostly as a salesperson, but also had computer programming background and some HVAC field experience.

*Susan*

She worked as the office manager and dispatcher.

## Professionalism

### *Attitude*

Technicians have an attitude of doing it right the first time so as not to spend the time and money for a return visit. They acted loyal to the company.

### *Bathrooms*

Technicians seldom use customer bathrooms. They go to a fast-food restaurant or store instead.

### *Booties or socks*

Technicians typically wear disposable booties over their shoes when they walk inside of the customer premises. In a pinch, they can remove their shoes and walk about in their socks. They do this to prevent tracking dirt from outside and/or from the attics.

### *Call wrap-up*

During call wrap-up, the technicians check with the home office to clarify any billing questions or other details that they need to cover with the customer. They also receive new instructions about the next call from the dispatcher.

Then they return to the customer to discuss the call with them and present the customers with bills, warranty papers, any other paperwork that require customer signatures, etc. Before they leave, they always thank the customer for their business.

### *Cleanups*

At the end of each call or call segment, the technicians vacuum and dust the customer premises wherever their work causes dirt that missed the drop cloths. They also try to clean any dirt or debris from their uniforms or themselves so that they leave with a clean, professional appearance for the customers.

For service calls, they offer the old parts to the customers so that the customers know that they really have replaced defective parts. They carry any boxes, old equipment, and other debris to the trucks or vans for disposal or recycle at Metro Environmental.

### *Clothing*

See *Uniforms* in this section.

### *Drop cloths*

Technicians use these large, rugged cloths from doorways to work areas to protect the customer premises from dirt.

### *Grooming*

Technicians felt good grooming presented a more professional appearance. This yielded more customer respect.

### *Integrity/honesty*

### *Introduction*

### *Problem explanations*

### *Radio*

When they worked, technicians seldom listened to any personal AM/FM radios or other musical devices at a customer location. They did listen to AM/FM radios in their trucks and vans.

### *Smoking*

Technicians find it hazardous to smoke around gas or gas lines especially near a furnace and in attics where old wood, paper boxes, etc. abound.

Some staff and technicians smoked cigarettes, but never inside customer and business locations. When technicians smoked outside, they usually did so around the van. I never saw them discard their cigarette butts on the customer premises or in the streets.

### *Uniforms*

Technicians mostly wore uniforms. Frequently these got dirty during their work, but they tried to arrive in clean clothes. Company clothing in coordinated styles and colors gave the technicians a professional appearance.

Also, see *Weather* in the *Working Conditions* section.

## Safety

### *Asbestos*

Technicians face exposure to asbestos. Asbestos causes skin to itch upon contact. Asbestos properties include heat, electrical, and chemical retardant as well as well as sound absorption and high tensile strength. Older homes and businesses used asbestos for insulation, drywall, joint compounds, tiles, adhesives, roofing tars, siding, shingles, gaskets, curtains, to coat wires, to fireproof or soundproof walls and ceilings, etc.

Many countries classify asbestos as a safety hazard because of its link to cancer. In the United States, regulations now force builders to use other materials for most applications of asbestos in newer homes and buildings.

### *Attic joist*

If a foot slips on insulation or other potential hazards while standing on or walking across an attic joist, a technician may lose their balance and fall through the ceiling of the room below.

### *CO (Carbon monoxide)*

See *CO (Carbon monoxide)* in the *Troubleshooting* section.

### *Crane cables*

For rooftop installations, Metro Environmental sometimes uses a crane to hoist the RTU. The cranes have super long cables that sway due to crane movements and/or to the wind. The chance for problems increases once they loosen and remove the RTU from the crane cables.

### *Customer requirements*

Corporate customers and construction sites may require hard hats, fluorescent cones for outside work, or steel-toed shoes as part of their safety rules.

### *Door interlock switches*

Some HVAC units have door interlock switches that cut power whenever the door opens.

### *Electric tools*

### *Fiberglass*

Some filters contain spun fiberglass. Fiberglass causes skin to itch upon contact.



### *Gas line*

See *Gas line* in the *Heating* section.

### *Metro Environmental*

Metro Environmental acknowledged technician safety as very important to them and that it involved potentially costly exposures so they required technicians to follow every safety precaution. Nonetheless, I saw that the technicians occasionally took some risks possibly because of customer service pressures.

### *MSDS (material safety data sheet)*

See *Physical dangers* in this section.

### *Physical dangers*

Safety concerns abound for falls, knee injuries, and back injuries.

All new HVAC units, some parts, and some supplies come with relevant MSDS (material safety data sheets) warning of any potential dangers upon use and/or in the future.

All new HVAC units, some parts, and some supplies display relevant caution and/or warning labels on the packaging and/or on the materials themselves.

### *Power dangers*

See both *Disconnects for Power* and *A/C Power* in the *Electrical - Electronics* section.

### *Situational awareness*

The technicians need to maintain situational awareness for potential on-the-job-site dangers to prevent injuries. For example, once the technicians removed the crane cables from a delivered RTU, the crane cables continued to sway due to the winds and the movement of the crane arm back to ground level. The technicians needed to maintain situational awareness before and after the delivery of the RTU as the crane created critical dangers to everyone's safety.

Also, see *Privacy awareness* in the *SightPros-VirTechs System* section.

### *Smoking dangers*

See *Smoking* in the *Professionalism* section.

### *Soldering dangers*

See *Soldering* in the *Tasks* section.

*Weather dangers*

See *Weather* in the *Working Conditions* section.

*Welding dangers*

See *Welding* in the *Tasks* section.

*Working in high places*

Technicians work carefully when working in high places like using and securing ladders properly. However, I observed one instance where they bypassed a locked ladder cage on a building. They carry the HVAC units, parts, supplies, the SightPros communication tool, and other tools up and down ladders both inside and outside of buildings.

## SightPros Communication Tool

*Acrylic cover*

The SightPros communication tool has an acrylic cover for weather protection of the network camera in the communication tool. The network camera sees through it, but the cover slightly distorts the images near its edges.

*Audio*

The SightPros communication tool can stream audio with the video, but John turns it off to conserve bandwidth. At bandwidths available during the study, audio works better over cell phones.

*Auxiliary antenna*

Cam2 has an auxiliary antenna. Cam1 needs it. Technicians mount it vertically with a wetted suction cup.

Plural of antenna: antennae or antennas.

Alternate names: external antenna, extension antenna, extender antenna, booster antenna, and antenna booster.

*Battery and charging*

Only the Cam2 communication tool has rechargeable battery capabilities. It has a lithium ion battery pack with approximately 3 hours usage when fully charged.

### *Cam1*

One SightPros communication tool prototype, Cam1, in a yellow transport case, requires a direct 120-VAC (volts alternating current) power connection. Cam1 typically stays at the office.

Also, see *Auxiliary antenna* in this section.

Also, see *Prototypes* in this section.

### *Cam2*

One SightPros communication tool prototype, Cam2, in a silver transport case, contains a lithium ion battery pack and an auxiliary antenna. On Cam2, a switch allows the communication tool to work on either a 12-VDC (volts direct current) battery or on a 120-VAC corded power connection. Cam2 typically travels with the apprentice technician, Kwame.

Also, see *Auxiliary antenna* in this section.

Also, see *Prototypes* in this section.

Also, see *Battery and charging* in this section.

### *Camera*

The security D-Link® network camera has glass not plastic lens.

Also, see *Acrylic cover* in this section.

### *Camera angle*

John adjusts the camera angle with the pan and tilt buttons.

### *Camera focus*

The camera and/or the software have auto focus.

### *Camera placement*

Camera placement makes a difference in connectivity and in what can get captured. The camera works better from a high spot than on the ground since it has a better line of sight to the tower. Photography rules apply. Sunlight yields reflections.

### *Camera zoom*

A high zoom setting makes it harder to center with a click. However, the user can quickly learn to adjust the cursor position to compensate for the zoom.

#### *Date and times*

The SightPros communication tool transmits date and time data.

#### *Effective throughput*

John estimates that the best effective throughput for a Sprint® G3 wide-area-network (WAN) card coupled with a wireless router will yield approximately 200-300 Kbps.

John estimates that the best effective throughput for a Wi-Max CDMA G4 due in April 2008 may yield approximately 1-2 Mbps.

The wireless networks support multiple SightPros communication tools simultaneously at the same site but they fight for bandwidth, especially during high traffic times.

#### *Frames per second*

John can adjust this. A setting of 2-3 frames per second works best with the wide-area-network G3 card for more stable video transmissions within the G3 bandwidth limits. John hopes to use higher frames per second with G4 Wi-Max.

#### *Light exposure and iris*

Iris control changes the color of the video from too dark to normal to washout. John needs to change this setting when going from attic to outdoors or vice versa.

#### *Low light conditions*

John adjusts the light exposure setting to deal with low light conditions such as in attics.

Also, see *Supplemental lighting* in this section.

#### *Pan*

*Webster's New World* (1957) defines this as "to move (a motion-picture or television camera) in order to get a panoramic effect or to follow a moving object" (p. 1055).

#### *Power*

At times, technicians use the outlet plug on their drop lights as extension cords.

Also, see *Cam1* in this section.

Also, see *Cam2* in this section.

### *Prototypes*

John built two prototypes to test his SightPros communication tools in 2007: Cam1 and Cam2.

Each prototype SightPros communication tool cost approximately \$2500.00. Manufactured communication tools will cost much less due to bulk purchase of components and automated manufacturing processes.

Also, see *Cam1* in this section.

Also, see *Cam2* in this section.

### *SightPros communication tool*

This refers to the patented Metro Environmental portable, wireless audio/visual communication device.

Also, see *Prototypes* in this section.

### *Signal interference*

Signal interference occurs frequently with the level of communications available at the time of the study. The next generation, G4 Wi-Max, may eliminate most of the interference problems. The first indication of problems shows as frozen frames or dropouts. The next level shows as stalled action and stalled clock. The third level shows as a black screen and a reacquire message. The fourth level shows as a cannot-find-web-page message.

### *Supplemental lighting*

Technicians need supplemental lights for some low-light conditions such as in the attics.

### *Theft concerns*

Although they face high theft potential in some locations, the technicians find it impractical to secure the SightPros communication tool every time so they take some risks.

### *Tilt*

*Webster's New World* (1957) defines this as "to slope; incline; slant; tip." (p. 1525).

### *Tripod*

Technicians can mount the SightPros communication tool on a tripod, if desired. Tripods prove somewhat cumbersome in tight places.

### *User control*

The remote user controls include pan, tilt, zoom, iris, etc. Remote control of the SightPros communication tool leaves the technician free to work.

### *View centering*

A single click of mouse on the streaming video causes the network camera to automatically re-center the image to the cursor point.

### *Wireless connectivity and Sprint*

Metro Environmental uses the Sprint wide-area-network G3 card. This mobile wireless router creates a mobile hot spot. Cellular traffic impacts connectivity. Pathway and distance to tower impacts connectivity. The technician's body can block the signals. Better connections occur with higher placement rather than low or ground level placement. An auxiliary antenna helps. Using multiple SightPros communication tools simultaneously from one location can impact connectivity.

## SightPros-VirTechs System

### *Big Brother*

This term refers to a "Big Brother" atmosphere as created by Orwell (1949) in the novel titled 1984. People in that book remained under the watchful eye of the ever intrusive Big Brother government. With the frequent use of streaming video in the SightPros-VirTechs system, Metro Environmental may need to monitor that the apprentice technicians do not feel overwhelmed by the ever watchful eye of the SightPros communication tool. Moreover, they may want to monitor customer comments regarding concerns about the invasion of technologies.

### *Camtasia® Studio® screen recorder software*

See *Screen recorder software* in this section.

### *Customer perception*

The customer rated their perception of the SightPros-VirTechs system highly.

### *Office personnel perception*

The office personnel rated their perception of the SightPros-VirTechs system highly.

### *Password protection*

See *Security concerns* in this section.

### *Privacy awareness*

See *Security concerns* in this section.

### *Screen capture interference*

When John opens another application while the screen capture software records, the streaming video from the SightPros communication tools gets lost until he moves or closes the application.

### *Screen recorder software*

Metro Environmental selected and purchased the Camtasia Studio screen recorder software to capture the streaming video from the SightPros communication tool. John Thomason installed it on his personal computer.

The software captures whatever displays on the screen including the mouse pointer and date/time codes. The software allows John to record either video or single snapshots of the streaming video from the SightPros communication tools.

Both John and I have learned how to use this software on his computer. John feels that he learned this software easily. He finds it easy to capture snippets of activity to save for Metro Environmental records and/or for the customer. He finds it easy to narrate his own audio for the recorded video. He finds it easy to save files and burn them to a CD or DVD.

### *Security concerns*

John uses logins and password protections to limit public accessibility to the streamed video. This addresses some potential security concerns with public Internet access since this makes the Internet connections somewhat more private.

Metro Environmental faces some security concerns when recording to screen capture software especially if John uses any other application screens and accidentally records them. Moreover, the video captures some background noises which can include private information. By maintaining situational and privacy awareness and/or reviewing the videos before public access, John can eliminate potential privacy and/or security risks.

### *SightPros communication tool*

See the *SightPros Communication Tool* section.

### *SightPros-VirTechs system*

The concepts, processes, and businesses that John Thomason developed in his patents actually constitute a business and training system that I call the SightPros-VirTechs system. The system has utilized Internet connections to link multiple, dispatched, field technicians with an in-office expert using various configurations of a portable, wireless audio/visual equipment to establish best-in-the-industry, two-way synchronous information. He designed the SightPros communication tool as a unique version of portable, wireless audio/visual equipment. He designed the system to make his apprentices billable sooner and to maintain his experienced personnel longer.

### *Stardom*

The SightPros-VirTechs system makes technicians into streaming media movie stars.

### *Streaming video*

Streaming video captures real time activities.

### *Technician perception*

The technicians rated their perception of the SightPros-VirTechs system highly.

### *Video or snapshots*

See *Screen recorder software* in this section.

## Study Procedures

### *Class studies*

Both pilot studies occurred as part of class activities. See final reports in Appendix A and/or Appendix B for full information.

### *Confidentiality*

I cannot contain complete confidentiality, so the permission forms address this with both the customers and all Metro Environmental personnel.

### *Customer awareness*

I have watched for instances of the customer awareness of the SightPros/VirTechs system. I also try to stay aware of the customer's presence in their home and give them privacy whenever feasible.

### *Dell® Inspiron® laptop computer*

I carried a Dell Inspiron laptop computer with a Microsoft® Webcam every day.



#### *Dissertation study*

I report this study throughout this dissertation. I selected methods and procedures for qualitative, case study, etc.

#### *Drawing maps*

In the pilot studies, I drew maps of each location. In this study, I have recorded video of the layouts of the Metro Environmental offices and several customer locations.

#### *Ellen*

I require all participants to sign the IRB reviewed permission forms. I taped all interviews.

#### *File management*

I save digital files on a My Book® Essential 500GB external hard drive. I save backups of all videos and audios. I kept files off-line for participant protection. I password protect the folders. I will eventually remove the files to DVDs for easier, more secure retention.

#### *Grants*

I received no grants relative to this study. My minor professor and I helped John Thomason apply for a NIST grant that proved unsuccessful. John may use parts of this dissertation study to apply for future grants.

#### *Human technology errors*

I have experienced instances where my human error caused a recording device to fail. For instance, I sometimes fail to notice the end of a tape or forget to turn a device on. If I forget to turn off a device, the battery may run down.

I also experienced human error with using the SightPros communication unit.

#### *John Thomason*

John asks verbal permissions of all participants.

#### *Procedural changes*

I have experienced instances where events or requests have caused minor changes to my planned study procedures.

#### *Scheduling and dissertation*

I have planned my study to satisfy needed dissertation schedules.

#### *Scheduling and Metro Environmental*

I have planned my study to satisfy needed Metro Environmental schedules.

## *Software*

I purchased an updated version of Transana™ qualitative analysis software for video and audio data (Woods & Fassnacht, 2007) to use with this study.

I purchased the Dragon® NaturallySpeaking® speech recognition software (2007, Version 9.0) once my committee authorized this study. But then, I decided that I worked too slowly with the software because I did not know dictation and/or the commands well enough to help transcribe the files.

I received download software with my new JVC® Everio® hard disk camcorder. I have used the CyberLink® PowerCinema® NE for Everio software (2006, Version 1.0) to easily transfer files to my computer and to burn the files to DVDs.

With my Panasonic® RR-US450 IC recorder (digital audio recorder), I received the Voice Editing software (2007, Version 2.00 Premium Edition). I used the software for file management of the recordings and converting the recordings into .wav files to import into Transana. However, I tried but failed to learn how to let that software automatically transcribe the audio files with their version of speech recognition software.

I purchased Pinnacle Studio Plus (2007, Version 11) to help create movies. It successfully modified the .mod files from my JVC hard disk camcorder into .mpg files that the Transana qualitative analysis software for video and audio data (Woods & Fassnacht, 2007) can recognize.

Also, see *Screen recorder software* in the *SightPros-VirTechs System* section.

## *Training on software*

I have learned new features with my updated Transana qualitative analysis software for video and audio data (Woods & Fassnacht, 2007).

I have learned the download procedures for all of my recording devices so that I can easily transfer files from the device to my computer.

I quickly learned to use the CyberLink PowerCinema NE for Everio software (2006, Version 1.0) to download JVC Everio hard disk camcorder video files to my computer.

I have learned new movie creation software, Pinnacle Studio Plus (2007, Version 11). I use it to change the JVC hard disk camcorder files from .mod files to .mpg so I can transcribe and code them in the Transana qualitative analysis software for video and audio data (Woods & Fassnacht, 2007).

I spent a month trying to learn dictation and voice commands using the Dragon NaturallySpeaking speech recognition software (2007, Version 9.0). I could not get it to reliably transcribe my voice.

Also, see *Screen recorder software* in the *SightPros-VirTechs System* section.

#### *UNT IRB*

The University of North Texas Institutional Review Board reviewed and approved all study procedures. John Thomason sent them a letter of understanding.

### Supplies

#### *Batteries*

Technicians use batteries in many battery-operated tools and devices. For example: with drills, with the SightPros communication tool, etc.

#### *Booties*

See *Booties and Socks* in the *Customer Service* section.

#### *Documents and forms*

Technicians use Metro Environmental forms as needed. They use loose paper to write serial numbers on, etc.

#### *Drop cloths*

See *Drop cloths* in the *Professionalism* section.

#### *Duster*

Usually cloth rags used to clean dusty surfaces around the work site in the customer's living quarters.

#### *Marking pen*

Technicians used these to draw circles (tracing a damper) on the sheet metal when constructing a plenum prior to snipping the holes for the flex duct.

#### *Oiler with spout*

Technicians use oil to lubricate components like motor bearings. An oiler with a spout helps them reach into tight spaces.

### *Solder*

Metro Environmental technicians use Sil-Fos® solder. This brand remains a popular choice for refrigerant lines in HVAC and refrigeration systems.

Solder comes in many styles. One style comes in silver-laden, rigid rods that contain a phosphorus flux mix. This solder does not require flux paste when joining copper to copper, but the manufacturer recommends adding flux for copper-based alloys like brass and bronze. Due to the toxicity of phosphorus, technicians should not use this solder for potable water lines.

For high pressure applications, technicians use acetylene gas in their blow torch. For low pressure applications, they use a MAPP (max power propylene) gas in their welding torch.

Also, see *Quick connect couplings* in the *Mechanical* section.

## Tasks

### *Air balance*

Technicians try to fix differences in temperature between first and second floors or between rooms on the same floor. They adjust louvers and dampers to achieve the balanced air flow.

### *Air remediation*

See *Air balance* in this section.

### *Call wrap-up*

See *Call wrap-up* in the *Professionalism* section.

### *Cleanups*

See *Cleanups* in the *Professionalism* section.

### *Condenser change out*

This task refers to the replacement of a HVAC condenser. This task requires removal of the old refrigerant and recycling or reclaiming it, cutting of the old refrigerant lines, cutting the old wiring, removing the old condenser, replacing it with a new condenser, welding and/or soldering in the new refrigerant lines, splicing in the new wiring, and then charging the new condenser with refrigerant.

### *Downtime*

For HVAC systems, this term refers to the amount of time that the system remains inoperable due to service maintenance, etc. Since customers dislike downtime, Metro Environmental tries to keep this to a minimum.

For people, this term refers to the amount of time that they have between finishing one task and getting assigned another task. For example, the technicians have a lot of downtime during the late spring and early fall due to fewer service calls because of the temperate weather conditions. However, Metro Environmental maintains fewer technicians during those time frames and/or schedules training or HVAC system checkups and routine maintenance like filter changes to minimize their downtime.

### *Ductwork*

#### *Furnace or AHU change out*

This task refers to the replacement of a HVAC furnace or AHU. For a gas furnace, this task requires disconnection of the gas lines, removing the old furnace from the ductwork, placing a new furnace into the ductwork, reconnection of the gas lines, and then checking the pilot light and flame. Often, the technicians upgrade to newer flexible ductwork for additional energy efficiency and convenience.

#### *Hedges or vegetation*

Customers use fences, hedges, and vegetation to decorate around and/or cover-up unsightly HVAC units. Technicians may need to trim or cut the hedges or vegetation to gain working access to outdoors units.

#### *Installation*

This task refers to the installation of a new HVAC system including the heating and cooling units and all of the ductwork.

#### *Installing a dryer*

See *Dryer* in the *Cooling* section.

#### *Inventory management*

Most of the inventory control occurs in the service call management software that Metro Environmental uses. Technicians carry numerous parts and tools on their trucks. John Thomason occasionally has them perform an inventory check to see what items they need and what items they have used. The technicians sometimes help do an inventory check of the small parts room to verify that the inventory matches the levels noted in the software.

#### *Level installed HVAC units*

Technicians level the HVAC units for long-term efficient operation. Technicians find this useful especially for suspended and/or horizontal furnaces and AHUs.

#### *MAPSCO maps*

See *MAPSCO maps* in the *Travel* section.

#### *Measurements - physical*

Technicians take many physical measurements. For example, when they install attic flooring, they measure the flooring to fit into the attic spaces. They measure attic openings to ensure that each HVAC unit fits through the drop-down staircases or other openings. They measure copper tubing and pipe insulation.

#### *Meetings*

Technicians spend a lot of time in various meetings. Meetings can range from office meetings, including training, to customer meetings that discuss job details.

#### *Misc. tasks*

Technicians perform many miscellaneous tasks like, helping with moves or other tasks at the office, organizing the warehouse, reading literature, etc.

#### *Mopping*

This refers to the act of brushing a sealant onto a curb or a flashing on a roof to get a good seal. In the old days the technicians used a real mop and warm tar.

#### *Multitasking*

This term refers to a person's ability to attend to multiple tasks simultaneously. For instance, technicians may talk with a customer while working on a system. John Thomason talks with office staff or on the telephone while watching the streaming video from the SightPros communication tool.

#### *Oil level*

Technicians check for oil levels in the motor housing for the blowers and the condensers that have an oil port. If low, they add oil.

#### *Ongoing maintenance*

Usually requires filter checks/changes.

#### *Packing or repacking*

#### *Paints*

### *Plenum build*

A plenum comes as a rectangular sheet metal box. The technicians must cut holes for each duct that runs to the input and output vents throughout the house. Techs mark the sizes for the duct by placing a damper on the plenum at the appropriate place and then tracing the damper with a felt-tip pen. They tap into the metal of the plenum as the first cut for each circle in the duct. Then, they finish cutting out the circles using snippers.

### *Pressure checks*

### *Refrigerant checks*

See *Refrigerant charge* in the Cooling section.

### *Refrigerant recycle and reclaim*

See *Refrigerant* in the Cooling section.

### *Removals*

### *Repairs*

### *Service call*

### *Soldering*

Technicians may need to solder some components during troubleshooting fixes and/or system replacements. They face potential dangers while doing that due to burns from the soldering tools, especially in tight spaces. Moreover, the heat generated by the tools can ignite combustibles so technicians remain cautious especially near gas lines and meters or anyplace that gas might accumulate.

### *Suspend furnace or AHU from rafters*

Technicians suspend furnaces or AHUs from rafters using metal straps.

### *Teardowns*

Teardowns occur when HVAC units get replaced. An old AHU or furnace unit literally comes apart in pieces, including some of the ductwork.

### *Thermostat placement or replacement*

Thermostat replacement caused problems for one customer due to the new placement in a direct air flow area. Thermostat replacements sometimes caused problems since newer thermostats contained more wires than the original thermostats so technicians installed new wiring.

### *Troubleshooting*

See the *Troubleshooting* section for a list of various troubleshooting tasks.

### *Welding*

Technicians use open flame welding torches to weld copper in refrigerant lines during HVAC unit installations and replacements. They face potential dangers while doing that due to burns from the welding tools, especially in tight spaces. Moreover, the heat and open flames generated by the tools can ignite combustibles so technicians remain cautious especially near gas lines and meters or anyplace that gas might accumulate.

## Teams

### *Absence from work*

Absences create problems, especially for the installation teams since those technicians typically work in coordination.

### *Attitude*

See *Attitude* in the *Professionalism* section.

### *Bonding*

Technicians at Metro Environmental bonded very closely.

### *Camaraderie*

*Webster's New World* (1957) defines this as "Loyalty and good spirit among comrades; comradeship" (p. 209). Teams can work effectively without camaraderie. However, good camaraderie helps to build better teams and communities of practice. Poor camaraderie can destroy teams.

All of the individuals at the Metro Environmental have a strong sense of community as evidenced in their camaraderie and joking.



### *CoP (communities of practice)*

Lave and Wenger (1991) first suggested the term *community of practice* to describe a group of people who share an interest, a craft, and/or a profession. When members participate in a group, they learn from each other and develop themselves personally and professionally. In 2002, Wenger, McDermott, and Snyder defined community of practice as: "Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (p. 4-5).

The Metro Environmental personnel have a strong community of practice, especially among the service force including John Thomason. The family relationships among all their personnel strengthen their sense of community.

### *Installation team*

The installation team usually includes just a 2-person team, but number varies depending on seasonal workloads and the size of the jobs. For instance, the main installation team includes Oscar and Luis. For large installations, the team first expands to include Kwame and possibly John, the technician. If they need more, then Greg helps. If needed, Ray, who started as a technician but now works as a salesperson, may help. During the slow season, the technicians that have no other jobs scheduled will sometimes converge on the installation site, even on a small installation job. During the busy season, John Thomason hires more technicians and/or temporary technicians as needed.

### *Suggestions - improvements*

### *Teamwork*

## Temperature Control

### *Air balance*

Technicians adjust the temperature throughout a building by adjusting the dampers and registers so that the rooms stay at approximately the same temperature.

### *"Kick it down"*

See *Thermostat* in this section.

### *"Kick it up"*

See *Thermostat* in this section.

### *Stat*

See *Thermostat* in this section.

### *Thermostat*

A thermostat monitors and adjusts the temperature in a building. Typically, each heating and cooling system will have a thermostat located within the living space of the building but remote from the actual HVAC units.

Technicians nickname this device as *stat*. Webster's New World (1964) defines "*stat*" as a "combining form meaning *stationary, making stationary*, as in *gyrostat, thermostat*" (p. 1424).

Technicians adjust the thermostat down by a significant amount to cause a new cooling cycle in the HVAC unit. They refer to this as "Kick it down."

Technicians adjust the thermostat upward by a significant amount to cause a new heating cycle in the HVAC unit. They refer to this as "Kick it up."

## Tools

### *Air flow meter*

See *Flow meter* in this section.

### *Bungee cord*

The technicians carry these cords to quickly but temporarily secure objects. For instance, I saw them use one to secure a ladder to the side of a tall building. They look like a covered elastic cord with metal hooks on each end.

### *Crescent wrench*

The technicians carry this tool for quick, efficient adjustments of nuts, bolts, etc.

### *Dolly*

Webster's New World (1964) defines a dolly, such as the ones used at Metro Environmental to move heavy HVAC units, as a "any of several kinds of low, flat, wheeled frames for transporting heavy objects" (p. 431).

### *Drill*

The technicians prefer a battery-operated drill, but an electric or hand-held one will work. They feel that the battery-operated one has added flexibility and speed.

### *Drop light*

The technicians carry a drop light that looks like a hand-held casing with a metal cage front and a light bulb behind the cage. A hook on the casing allows it to hang from rafters, etc. Their drop light has an accessory outlet plug in the handle just below the light bulb.

### *Extension cords*

The technicians carry 25-foot and/or 50-foot extension cords to connect to power sources as needed.

### *Flow meter*

See *Gauges* in this section.

### *Gauges*

Technicians use gauges for a variety of purposes. They use pressure gauges to measure the refrigerant levels. They use air gauges to check tire pressures on their vehicles.

### *Hammer*

Technicians use hammers for a number of tasks. For instance, they use them to tap down the sheet metal in plenum building.

### *Heat sink*

When soldering or welding, technicians need to keep other components cool. They come up with creative use of metal parts in some instances. Also, cool wet cloths suffice sometimes when welding and/or soldering.

### *Infrared thermometer with a laser pointer*

See *Temperature gauge* in this section.

### *Inspection mirror*

The technicians like to use an inspection mirror to see in tight spaces or behind objects. It looks like a small mirror on a thin swivel handle.

### *Ladder*

Technicians carry 30-foot ladders for roof access and 6-foot ladders for inside access.

### *Laser gun or laser thermometer*

See *Temperature gauge* in this section.

### *Measuring devices*

Technicians carry measuring tapes and other measuring devices to quickly take needed measurements.

### *Multimeters*

Technicians carry multimeters to quickly and accurately measure electrical voltages, electrical resistance, and grounds.

### *Mirror*

See *Inspection mirror* in this section.

### *Miscellaneous tools*

Technicians carry a number of miscellaneous tools that they find helpful on the job. They quickly remove any tools from their tool kits that do not prove out as beneficial to on-the-job tasks.

### *Needle-nose pliers*

Needle-nose pliers prove helpful as a pick-up tool or as a holding device as well as a convenient set of small pliers.

### *Nut driver*

The technicians prefer a battery-operated nut driver, but an electric or hand-held one will work. They feel that the battery-operated one has added flexibility and speed.

### *Schrader valve core removal tool*

This tool removes the Schrader valve core (a valve stem for HVAC systems and gauges). It acts like a poppet valve aided by a spring. The valve looks like a hollow cylindrical metal tube, typically brass, with a threaded exterior end. The technicians can depress a pin to deflate the pressure. These work good for high and low pressure. [http://en.wikipedia.org/wiki/Schrader\\_valve](http://en.wikipedia.org/wiki/Schrader_valve)

### *Screwdriver*

The technicians prefer a battery-operated screwdriver, but an electric or hand-held one will work. They feel that the battery-operated one has added flexibility and speed.

### *Shears*

See *Snippers* in this section.

### *Snippers*

Technicians use snippers/sheet metal snippers/tin snippers/shears to cut holes in the sheet metal box for the flex duct when constructing a plenum.

### *Soldering iron*

See *Soldering* in the *Tasks* section.

### *Temperature gauge*

Technicians use an infrared thermometer with a laser pointer that they sometimes call a laser gun and/or a laser thermometer.

### *Tool kits and tool belts*

The technicians typically carry their tools in zippered pouches or medium-sized buckets with handles. Tool belts prove awkward when working, especially in tight spaces like attics and around bush-enshrouded outside units.

### *Vacuum cleaner*

Technicians carry a small vacuum cleaner for final clean-ups in customer locations.

### *Welding torch*

See *Welding* in the *Tasks* section.

## Training

### *Adaptability*

Technicians quickly learn adaptability in various job situations. Metro Environmental encourages this in training.

If they need a tool and discover that they do not have it, they may improvise rather than taking time to go get it elsewhere.

A technician may watch another technician use a reducer to lift the suction line to give it clearance from the ground to weld it while working in very tight conditions. The next time the observant technician may use a similar trick or use this as encouragement to find a way to adapt in an entirely new situation.

Also, see *Tips* in this section.

Also, see *Customer storage* in the *Customer Location* section.

### *Apprentice*

An apprentice might know or learn basic information like flame characteristics.

### *Books and manuals*

Technicians receive equipment books and manuals during training classes. Later, they use these books and manuals as needed to refresh their memory or recall information.

### *Certification*

North American Technician Excellence® (NATE®) tests and certifies HVAC technicians. Technicians highly value this certification since they can ask for premium pay if they get it.

### *Charts*

Technicians learn to properly use charts as needed.

Also, see *Refrigerant charge* in the *Cooling* section.

### *Confidence*

### *Creativity*

### *Expert*

### *Helper*

### *In-house training*

### *Just-in-time training*

### *Knowledge management*

### *On-the-job training*

See *Just-in-time training* in this section.

### *Processes*

### *Professional training*

See *Trane classes* in this section.

*Real world experiences*

*Schools*

*Self-taught*

*SightPros communication tool training*

Technicians quickly learn the operation, maintenance, and desirable placement of the SightPros communication tool.

*Site-based training*

See *Just-in-time* training in this section.

*Streaming video*

See *Streaming video* in the *SightPros Communication Unit* section.

*Technician*

A technician has learned more skills than an apprentice, but not enough skills to advance to an expert level.

*Tips*

For instance, technicians can use a wet rag to keep a welding and/or soldering area from overheating near rubber rings and/or plastic parts.

*Trane classes*

Metro Environmental uses Trane as their major provider of HVAC units. When Trane develops new technology or new equipment, Trane holds classes to introduce the technology and equipment to the technicians, sales personnel, and management.

*War stories*

Technicians share many war stories about memorable things that happened to them. These stories provide a friendly way to share knowledge about realistic on-the-job events.

## Travel

### *Company vehicles versus personal vehicles*

The owners use their personal vehicles as company cars. The other office personnel use their personal vehicles to do errands but get reimbursed for mileage. The technicians use the company trucks and vans for transportation.

Also, see *Trucks and vans* in this section.

### *For lunch breaks*

When they take formal lunch breaks, the technicians often travel to nearby fast food restaurants.

### *For parts*

Technicians usually take needed parts to the customer accounts. If they need additional parts, they travel to the manufacturer parts houses and/or to local hardware retailers.

### *MAPSCO maps*

Technicians carry and use MAPSCO maps to find customer locations and to coordinate travel plans with the other field and/or office personnel.

### *Parking*

Technicians use convenient parking locations since tools and equipment get heavy. For instance, at one location, they parked in front at the start and end of the call to discuss their work with the customer, but drove around and parked at the back of the building to access the rooftop units for maintenance.

### *To and from customers*

Technicians usually take the shortest driving time rather than the shortest driving distance to a customer account. Sometimes the shortest route has congested traffic and therefore takes more time and more gas. As needed, they take alternate paths when they experience unexpected traffic delays.

### *Toll roads*

Technicians use toll roads to save time and gas.



### *Traffic*

Traffic poses an everyday concern, especially during the local rush hours as they try to get to their first customer of the day and return from their last customer of their day. Lunchtime traffic sometimes poses a problem.

Also, see *To and from customers* in this section.

Also, see *Weather* in the *Working Conditions* section.

### *Travel time*

Travel time refers to the measurement of time that it takes the technicians to travel to and from the home office and between customers.

Also, see *To and from customers* in this section.

Also, see *Traffic* in this section.

Also, see *Weather* in the *Working Conditions* section.

### *Trucks and vans*

Most of the technicians use company trucks for transportation. The installation team uses a commercial box truck that easily carries an entire HVAC system. The technicians use a commercial panel van that easily carries individual HVAC units.

Also, see *Company vehicles versus personal vehicles* in this section.

## Troubleshooting

### *Age of the HVAC unit*

Technicians check the age of the HVAC units to help determine warranty coverage. For non-warranty parts and equipment, the technicians use the equipment age to help determine the best financial choice for the customer for either repairs and/or parts replacements. For older HVAC units, they may refer the customer to John Thomason or to the sales department to discuss options and recommendations.

### *Air balance*

See *Air balance* in the *Tasks* section.

### *Air remediation*

See *Air balance* in the *Tasks* section.

### *Blinking PWB LED*

LEDs blink on the PWB (printed wiring board) to indicate troubles in the system.

### *Blower motor dirty*

Technicians check the dirt levels on the housing of the blower motor. Customers cause dirt problems over extended timeframes usually because they fail to install and change filters regularly.

### *Blower noise*

Technicians check that the blower spins freely without noise. Noise can sound like a growl at motor startup or squeals when the squirrel cage spins. Probable causes include worn, dry, or seized bearings. T

### *Blower scoop bent or broke*

This problem rarely occurs. A bent or broken blower scoop might indicate a problem with the way a customer installed their filters. It might also indicate loose components that fell from or through the furnace or AHU. It can also indicate a broken grille on an intake air duct that allowed something large to enter the blower.

### *Blower scoops dirty*

See *Blower wheel dirty* in the *Troubleshooting* section.

### *Blower shaft bent or broke*

A bent or broken shaft might indicate seized bearings.

### *Blower spins slowly*

See *Blower noise* in this section.

### *Blower wheel dirty*

Technicians check for the dirt levels on the scoops in the blower wheel. Customers cause dirt problems over extended timeframes usually because they fail to install and change filters regularly.

### *Blown fuse*

### *CO (Carbon monoxide)*

The technicians test the furnace for carbon monoxide (CO), a deadly gas. If an improper gas to air ratio occurs in the furnace, carbon monoxide (CO) may result.

### *Condenser fan noise*

Technicians check that the fan spins freely without noise. Noise can sound like a growl at motor startup or squeals when the fan spins. Probable causes include worn, dry, or seized bearings.

### *Creative solutions*

The technicians sometimes find creative solutions for unusual problems. For example: Warm air rises. Cool air falls. In an unusual air balance situation, they may connect the return air boxes from the upstairs and downstairs HVAC units to merge warmer air with cooler air. This puts warmer air from the upstairs return into the downstairs return by tying them together. This also puts cooler air from the downstairs return into the upstairs return.

### *Cycling*

This task refers to the process of checking the different cycles of the various HVAC units. The technicians will adjust the thermostat higher to check for proper heating and lower to check for proper cooling. Some motors have multiple speeds so the technicians will verify each speed by the amount of adjustment on the thermostat. For instance, John asked Kwame to just start a furnace up on its second cycle. Kwame adjusted the thermostat appropriately to comply with the instructions.

### *Filters dirty*

Filters should be changed on a regular basis. Dirty filters diminish air flow and cause build-up of dirt on other components.

### *Flame characteristics*

Technicians check for the proper flame shape in the gas furnaces during operation. Proper flame shape indicates the cleanliness of the burners and/or the burner rack.

### *Flame color*

Technicians check for the proper flame color in the gas furnaces during operation. Proper flame color indicates a correct balance of gas and air.

### *Ignition*

Technicians check that the flames inside the gas furnaces fire off quickly. Late ignition may indicate a bad ignition switch, a bad pilot light, an incorrect balance of gas and air, dirty burners, and/or a dirty burner rack. Kwame noted to John that "everything fires off as they are supposed to do."

### *Noise problems*

Technicians listen for unusual noises like growls, ramping up of multi-stage motors, and timing for smooth operation

### *Refrigerant loss*

Loss of refrigerants causes problems. Breathing problems occur when ground level contaminants get high. Temperature changes occur when contaminants impact the upper atmospheric ozone layer that protects the earth. State and federal laws regulate the discharge of refrigerants into the atmosphere.

### *Rust*

Heat exchanger will rust with excessive moisture or age. If the heat exchanger is cracked then CO can enter into the house.

### *Solutions*

### *Squirrel cage dirty*

See *Blower scoops dirty* in the *Troubleshooting* section.

### *Tripped switch*

### *Voltage checks*

See *Meter/multimeter* in the *Tools* section.

## Working Conditions

### *Always new and different*

The technicians work inside and outside. They work at ground level, inside houses, in attics, and on rooftops. They work in customer homes and business in many different cities and towns. They travel a lot and see a lot. They meet new people, mostly customers, and visit with old customers. They develop new friendships.

### *Asbestos*

See *Asbestos* in the *Safety* section.

### *Bathrooms*

See *Bathrooms* in the *Professionalism* section.

### *Company atmosphere*

Metro Environmental tries to maintain an atmosphere of family, friendship, and fun.

Also, see Family in this section.

Also, see Friendship in this section.

Also, see Fun in this section.

### *Family*

Metro Environmental personnel include three family groupings.

### *Fiberglass*

See *Fiberglass* in the *Safety* section.

### *Friendships*

The Metro Environmental personnel form many personal friendships that exist both on and off the job.

### *Fun*

The Metro Environmental personnel work hard and play hard. They try to keep an atmosphere of professional fun around the various work environments.

### *Lunch*

Lunches vary, especially between the office personnel and the field personnel. The field personnel take their lunches at a convenient time and often work around normal lunch hours and/or take lunches between customer sites. Someone at the office usually makes a lunch run once a day for anyone at the office wanting lunch from a local diner. They use the company refrigerator and freezer for occasional lunch preparations.

### *Overtime*

Metro Environmental tries to limit overtime for technicians to the busiest times of the year. However, they try to maintain a balance between the cost of overtime and the cost of time and gas for a return visit if the job site time extends past planned or normal working hours.

### *Physical demands*

Technicians face a lot of physical demands. They lift heavy loads, bend, squeeze into tight places, stand for long hours, squat, crawl through tight attic spaces, and climb many steps and ladders.

Also, see *Physical dangers* in the *Safety* section.

### *Radio*

See *Radio* in the *Professionalism* section.

### *Regulations: Industry and federal*

Metro Environmental must follow various regulations that apply to their entire industry. For instance, they must follow EPA guidelines for refrigerants.

### *Regulations: Local and state*

Metro Environmental must follow various local and state regulations. They have a permit for their home office. They must get various permits for work at customer sites. Texas requires several certifications for the technicians.

### *Weather*

Weather generates unpleasant working conditions. Wet weather and/or sprinklers create muddy conditions. Wet or muddy conditions make their clothing look unprofessional. Rain can soak a uniform which then makes it uncomfortable to work in wet clothes. Muddy shoes can track mud into the customer's premises.

Weather generates dangerous and/or hazardous working conditions. Technicians face dangers and/or hazards from lightening, high winds, fog, wind chills, snow, ice, etc. Many weather conditions aggravate travel situations and can cause traffic accidents. Wet or muddy shoes can cause accidental slips and/or falls. Wet conditions increase the potential for electrocutions.

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