PERCEIVED CONSEQUENCES AND CONCERNS IN THE DIFFUSION OF INTERNET2® AT TEXAS A&M UNIVERSITY

A Dissertation

by

NOEMI VERONICA MENDOZA DIAZ

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2006

Major Subject: Educational Human Resource Development

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ABSTRACT

Perceived Consequences and Concerns in the Diffusion of Internet2® at Texas A&M University.

(December 2006)

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The purpose of this inquiry was to examine the consequences and concerns with the diffusion of Internet2 at Texas A&M University (TAMU). Internet2 is a university-led effort to develop advanced network applications and the network technologies needed to support them. Internet2 adoption at TAMU took place towards the end of the 90s decade with the inclusion of the university in the University Corporation for the Advanced Internet Development (UCAID).

This dissertation reviewed the Internet development and its relationship to universities. There were two theoretical models of change used, Diffusion of Innovations and Concerns-Based Adoption Model (CBAM). Specifically, "the consequences of change" was the focus in the Diffusion model, and "the stages of concern" was the focus in CBAM.

This study used qualitative methods of inquiry with three sources of information -- interviews, observations and archival information (printed and online). Seventeen participants were interviewed during the spring of 2006, selected on the basis of convenience, homogeneous, and snowball sampling. The participants were placed in an area, or an intersection of areas, of a diagram with teaching, research, and support-services realms.

Through qualitative analytic induction, emerged twenty categories arranged in five different themes: (1) Texas A&M's use of Internet2, (2) the dilemma of the information sharing, (3) the influences of Internet2, (4) Internet2 discussion, (5) Internet2 concerns. Internet2's creation and Texas A&M University's adoption rationale emerged through the narrative analysis. This study matched partially the frameworks of Rogers and Hall and Hord because a pre-stage of unawareness was necessary to install since Internet2 resulted to be extensively used at Texas A&M University, but with most of the users not aware of it.

The audit trail, peer-debriefing, and member checks were the mechanisms installed to guarantee trustworthiness. Qualitative analytic induction and narrative analysis were the research strategies and the report was presented in the manner of a case study and summary of findings.

DEDICATION

To my family…To my mamita Lolita, to my papito Nabor, to my manito Lalo, and to my amor, my hubby Chuchito. Without your example, your words, your support, and your love I would have never accomplished this six-year project. Los amo.

To you my GOD, I put my life and this degree to your service.

ACKNOWLEDGEMENTS

Great authors tell the three necessary things to have in order to complete great works. They are; (1) discipline, (2) discipline, and (3) discipline. (Oncetv, National Polytechnic Institute Television, MEXICO).

I would like to thank my advisors Dr. Kim Dooley and Dr. Larry Dooley. Thank you for guiding me through this process. There are no words that can reflect my immense gratitude. Dr. Kim, you are super, my role model. Dr. Larry, you have been there for me since my arrival. Thank you both.

Thanks to my committee, Dr. Rod Zent, Dr. Karen Murphy, and Dr. Walt Magnussen. Through the years your help and your advice have made me a researcher.

Thanks to my employers, Dr. Lloyd Korhonen, Dr. Walt Magnussen, and Mr. Willis Marti. You three provided me the experiences that shaped this study and will guide my professional life.

Thanks to my friends at the CDLR and the Academy (a long list but you know who you are), your smiles, your words and your friendship kept me going when I felt really down.

Thanks to my editor, Mr. Bill Ashworth. I deeply appreciate your effort.

Thanks to my sponsors, the National Council for Science and Technology, and the Ministry of Education of MEXICO. Thank you my beloved MEXICO.

Thanks to my family and my GOD, YOU are my strength.

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CHAPTER I

INTRODUCTION

The Internet invention has been compared to the 15th century Gutenberg's press (Norman, 2005). In 2004, the number of Internet users in the world was around 873 million (International Telecommunications Union, 2005). Education and research, universities' primary activities, have changed drastically from one decade to the next thanks to the Internet's unlimited access to information and communications. The involvement of universities in the Internet invention can be traced back to 1965 with the inclusion of Massachusetts Institute of Technology in the ARPA project. Moreover, still during the sixties, the involvement of universities such as the University of California at Berkeley, the University of California at Los Angeles, Stanford University, the University of California at Santa Barbara and the University of Utah firmly established the participation of universities in the Internet development (Internet Society, 2005; Lin, 1993).

This dissertation follows the style and format of *Human Resource Development Quarterly*.

On the other hand, it is general knowledge that the Internet suffers now from overexploitation. Its original planned traffic and number of users were surpassed several years ago (Comer, 2004; Tanenbaum, 2003). In order to cope with the problem, several initiatives were launched during the last decade --the Next Generation Internet, the NSF's vBNS (very high speed Backbone Network Service), and the Internet2. Among all these initiatives, Internet2 has gained notoriety because it is a university-led effort. In contrast with the unofficial university organization that created the Internet in the past, Internet2 was constituted as a nonprofit organization in 1997, with the official name of Internet2 being the University Corporation for the Advanced Internet Development (UCAID) (University Corporation for the Advanced Internet Development, 2005a).

Internet2 Challenges

Most criticism of Internet2 focuses on the mission of the organization as well as its alleged "elitism." While some private sector voices have called for the creation of an academic-led research network (recreating the current Internet history), others have contended that development of new technologies and applications do not fall necessarily under direct academic responsibility (Barrett, 1998; McGarvey, 1999). Elitism is explained as the accessibility to the Internet2 project exclusive to those who are able to afford it (Dugan & Trump, 1999).

Other related critiques point out that for some institutions that have been able to afford Internet2, questions have risen about its usefulness and impact in their daily activities. In addition, there are reported concerns caused by those who are pushing the

limits overseeing a need of an Internet3 (Olsen, 2003). In the least radical position are the reports of individuals who are tapping their fingers impatiently waiting for the publicized advances to be available to their desktops (Rapoza, 2002).

Perhaps the most important challenge Internet2 has faced is its merger with a relatively new initiative, the National Lambda Rail (NLR) created in 2003. A special commission constituted by NLR and Internet2 members, called Internet2's Group B, produced a report for the purpose of analyzing this merger. It is worth noting that such consolidation was approved, and the corresponding strategic plan was under discussion (University Corporation for the Advanced Internet Development, 2005b). Because of its importance, the report's section that justifies the consolidation will be quoted:

> We recommend merger since this scenario, in our view, produces the greatest progress toward our collective goals with the greatest speed and efficiency. But it is important to start by rehearsing the insufficiencies of the status quo.
>
> - As Group A documented, the current combination of divergence and competition between Internet2 and NLR seems likely to impede technological opportunities for collaboration by having the two organizations unnecessarily duplicate services.
> - Neither Internet2 nor NLR has enough resources of its own to achieve its current, near-term, or long-term goals. Moreover, the universities and RONs [Regional Optical Networks] that directly or indirectly provide funding for NLR and Internet2 are beginning to ask why two separate funding mechanisms make sense, and to seek escape from one or the

other. Other funding agencies are equally confused, and thus reluctant to contribute additional funds to the enterprise.

- Our primary constituencies, the research and education communities within our campuses and affiliates, have become immensely confused by the increasingly parallel and redundant network offerings from NLR and Internet2.
- The widespread perception that NLR and Internet2 squabble rather than collaborate is damaging each organization's credibility, and increasing the likelihood that other actors will try to enter the national research and education high-performance networking space. (University Corporation for the Advanced Internet Development, 2005b, p. 7)

As can be noticed, the general perception of this merger rationale is that Internet2 rivals with National Lambda Rail. The merger, by October of 2006, has not taken place.

Theoretical Framework

Internet2 can be called the innovation that has caught the attention of almost all RU/VH: Research Universities (very high research activity) with 95% of them being members of UCAID, based on the Carnegie Foundation classification (2006) and the Internet2 membership list (2006f). Rogers (1993) studied innovations in many dimensions, the innovation itself dimension (with the sound innovation-decision process or the perceived attributes of innovations), the communications channels dimension, the

time dimension (with its sound adopter categories), and finally the social system dimension. It is in the social system dimension that Rogers introduced the consequences of innovations concept, which is of relevance for this research. He defined consequences of innovations as "changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation. Invention and diffusion are but means to an ultimate end: the consequences that result from the adoption of an innovation" (p. 436). He also proposed categories for consequences in the manner of desirable vs. undesirable, direct vs. indirect, and anticipated vs. unanticipated. All these are also of interest for this study.

On the other hand, Hall and Hord (1987) introduced the concept of concerns in change in schools. They defined concerns as "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (p. 58). In their stages of concern about the innovation, they explicitly considered the impact of the innovation in a "consequential" dimension. This is of special interest for this research.

Statement of the Problem

> The explosion of the Internet has generated economic growth, high-wage jobs, and a dramatic increase in the number of high-tech start-up companies...The technology developed under this initiative will enable U.S. industry to develop hardware and software to enhance our worldwide leadership in advanced

> networking services and applications. (National Coordination Office for Networking and Information Technology Research and Development, 1997, p. 3)

The history of the Internet recognizes the critical participation of universities in projects such as ARPANET or NSFNET. Internet2, a university-led effort, has responded to the challenge and has positioned itself as a leader in comparison with other initiatives. Although the number of members of Internet2 is now in the order of hundreds, with its corresponding impact in education and research in America, there is a lack of formal studies to determine the concerns and consequences of Internet2 (in accordance with searches performed in major HRD publications as well as EBSCO, ERIC and WILSON databases).

Purpose of the Study

The purpose of this study is to examine the consequences and concerns with the diffusion of Internet2 at Texas A&M University.

Significance of the Study

The University Corporation for the Advanced Internet Development estimates the cost of Internet2 at $500,000 per year "in order to be able to participate in Internet2 activities. In addition, applicants (universities) should be committed to at least this level of investment and/or more, depending upon their own state of advanced networking preparedness" (UCAID, 2006e). The exploration of consequences and concerns after

Internet2 adoption at Texas A&M University will determine boundaries of Internet2 and provide guidance for current and future planning and execution of connectivity for university settings.

Research Questions

The responses to the following four questions were sought through this dissertation in order to accomplish the purpose of this study.

1. What have been the consequences of the diffusion of the innovation (Rogers, 2003), entitled "Internet2," at Texas A&M University?
2. What were the concerns (Hall & Hord, 1987) regarding the use of Internet2 at Texas A&M University?
3. How might Texas A&M University further enhance professional development and interventions for diffusion?
4. To what extent do the findings match or not match Roger's (2003) diffusion of innovation research and the Concern-Based Adoption Model (Hall & Hord, 1987)?

Operational Definitions

Internet: An electronic communications network that connects computer networks and organizational computer facilities around the world. This study will use the term also as a product under development.

UCAID: University Corporation for Advanced Internet Development. This is the official name of the organization, which affiliates work in the development of the Internet2.

Internet2: Trademark term which refers to the UCAID product. UCAID members also use Internet2 interchangeably with the UCAID term when referring to UCAID.

Diffusion: "Process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 5).

Innovation: "An idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12).

Consequences: "Changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation. Invention and diffusion are but means to an ultimate end: the consequences that result from the adoption of an innovation" (Rogers, 2003, p. 436).

Concerns: "The composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (Hall & Hord, 1987, p. 58).

Other definitions and acronym explanations can be consulted in the glossary/index (Appendix A).

Assumptions

The instrumentation of this study will provide accurate information in response to the research questions. The participants will be staff and faculty members at Texas A&M University who will respond honestly and accurately. Interpretation of the data will be supported with archival data and observed behavior.

Limitations

The study is limited to those faculty and staff members of Texas A&M University. Generalizations with other institutions should be avoided, although some transferability aspects may apply (Lincoln & Guba, 1985). The study is also limited to a higher education institution in the United States of America. Foreign higher educations institutions may differ in perceived consequences and concerns.

CHAPTER II

LITERATURE REVIEW

In order to understand the higher education context of this dissertation, the researcher begins this chapter with Internet historical information and the transition to Internet2 from a university-related perspective. As part of the theoretical framework, change in universities within the human resource development discipline will be addressed. Rogers' Diffusion of Innovations (2003) and Concerns-Based Adoption Models (Hall & Hord, 1987; Hall & Hord, 2006) will be presented --the former as the basis for the study of consequences of Internet2'diffusion at Texas A&M University and the latter as the foundation for the understanding of adopter perceptions. The last section of this chapter will exhibit studies of relevance to this dissertation.

Internet Development and Its Implications for Universities

Hobbes (2005) and Griffiths (2005) recognize the Advanced Research Projects Agency (ARPA) of the Department of Defense (DoD) as responsible for the creation of the Internet. During the first half of the 60s, preliminary computer studies conducted by Massachusetts Institute of Technology (MIT, academic institution) and RAND (nonprofit-consulting organization) were considered the early precursors of the Internet. By 1969 ARPA requested proposals for the ARPANET project awarded to University of California Los Angeles (UCLA) for the Network Measurement Center, and BBN (Bolt, Beranek and Newman Technologies) for the Packet Switch contract (again an academic

and a commercial-consulting firm respectively). During 1969, ARPANET was created with a connection among four major universities: UCLA, Stanford Research Institute, University of California Santa Barbara, and the University of Utah. From this point on, a number of initiatives were launched for mainly three purposes: Military, academic and commercial (in chronological order). The next in-depth explanation will switch the order between academic and commercial networks for the purpose of keeping the context of the sections to follow (with an academic emphasis).

Military and Commercial Networks. ARPANET itself is considered to be a military network. Until 1983 however, when ARPANET split into ARPANET and MILNET, research efforts and applications led by academic institutions shared the network and resources. This can be translated as an indirect consequence of ARPANET, which had an intended military use but was also beneficial to the higher education research community. Commercial networks, on the other hand, are considered to be providers of communications or content with a lucrative purpose in mind (i.e., Internet service providers). The first commercial network, designed as a commercial ARPANET, is considered to be TELENET launched by Bolt, Beranek & Newman (BBN) in 1975 (Bolt, Beranek & Newman, 2005). Commercialization of the Internet is an important aspect of its evolution as will be presented later.

Academic Networks. Despite the fact that academic networks appeared earlier than commercial networks, they are presented here due to the emphasis of this study on the Internet2. Because of the exclusiveness of ARPANET which limited access to those academic institutions related to ARPA, some other interested universities joined forces

in a number of academic initiatives that contributed greatly in the development of Internet and Internet2. The most important of these academic initiatives will be described in depth in the next paragraphs.

Close to the ARPANET division in military and academic networks, a new academic effort entitled BITNET (Because its Time) was launched. It was greatly inspired and supported by IBM Corporation. It started with only a single wire but with an inspired vision of a global community of scholars, sharing research, ideas, and information (Oberst & Smith, 1986). The first link was established in the spring of 1981 between the City University of New York (CUNY) and Yale University. The concept behind BITNET was simple: each institution was to pay its own communications link and provide facilities for at least one new member to connect. EDUCOM (Interuniversity Communications Council Inc.), another ally of BITNET, both promoted and participated in BITNET and by 1984 was granted with the Network Information Center (BITNIC). By 1986, the number of institutions connected to BITNET was around 200. BITNET's success also "led to the formation of a worldwide network of computers … that included 174 sites in Europe and the Middle East, 35 in Canada, 5 in Japan, and one in Mexico" (Oberst & Smith, 1986, p. 13).

The Computer Science Network (or CSNET), was another important academic network that was initially supported by the National Science Foundation in 1981. The idea of this network was to interconnect computer science departments' machines with emphasis on those who could not afford connections to ARPANET (Comer, 1983). The plan of work consisted of building a network that at the end of a five-year period could

become self-sufficient (through membership dues). With the University of Delaware, the University of Wisconsin, Purdue University and the University of Utah leading the efforts, CSNET, was implemented connecting ARPANET and TELENET with a new telephone-based network titled PhoneNet. PhoneNet specifically addressed the need of those who could not afford ARPANET. Interestingly, by 1989, BITNET merged with CSNET adopting a new corporate name, the Corporation for Research and Education Networking, or CREN.

The third important academic network is the National Science Foundation (NSF) network known as NSFNET. After the CSNET success, NSF began funding improvements in the academic computing infrastructure in a supercomputing initiative. In addition,

> NSF envisioned a general high-speed network, moving data more than twenty-five times the speed of CSNET, and connecting existing regional networks and local academic networks. NSF wanted to create an inter-net, a network of networks, connected to DARPA's own Internet, which included ARPANET. (National Science Foundation, 2006, ¶5)

NSFNET started operations in 1986. Its connection to ARPANET took it to a leading role and, as the case of CSNET, it gave access to supercomputer and academic users. A year after, due to the volume in traffic, an upgrade was required. According to NSF, due to the tremendous growth and upgrade requirement, a solicitation calling for the participation of the private sector had to be issued. Otherwise, the academic community would remain on the margin in a multiple networks scenario. In Steve

Wolff's (program director for NSFNET) own words "there had to be commercial activity to help support networking, to help build the volume on the network" (NSF, 2006, ¶7).

The upgrade solicitation came out by 1987, and by July 1988 the MERIT Network-IBM-MCI winning proposal, made the new backbone operational. By 1991, a for-profit subsidiary was derived to enable commercial development of the networks. Leitner, et al. (2003) state, "NSF's privatization policy culminated in April, 1995, with the defunding of the NSFNET Backbone. The funds thereby recovered were (competitively) redistributed to regional networks to buy national-scale Internet connectivity from the now numerous, private, long-haul networks" (¶41). It is worthy to note that MERIT (a consortium of Michigan universities and the state of Michigan), was led during this privatization time by Dr. Doug van Houweling, current President and CEO of Internet2 (Cook, 1993).

Academic Organizations Appraising Internet. Great support has been given to the Internet as an innovation through academic organizations (as the EDUCOM-BITNET case). In addition, regional networks have both fostered and benefited from Internet.

The Regional and State Networks. These networks were born during the 80's from the rationale that the "only way many institutions could afford connectivity to NSFNET was by collaborating with other institutions to create a critical mass of users and to share the cost of accessing NSFNET" (Neas, 2004, ¶1). Initially, a number of these networks were developed by established academic organizations such as the

NorthWestNet, created by the North West Academic Computing Consortium, whose members came from the Western Interstate Commission for Higher Education (WICHE). By 1997, with Internet2 and Abilene as the new backbone, a second impetus was gained, and another number of regional networks were born, among them, the Great Plains Network (GPN). Now, as part of a third iteration triggered by the National Lambda Rail initiative (with a multiplexing optical fiber infrastructure), more regional networks are being accommodated, among them, the Northern Tier Network Consortium (NTNC) or the LoneStar Education and Research Network born in Texas in 2002.

EDUCAUSE. Academic organizations are forged for different purposes. They act as representatives, developers, and even lobbyists for the goals and missions of their constituencies. The history of EDUCAUSE, a key player in the development of Internet, starts in 1964 when a group of medical school deans and vice presidents met "to found an organization dedicated to the idea that digital computers offered an incredible opportunity for sharing among institutions of higher education" (Heterick, 1998, p. 1). The name given to this organization was originally Interuniversity Communications Council, Inc., better know as EDUCOM. Seven years later, another initiative was born dedicated to administrative computing issues named CAUSE, Inc. For several years, EDUCOM struggled with a small association existence until the adoption of the personal computer and its office establishment in Washington, DC, around 1988. EDUCOM and CAUSE joined forces by 1997 and EDUCAUSE was born. As in the case of BITNET, EDUCAUSE intervention was critical in the rise of Internet2. Around 1987, with strong membership, publication, and financial foundations (based on dues), EDUCAUSE

participated actively in the education component of the National Research Network, later known as National Research and Education Network (NREN). A series of member conferences in Monterey, California, laid the foundation for the Internet2 project.

Transition to Internet2

In addition to the EDUCAUSE's assiduity, several others factors contributed to the establishment of the Internet2. Other initiatives framed and shaped the evolution of Internet. Internet2 was not alone in the quest for better and improved communications services. In order to understand much of the literature and terminology surrounding Internet2, a brief explanation of these initiatives will be provided

The National Research and Education Network (NREN). NREN was officially "approved by the US Congress in fall 1991, as a project to upgrade the Internet backbone" through the High Performance Computing Act of 1991 (Sterling, 2006, ¶33). McClure, Bishop, Doty and Rosenbaum (1997) stated that "the NREN aims to achieve national goals by improving the nation's electronic communications infrastructure and encouraging the development of more electronic information services and resources" (p. 1). Although the principles that guided this initiative remain, the initiative faded away into the NII and NGI (National Information Infrastructure and Next Generation Internet, respectively). Now, some people get NREN confused with the NASA Research and Engineering Network (Cyhist, 1999). The terminology stays somehow alive in the academic community due to the fact that many other international academic initiatives

kept the Research and Education Network term component such as TERENA (Trans European Research and Education Networking Association).

The Next Generation Internet (NGI). NGI was born during the Clinton administration in 1996. It relied on a previous initiative titled National Information Infrastructure proposed in 1993 (Cameron, 1999; McLoughlin, 1998). Next Generation Internet Implementation Plan had three goals: (1) focused in experimental research and advanced network technologies; (2) The next generation network testbed; and (3) revolutionary applications. NGI focused on serving the advanced applications needs of federal agencies and also provided support to what was called, the U.S. university initiative or "InternetII" (McLoughlin, 1998, p. 1). Please notice the way Internet2 was addressed in those early days (as InternetII).

Internet2. This innovation is a creation of an academic organization titled University Corporation for the Advanced Internet Development or UCAID. The Internet2 term is actually a registered mark of UCAID and should be formally written as Internet2®. UCAID is constituted as a nonprofit organization created in 1996-1997 based on memberships and shared responsibilities, as was the case of BITNET and CSNET. It is currently composed of around 200 university members (UCAID, 2005a). The organization is not only composed of universities but of around 60 corporate members such as vendors, and around 40 affiliate members such as government laboratories, regional networks and non-research educational institutions. The primary goals of Internet2, according to its official Website, are: "(1) Create a leading edge network capability for the national research community; (2) Enable revolutionary

Internet applications; and (3) Ensure the rapid transfer of new network services and applications to the broader Internet community" (UCAID, 2005a, ¶1). Hanss and Van Houweling (2005), go further and set five main principles for Internet2 which are as follows:

> (1) Address the advanced networking needs and interests of the research and education community; (2) provide leadership in the evolution of the global Internet; (3) implement a systems approach to a scalable and vertically integrated advanced networking infrastructure; (4) leverage strategic relationships among academia, industry, and government; and (5) catalyze activities that cannot be accomplished by individual organizations. (p. 120)

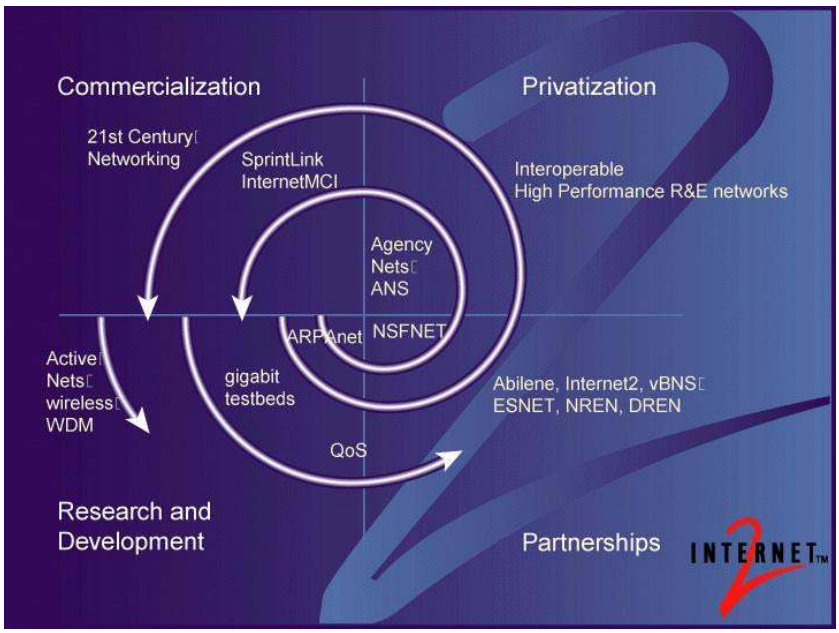
The similarities of the first three statements of both lists are noticeable. The last two items on Hanss and Van Houweling list emphasize the advantages of being an organized group.

On several occasions the researcher was guided to understand the Internet2 development as a second iteration of an ongoing development of the Internet in general. This means that it is necessary not to see the current Internet and Internet2 as two separate entities but rather as a continuum of planning and deployment as in the form of a spiral. Figure 1, taken from the Internet2 information kit illustrates this concept. Because of its importance, Hanss and Van Howeling's explanation of the spiral is quoted:

> The R&D phase is concentrated within university, government, and industry laboratories. In the partnership phase, promising research efforts are translated

into leading-edge production uses for the education community. Privatization occurs when successful technologies are transformed into offerings that make up the commercial Internet of today. (Hass & Van Houweling, 2005, p. 121)

Figure 1. Internet Spiral of Development. (Source: UCAID 2006)



The presentations mentioned above also emphasized the phases of partnership, privatization, and commercialization as expected for Internet2.

Internet2 infrastructure, on the other hand, consists of two complementary networks: The very high speed Backbone Network Services (vBNS) and the Abilene. VBNS, created soon after the 1995 NSFNET privatization (and before Abilene and

Internet2), was "the National Science Foundation commissioned portion of the network built and run by MCI" (Higgins, 1999, p. 4). Abilene is "a high-performance network developed by Internet2 in partnership with Juniper Networks, Nortel Networks, Qwest Communications, and Indiana University" (UCAID, 2006a, ¶1). Internet2, to finalize this section, fosters the development of new technologies and applications through a number of working groups, special interest groups, and advisory groups. For example, the case of the teaching and learning special interest group's mission to "increase awareness of and engagement in the uses of advanced networking technologies in support of teaching and learning activities throughout the Internet2 member community" (UCAID, 2006b, ¶1).

National LamdbaRail. The most recent of the efforts towards the advancement of Internet is NLR or National LambdaRail. Founded in 2003, NLR aims to "(1) Support experimental and production networks, (2) foster networking research, (3) promote next-generation applications, and (4) facilitate interconnectivity among high-performance research and education networks" (National LambaRail, 2006, ¶1).

The differences of Internet2 and NLR are: (1) The NLR infrastructure is owned and operated by the members and not carriers, (2) the NLR emphasis is on research, (3) NLR employs two full time staff so the organizational approach is not the same, and (4) the NLR governance (Futhey, 2005; Paulson, 2003). However, Futhey (2005) and UCAID (2005b) recognize NLR and Internet2 competition and thus emphasize the need to merge both initiatives. The merger, by October of 2006, has not taken place.

Theoretical Framework

Human resources in universities pose a unique challenge when attempting to implement changes or innovations (Torraco & Hoover, 2005; Watkins 2005). The seminal theories in which human resource development literature interprets changes in universities are three: Organization development, top management-driven change, and learning organizations. The first, organizational development, is explained as being led by participation of all constituencies with an emphasis in developing organizational capabilities. It has an emergent planning phase and all organizational members take responsibility. Top management-driven change, the second, is guided by a top-down leadership, emphasizing economic value, structured and programmatic planning, and responsibility of management (Torraco, 2005). Finally, the third, learning organizations are defined as the organization that "has an enhanced capacity to learn and to change" (Watkins, 2005, p. 415). Learning organizations have ample participation of management, organization, and individuals with strong emphasis on inquiry and dialogue for the creation of learning opportunities. It is noticeable how Watkins complements her work on learning organizations using Hall and Hord' stages of concerns model (Sta. Maria & Watkins, 2003; Watkins, Ellinger & Valentine, 1999). The Stages of Concerns model has been selected as one theoretical framework for this dissertation. Organizational development and top management-driven change theories were used extensively in the August of 2005 issue of *Advances in Developing Human Resources* (AHRD publication) where seven university cases were presented. Because of

the implications for this study, Torraco and Hoover's (2005) summary and final conclusions are presented here.

1. A thorough needs assessment should be conducted at the beginning of the change process to provide guidance as the needs of the organization and its personnel. Using this information, the implementation plan and the overall goals of the plan can be adapted to the specific needs of the organization. This gives the process much more relevance and applicability to organizational members and further encourages their involvement in the change process.
2. Senior administration in higher education must be committed to the OD changes for the institution. If the change is of a lesser part of the organization, the hierarchy, at least two positions above the unit administrator, must be in agreement and fully support the OD changes that are desired.
3. Leadership before and during the change process is indispensable. In academe, a transformational approach to leadership seems essential, yet there appear to be times when the approach must be more transactional in setting standards or parameters for the developing process.
4. Many times when change is pursued in academe, there is a tension that develops between the administration and the faculty. The tension can be useful but also destructive if it is not dealt with carefully and constantly.

5. When change is brought to academe, everyone in the organization must be involved in the process in some way. Otherwise, there will be major dissension and probable failure.
6. When change is desired in an institution, it is important to design or adapt a process that fits the mission, culture, and environment of the institution rather than using a predetermined process that was used in another institution.
7. It is important to determine the individuals in the organization who are favorable to making changes and to use these persons in the teams and the process at the institution. Also of importance is to find informal leaders throughout the organization, --but most important, in the faculty--, who are favorable toward change and to ask these people to get actively involved in the process, as they assist in building support from their colleagues and friends in the organization.
8. Change processes and OD take a lot of energy and perseverance. Because of the many detractors to change, the people involved in the process need to be highly motivated and persistent. (p. 435)

Educational Change Theories

The literature review on educational change theories and models resulted in the discovery of an important resource, the book entitled: *Surviving Change: A Survey of Educational Change Models*. Ellsworth (2000) published this "practitioner toolbox"

through the Office of Educational Research and Improvement and the Education Resource Information Center (ERIC). An important aspect in his review is that it reports how different traditions of change models have treated change as those explorers who had found different parts of an elephant and claimed them individually as "the elephant." That is, they have opted to compete and invalidate others despite the fact that a systemic-holistic view of all traditions would prove to be much more convincing. His account of models is innovative because he finally concedes validity to all traditions arranging them in an integrative model called the Change Communication Model, which describes the elephant as a whole living system composed of all the parts reported by various explorers. Figure 2 is Ellsworth's metaphoric image of the change theories and models: To the elephant outline (taken from a non-copyrighted Website), the seven different components in Ellsworth's Change Communication Model were added in this dissertation. Table 1 is a snapshot on these components; the questions they address, the flagship publications, principal authors, and location in the Ellsworth publication.

Figure 2. Elephant Explorer's Holistic View of Educational Change Theories (metaphor).

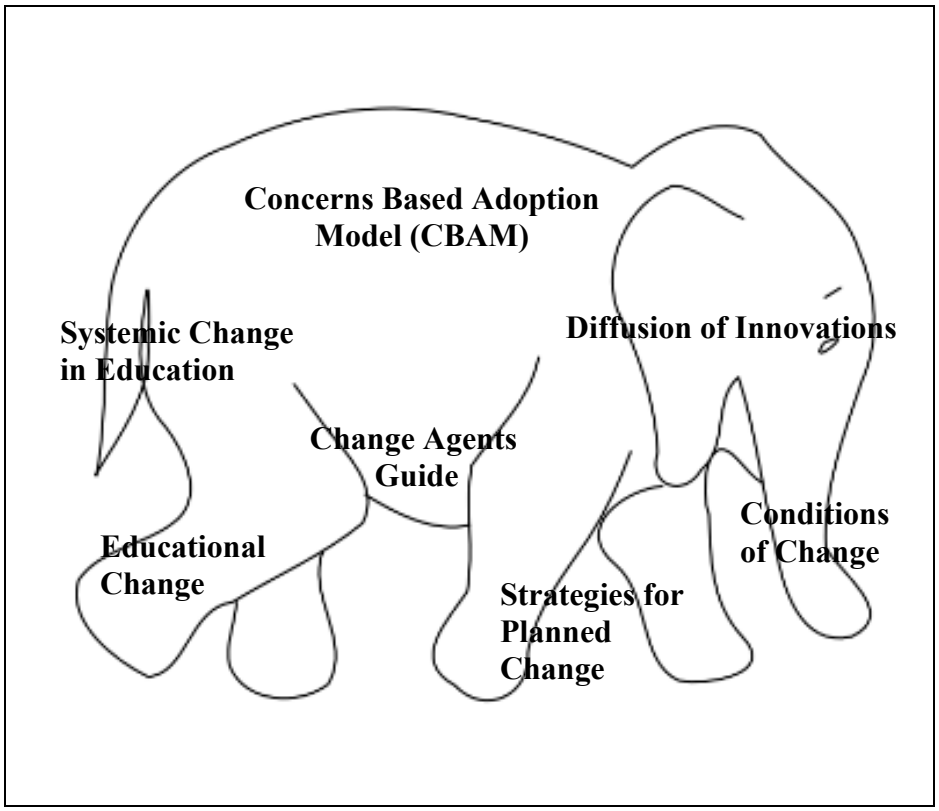


Table 1. Taxonomy of Change (Source: Ellsworth, 2000)

Question(s)	Component of Change Communication Model	Title of Flagship Publication (or Framework Name, if Different)	Principal Author(s)	Location in Monograph
What *attributes* can I build into the innovation or its implementation strategy to facilitate its acceptance by the intended adopter? How can the presence or absence of these attributes affect the rate of acceptance by the intended adopter (or prevent acceptance altogether)?	Innovation	*Diffusion of Innovations*	Rogers, E.M.	Chapter 3
What are the conditions that should exist or be created in the environment where the innovation is being introduced to facilitate its adoption?	Environment	*Conditions of Change*	Ely, D.P.	Chapter 4
What are the implications of educational change for people or organizations promoting or opposing it at particular levels? What can I, as a(n)...(e.g., teacher, district administrator, parent) do to promote change that addresses my needs and priorities?	Change Agent	*Meaning of Educational Change*	Fullan, M.G. Stiegelbauer, S.M.	Chapter 5
What are the essential stages of the change facilitation process? What activities should the change agent be engaged in during each stage?	Change Process	*Change Agent's Guide*	Havelock, R.G.	Chapter 6
What stages do teachers go through as an innovation is implemented? What will be the major focus of their concerns at each stage? What levels of innovation use are likely to be exhibited at each stage? How do I identify which stage teachers are at right now? How do I assess the extent to which teachers are actually using the innovation as its developers intended?	Intended Adopter	*Concerns-Based Adoption Model (CBAM)*	Hall, G.E. Hord, S.M. Newlove, B.W.	Chapter 7
What are the cultural, social, organizational, and psychological *barriers* to change that can promote resistance to the innovation? What can I do to lower these barriers and encourage adoption?	Resistance	*Strategies for Planned Change*	Zaltman, G. Duncan, R.B.	Chapter 8
What are the factors *outside* the immediate environment in which the innovation is being introduced that can affect its adoption? How can change efforts combine multiple, mutually reinforcing innovations to increase the likelihood of effective, lasting change? What stakeholders and constituencies are likely to see their interests impacted by this change, and how can I work with them to ensure they see their concerns being addressed?	System	*Systemic Change in Education*	Banathy, B.H. Reigeluth, C.M. Garfinkle, R.J. Carr-Chellman, A.A. Jenlink, P.M.	Chapter 9

In Chapter I of this dissertation, four research questions were presented. Those research questions are closely tied to two of Ellsworth's theoretical frameworks, the diffusion of innovations and the concerns-based adoption model (CBAM). The next paragraphs will introduce both frameworks.

Rogers's Model (Diffusion of Innovations)

According to Rogers (2004), the number of diffusion publications by the time of his 2003 *Diffusion of Innovations* book edition, was about 5,000. Before focusing on the studies that are of relevance for this dissertation, it is important to review his model.

Rogers (2003) defines *diffusion* as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). *Innovation*, on the other hand, is defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 12). For the purposes of this dissertation, the innovation is Internet2. Therefore, via the research questions, this study is focused on the process in which Internet2 is communicated through the A&M channels over time among the members of the university system.

Rogers also outlines the Diffusion of Innovations from a four-elements perspective. The elements are (1) the innovation, (2) the communication channels, (3) the time, and (4) the social system.

Table 2 is an overall diagram of these four elements. In addition, it denotes some of the sound theoretical concepts that Rogers provides in each element description. They all will be explained in depth immediately after.

Table 2. Diagram of Rogers' Diffusion of Innovations Model (with Its Four Elements and Soundest Concepts)

ELEMENT II **COMMUNICATION CHANNELS** - Mass vs. Interpersonal Channels. Innovations. - Homophily vs Heterophily.	**ELEMENT I** **INNOVATION** - Perceived Attributes of
ELEMENT III **TIME** - Innovation-Decision Process. - Adopter Categories.	**ELEMENT IV** **SOCIAL SYSTEM** - Opinion Leaders & Change Agent Categories. - Types of Innovation-Decisions. - Consequences of Innovations.

Newness, the defining quality of an innovation, the first element in Table 2, is explained in terms of perceived newness and not objective newness. That is, the model is not really based on how the innovation has been diffused since its discovery or first use, but rather on the perception of newness that the adopter has (for example, the personal computer diffusion that took place during the last two decades although the computer invention can be traced back to the 60s). Furthermore, most diffusion processes analyzed under this framework have been said to be relative to technological innovations. Rogers (2003) defines *technology* as "a design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome" (p.

13). In this sense, technology is said to create uncertainty in the mind of the potential adopter giving room to the concept of the innovation-decision process (fully described in the third element section, the time element), which is in turn based on the perceived attributes of the innovation. Table 3 is an explanation of the perceived attributes of the innovation provided by Rogers (2003).

Table 3. Innovations Attributes as Described by Rogers

Attribute of the Innovation	Definition
1. Relative advantage	Degree to which an innovation is perceived as better than the idea it supersedes.
2. Compatibility	Degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
3. Complexity	Degree to which an innovation is perceived as difficult to understand and use.
4. Trialability	Degree to which an innovation may be experimented with on a limited basis.
5. Observability	Degree to which the results of an innovation are visible to others.

Another important concept is the reinvention, which is the last one explained in the innovation section. Rogers (2003) states that during the early days of diffusion research, the innovation was assumed to be an invariant quality that did not change as it was diffused. When this appreciation was corrected, the reinvention concept appeared and was defined as the "degree to which an innovation is changed or modified by a user in the process of adoption and implementation" (p. 17).

The second element in Table 2, the communication channel element is explained in terms of communication and its channel(s). *Communications* is defined "as the

process by which participants create and share information with one another in order to reach a mutual understanding" (p. 18). Communication channel, on the other hand, is the vehicle by which messages get from one individual to another. Rogers (2003) also discusses a classification of communication channels. Table 4 describes the types of communications channels.

Table 4. Classification of Communication Channels as Described by Rogers

Type of Communication Channel	Definition
1. Mass media channels	Those means of transmitting messages that involve a mass medium, such as radio, television, newspapers, and so on, which enable one or a few individuals to reach an audience of many.
2. Interpersonal channels	Those involving a face-to-face exchange between two or more individuals.

In addition, this second element contemplates the concept of homophily and heterophily. They both are considered of relevance to communications since they refer to the degree to which two or more individuals who interact are similar in certain characteristics such as education or socioeconomic status. *Homophily* refers to a high degree of similarity and *heterophily* refers to low or nonexistent similarity.

The third element, the time element, has been recognized in Rogers' (2003) model. In contrast to most of the behavioral models, time is considered a variable in the diffusion of innovations. In this element, two of the soundest theoretical concepts are presented, the innovation-decision process and the adopter categories. The innovation-decision process situates the individual from first knowledge of an innovation, to the

formation of an attitude, then to a decision to adopt or reject (resulting in an implementation), and finally to confirmation of the decision. Table 5 provides an in-depth explanation of each of the components of Rogers' (2003) innovation-decision process.

Table 5. Components of the Innovation-Decision Process Based on Rogers

Components of the Innovation-Decision	Definition
1. Knowledge	Knowledge is gained when an individual (or other decision-making unit) learns of the innovation's existence and gains some understanding of how it functions.
2. Persuasion	Persuasion takes place when an individual forms a favorable or unfavorable attitude toward the innovation.
3. Decision	Decision occurs when an individual engages in activities that lead to a choice to adopt or reject the innovation.
4. Implementation	Implementation takes place when an individual puts an innovation into use.
5. Confirmation	Confirmation occurs when an individual seeks reinforcement of an innovation-decision that has already been made, but he or she may reverse this previous decision if expose to conflicting messages about the innovation.

The innovation-decision process can culminate not only in adoption or rejection but discontinuance if the process goes for a longer period of time. In consequence, the innovation-decision process can also be limited by a length of time, creating the concept of an innovation-decision period.

The adopter categories, on the other hand, are explained as the taxonomy of members of a social system based on how relatively early a person adopts new ideas in comparison with other members of the system. Table 6 provides the descriptions of each of these categories.

Table 6. Adopter Categories as Described by Rogers

Adopter Categories	Description
1. Innovators	Seek actively information about new ideas. They are venturesome.
2. Early Adopters	Have the highest degree of opinion leadership. They help trigger the critical mass when they adopt an innovation.
3. Early Majority	Adopt new ideas just before the average member of a system.
4. Late Majority	Adopt new ideas just after the average member of a system. They are skeptical.
5. Laggards	Adopt an innovation lastly in a social system. They are considered traditional.

The final concept presented in the time element is the *rate of adoption*, defined as "the relative speed with which an innovation is adopted by members of a social system" (Rogers, 2003, p. 23).

The last element, the most important for this study, is the social system element. Diffusion is known to take place in a social system, which constitutes the limits of the diffusion. The social system is in turn dependent on the social system's own structure, norms, the opinion of its change agents, the types of innovation-decisions and consequences of innovations. The three primary concepts of the social system are (1) the change agents and opinion leaders' classification, (2) the types of innovation-decisions,

and (3) the consequences of innovations. Opinion leaders are those able to influence other individual's attitudes or behavior informally in a direction desired by the change agency. Change agents are considered persons with influence over clients in the decision of adopting an innovation. The authority by which an innovation is diffused in a system is explained under the innovation-decision types. Table 7 describes these types of innovation-decisions.

Table 7. Types of Innovation-Decisions as Described by Rogers

Types of innovation-decisions	Description
1. Optional innovation-decisions	Choices to adopt or reject an innovation that are made by an individual independent of the decisions of the other members of the system.
2. Collective innovation-decisions	Choices to adopt or reject an innovation that are made by consensus among the members of a system's decision once it is made.
3. Authority innovation-decisions	Choices to adopt or reject an innovation that are made by relatively few individuals in a system who possess power, status or technical expertise
4. Contingent innovation-decisions	Choices to adopt or reject that can be made only after a prior innovation-decision

The last concept outlined in the social system element corresponds to the consequences of innovations. Consequences are "changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation" (Rogers, 2003, p. 31). Rogers (2003) classifies these consequences in the following manner (see Table 8).

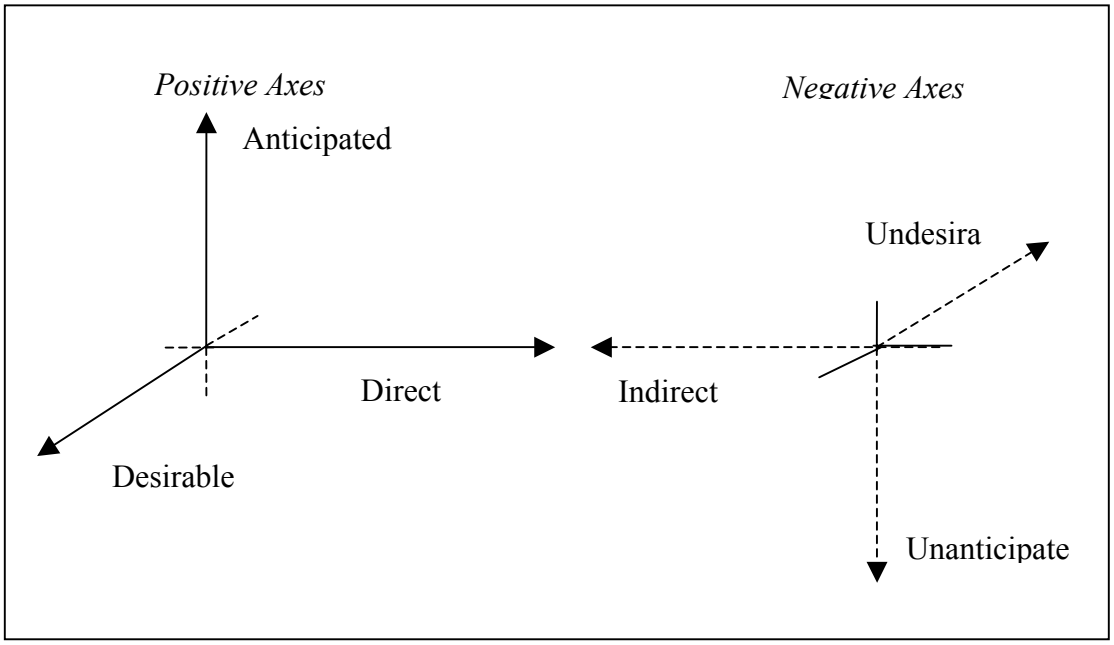
Consequences of innovations can be seen as three-dimensional. Based on Berger's (2005) model, the following graphic is a representation of these dimensions

(see Figure 3). The positive values are given to desirable, direct, and anticipated attributes. Negative values are thus given to undesirable, indirect, and unanticipated. The axes are a portrayal of the bipolar character of each attribute. The octants (eight subdivisions) represent the possible combinations of consequence classification.

Table 8. Consequences of Innovations Categories as Described by Rogers

Consequences of Innovations	Descriptions
1. Desirable versus undesirable	Depending on the functional effects of an innovation for an individual or a social system, a consequence can be desirable or undesirable.
2. Direct versus indirect	The directedness of a consequence is assessed by how immediately respond to the innovation. Indirect consequences are the so-called consequences of the consequences, in other words, derivates of the original direct consequence.
3. Anticipated versus unanticipated	Anticipation is explained as the changes that are recognized and intended. Unanticipated, in consequence, are the changes that are neither intended nor recognized by the members of a social system.

Figure 3. Roger's Diffusion of Innovations-Consequences Three Dimensional System.



Up until this point, the innovation has been the focus of the theoretical framework; the next section will emphasize the role of the intended adopter.

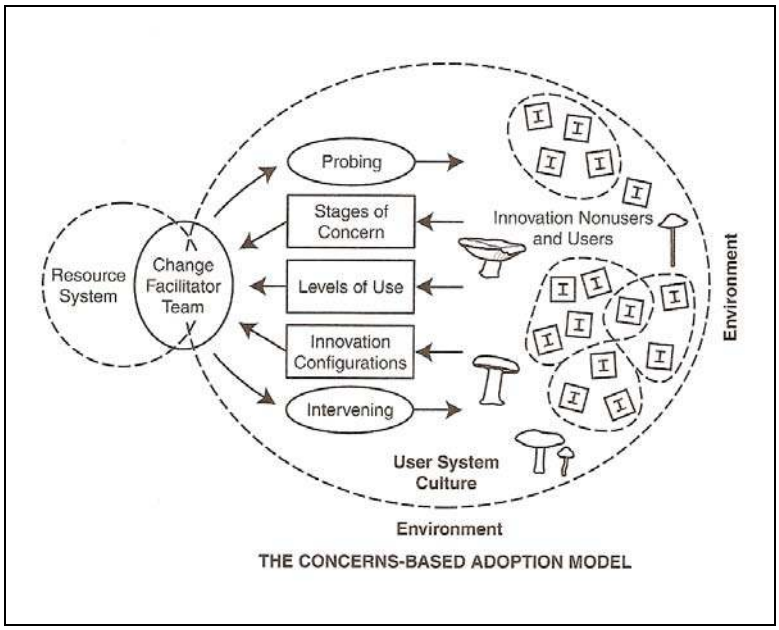
Hall and Hord's Concerns-Based Adoption Model (CBAM)

The concerns-based adoption model is the second educational-change framework this dissertation used. It emphasizes the attitudes and concerns of the intended adopter and complements the analysis of diffusion consequences, thus setting the stage for aspects that are relevant for further adoption and diffusion of Internet2. The CBAM theoretical model was developed originally by the Research and Development Center for

Teacher Education at the University of Texas-Austin (Hall, Wallace, & Dossett,1973). *Concern* is defined as "the composite representation of feelings, preoccupation, thought, and consideration given to a particular issue or task"(Hall & Hord, 2006, p. 138). CBAM was conceived specifically for school settings so it is described by terminology such as teachers and principals. Despite this fact, the researcher valued the applicability of the framework to higher education environments. The model is composed, as in the case of Rogers' (2003) model, by elements. The elements are (1) Change Facilitator, (2) Resource System, (3) Stages of Concern, (4) Levels of Use, (5) Innovation Configuration, and (6) User System Culture and Environment. Figure 4 is a representation of these elements in interaction.

The Change Facilitator (first element of the model) helps others, either individuals or groups, in the development of competencies and confidence required in the use of an innovation. The Resource System, second element, is composed of all the aids that the change agent relies upon.

Figure 4. CBAM Model Picture (Source: Hall & Hord, 2006)



The Stages of Concern, the third element and the most important for this dissertation, is a dimension that "addresses how teachers and others perceive an innovation and how they feel about it" (Hall & Hord, 1987, p. 13). Figure 5, taken from the original publication, is a description of the stages of concern in detail.

The Levels of Use (fourth element) is a dimension that describes how progressively the innovation is used. The levels go from non-use to renewal or reevaluation. The Innovation Configuration, fifth element, is the form an innovation can take when applied, sometimes adapting its operation to the specific context. The User System-Culture element is defined as "the socially constructed values, norms, and beliefs about an organization and how it should behave that can be measured only by observation of the setting using qualitative methods" (Hall & Hord, 2006, p. 20). The

Environment Element is finally explained as the external forces such as legislation that shapes the agenda of change.

Figure 5. Stages of Concern (Source: Hall & Hord, 2006)

Impact	**6 Refocusing:** The focus is on the exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.
	5 Collaboration: The focus is on coordination and cooperation with others regarding use of the innovation.
	4 Consequence: Attention focuses on impact of the innovation on clients in his or her immediate sphere of influence. The focus is on relevance of the innovation for clients, evaluation of outcome including performance and competencies, and changes needed to increase client outcomes.
Task	**3 Management:** Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.
Self	**2 Personal:** Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision-making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
	1 Informational: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner, such as general characteristics, effects, and requirements for use.
Unrelated	**0 Awareness:** Little concern about or involvement with the innovation is indicated.

Studies of Relevance

Each element of Diffusion of innovations model, the innovation, the communication channels, the time, and the social system, constitute a whole cluster of

literature. Most of the literature, however, pertains to the first three elements leaving the social system element and the consequences of innovations' studies (as part of it), with very scarce number of publications (Rogers, 2003; Rogers, Daley, & Wu, 1982). Despite this fact, an extensive literature review on studies framed under consequences of innovations and stages of concern was conducted resulting in the identification of eight different studies, all providing rich information for the purposes of this dissertation, five of them based on consequences of innovations and three on stages of concern.

The most influential studies related to this dissertation are three: The diffusion of computer technology and telecommunications --a comparative case study of middle schools in the Texas Education Collaborative (Dooley, 1995); perceived consequences of adopting the Internet into adult literacy and basic education classrooms (Berger, 2005); the diffusion of home computers --an exploratory study (Rogers, et. al., 1982). All studies made Rogers' elements of diffusion of innovation framework operational in different manners. The first was a case study which purpose was to understand the process of diffusion of computer technology and telecommunications in three middle schools that joined the Texas Education Collaborative in 1992. The study took specifically the innovation-decision process in a complementary way with the stages of concern providing an example from where the researcher took the model for the case of Internet2 at Texas A&M. The second, Berger's (2005) study, was focused on the consequences of adopting the Internet into adult literacy and basic education classrooms. The study proposed the graphic representation of consequences from where the researcher based the three dimensional model provided before in this chapter. The third,

Rogers, et. al. (1982) study, applied in detail the four elements of Diffusion of Innovations model when explaining the adoption of home computers in the Stanford University vicinity. Since Rogers is the author of the model itself, this is a "must read" study when attempting to implement a study on computer technology innovations as the case of this dissertation.

The other consequences of innovations studies focus on computer innovations as well: One analyzes the electronic patron adoption at the author's university (Smith, 1998), another analyzes the adoption of a software cataloging system in a rural elementary school (Baker, 1985), and the third one evaluates the educational technology and distance education initiatives in South Dakota (Simonson & Sparks, 2001). All of them emphasize the directedness, or the anticipation, or the desirability of such innovations separately. Since they do not use the three-dimensional consequences reference as a whole, just one or two of the attributes, they reflect the flexibility of Rogers model (which components can adapt easily to studies of this nature).

The stages of concern literature, with much more abundance of publications where to choose from, provided the two remaining selected studies of this review. One is a study of faculty concerns and developmental use of Web-based course tools (Singer, Hall & Upton, 2000), and the other is a study of learners in telecommunication courses (Well & Anderson, 1997). Both studies were also concentrated on the adoption of computer technologies, specifically the adoption of online-Internet tools. The two, however, shared the particular characteristic that they also incorporated the diffusion of innovations framework (although not consequences of innovations) and were chosen

because they provide examples from the perspective of faculty and students (respectively) on similar issues and concerns.

Summary

For the purpose of adopting Internet2 in university settings (its intended audience), it is important to understand the forces that influence adoption, rejection, and even speed of diffusion. The history of the Internet and its transition to Internet2 make perceptible those forces that have shaped Internet2 to what we have today and will continue shaping it in the future. Funding issues and the tradition of non-profit academic organizations are good examples of those influences. For a foreigner (non-American citizen), it is important to be aware of these because it explains in many ways our own home initiatives (most of them based on the American model).

As reviewed on this chapter, there have been several ways in which changes in universities have been understood. Three major areas covered are those related to HRD, Diffusion of Innovations and the CBAM model. These three are extraordinary frameworks that in many ways explain the way innovations can be comprehended. Chapter IV, will frame on these theories with the explication of the findings of this study.

CHAPTER III

METHODOLOGY

This study used the qualitative method of inquiry. In this chapter, I will justify this selection and will present the research design options. Case study was chosen as the strategy for research, so an in-depth description of the elements for this strategy was addressed. The elements will be accompanied by the specific sources of data and data analysis for the case of perceived consequences and concerns in the diffusion of Internet2 at Texas A&M. Finally; the trustworthiness was set in the final section providing detailed information about the mechanisms used in this dissertation.

Why Qualitative Methodology Is the Most Appropriate Method

Creswell (2002) mentions that the selection of the method of research is closely tied to the identification of a research question and the purpose of the study. The research questions and purpose of this study are in the examination of the consequences and concerns with the diffusion of Internet2 at Texas A&M University. In addition, there was a lack of evidence of studies of this nature applied to the organization in the past. As a consequence, the research problem appointed this study to be of exploratory and understanding nature. Creswell (2002) and Swanson and Holton (1997) recommend the qualitative research method as the most appropriate for the case of the exploration and understanding of a central phenomenon.

The qualitative method of research, as Creswell (2002) and Lincoln and Guba (1985) recognize, is a tradition of research without a fixed set of characteristics (i.e., the anthropological or sociological traditions); however, they all agree it has a distinctive set of shared basic assumptions. Creswell (1997) offers a list of reasons for conducting qualitative research:

- Select a qualitative study because of the nature of the research question.
- Choose a qualitative study because the topic needs to be *explored*.
- Use a qualitative study because of the need to present a *detailed view* of the topic.
- Choose a qualitative approach in order to study individuals in their *natural setting.*
- Select a qualitative approach because of interest in *writing* in a literary style.
- Employ a qualitative study because of *sufficient time and resources* to spend on extensive data collection in the field and detailed data analysis of "text" information.
- Select a qualitative approach because *audiences are receptive* to qualitative research.
- Employ qualitative approach to emphasize the researcher's role as an *active learner* who can tell the story from the participants' view rather than as an expert who passes judgment on participants. (p.17)

It is noteworthy how all the items were in complete accordance with the research questions and purpose of this study. In addition, this list also provided an initial guideline for the research design explained in what follows.

The Research Design

Creswell (2002) offers a variety of qualitative research designs such as Grounded Theory Designs, Ethnographic Designs, and Narrative Research Designs. Denzin and Lincoln (2000), on the other hand, list Ethnography, Case Study, Grounded Theory, Narrative, Participatory Action Research, and Clinical Research as some of the most important strategies of inquiry.

With such abundance of research designs, the natural question to be asked is: What strategy of inquiry best suited the research questions of this dissertation? In order to respond, Gay and Airasian (2000) offer a comparison list of different research designs. The list is composed of questions and associated research designs. The question, "What are the characteristics of this particular entity, phenomenon or person?" (p. 202) is associated with Case Studies and is the most similar to the actual research questions. Thus, Case Study seems the most appropriate choice. Yin (2003) reinforces this conclusion by stating:

> To summarize, the first and most important condition for differentiating among the various research strategies is to identify the type of research question being asked. In general, "what" questions may either be exploratory (in which case any of the strategies could be used) or about prevalence (in which surveys or the

> analysis of archival records would be favored). "How" and "why" questions are likely to favor the use of case studies, experiments and histories. (p. 7)

Yin (2003) also emphasizes other important features considered in the strategy. Among them, the creation of rapport by means of direct observation or the inclusion of more sources of information

> The case study is preferred in examining contemporary events, but when the relevant behaviors cannot be manipulated. The case study relies on many of the same techniques as a history, but it adds two sources of evidence not usually included in the historian's repertoire: Direct observation of the events being studied and interviews of the persons involved in the events. Again, although case studies and histories can overlap, the case study's unique strength is its ability to deal with a full variety of evidence --documents, artifacts, interviews, and observations --beyond what might be available in a conventional historical study. (p. 8)

Finally, Dooley (2002) recognizes the case study as a research strategy by stating "Case Study can also be thought of as a research strategy. As a strategy, case study research attempts to examine a contemporary phenomenon and the associated contexts that are not clearly evident" (p. 338). Since Internet2's diffusion is clearly a contemporary phenomenon, case study was chosen as the strategy for this study.

Case Study Research Design

Sources of Data. According to Creswell (1997), the case study design might be composed of multiple sources of information such as documents, archival records, interviews, observations, and even physical artifacts. The research questions of this study focused in an organization "as it is" (Burrell & Morgan, 1979). Since this particular organization possesses physical offices, employs staff, holds meetings, and keeps records of their activities (printed and online), almost all sources of information for case studies were included.

Before getting into the sources of data, it is important to note how the selection of information took place. In that respect, qualitative methods are known for their use of purposeful sampling. This means that the selection of individuals and sites was intentionally based on the richness of information they could provide (Creswell, 2002; Merriam, 1998). Under such criteria all sources of data for this study and the respective instrumentation will be explained in detail in the following paragraphs.

In order to select the most appropriate sampling type, two authors were consulted. Merriam (1998) contended with the following types of sampling.

1. Typical sample: "Is selected because it reflects the average person, situation, or instance of the phenomenon of interest" (p. 62).
2. Unique sample: "Is based on unique, atypical, perhaps rare attributes or occurrences of the phenomenon of interest" (p. 62).
3. Maximum variation: "Select small sample of great diversity" (p. 63).

4. Convenience sample: “Is just what is implied by the term. You select a sample based on time, money, location, availability of sites or respondents and so on” (p. 63).
5. Snowball, chain or network: “This strategy involves asking each participant or group of participants to refer you to other participants” (p. 63).
6. Theoretical sampling: “Is the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges” (p. 63).

Additionally, Creswell (2002) offered the following types:

7. Critical sampling: “Sometimes individuals or research sites represent the central phenomenon in dramatic terms. The sampling strategy is to study a critical sample because it is an exceptional case and the researcher can learn much about the phenomenon” (p. 196).
8. Opportunistic sampling: “Undertaken after the research begins in order to take advantage of unfolding events” (p. 196).
9. Confirming sampling: “Is a purposeful strategy used during a study to follow up on specific cases in order to test out or explore further specific findings” (p. 197).
10. Homogeneous sampling: “The researcher purposefully samples individuals or sites based on membership in a subgroup that has defining characteristics” (p. 196).

Convenience sampling, homogeneous sampling, and snowball sampling were chosen as the sampling types for the purpose of this dissertation. Following these sampling techniques, the Texas A&M activities (and thus its structure) were conceptually categorized in Teaching, Research and Support-Services groups.

Teaching Group Sample. For the part corresponding to the teaching activities at Texas A&M, I chose as gatekeepers or snowball points of entry, the College of Education and Human Development-Technology Council as well as the TAMU's Office of Graduate Studies. Once the snowball was "set into motion", 7 more participants were identified related to this group.

Research Group Sample. For the part corresponding to the research activities at Texas A&M, I selected as gatekeepers the Council of Principal Investigators of Texas A&M which hold meetings once a month. Six more participants were identified related to this group.

Support-services Group Sample. Administration and Support-services were grouped in the same area because administrative tasks were considered to be supportive of teaching and research activities. For this part, I chose as gatekeepers a group of individuals in the Telecommunications and Computing and Information Services at Texas A&M University. Thirteen more participants were identified related to this group.

Overall Sample. According to the Internet2's official Website, around 30 different TAMU personnel had attended the Internet2 members meetings during the last two years (2004, 2005). In addition, from TAMU's Website, a couple of Internet2 days took place between 2003 and 2004 in College Station. As a result, both printed and

online records of Internet2 activities and potential participants were available at Texas A&M and Internet2 sites. That way, and in addition to the reference provided by the gatekeepers, I was able to perform the snowball sampling, identifying support members, faculty, and staff directly related to Internet2. Table 9 provides information about the gatekeepers and participants.

On the other hand, because this study took place at Texas A&M University (the same institution where I am located), there were opportunities to visit participants in their work places in order to make observations. Therefore, additional sources of information for the case studies (documents, artifacts, interviews, and observations) were included.

Table 9. Information of Gatekeepers and Participants

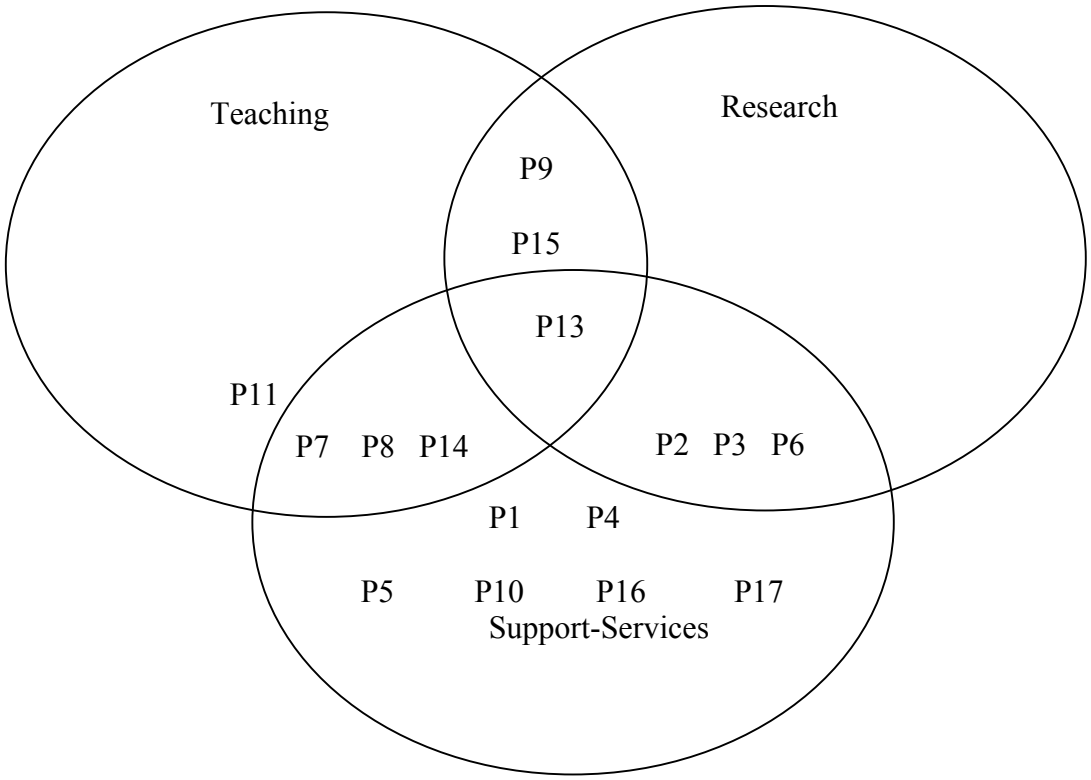
Teaching	Research	Support
Gatekeepers: College of Education and Human Development-Technology Council as well as the TAMU's Office of Graduate Studies	**Gatekeeper:** Council of Principal Investigators	**Gatekeepers:** Telecommunications and Computing and Information Services
Snowball: Participant 7: Training Specialist Participant 8: Director (College of Education and Human Development) Participant 9: Professor And Head of Department (College of Engineering) Participant 11: Associate Professor (College of Education and Human Development) Participant 12: Associate Professor (College of Education and Human Development) Participant 13: Associate Director Participant 14: Assistant Dean Participant 15: Professor, Executive Associate Dean & Director (College of Architecture)	**Snowball:** Participant 2: Group Manager Participant 3: Associate Research Specialist Participant 6: Applications Development Administrator Participant 9: Professor And Head of Department (College of Engineering) Participant 13: Associate Director Participant 15: Professor, Executive Associate Dean & Director (College of Architecture)	**Snowball:** Participant 1: Associate Director Participant 2: Group Manager Participant 3: Associate Research Specialist Participant 4: Chief Officer Participant 5: Assistant Director Participant 6: Applications Development Administrator Participant 7: Training Specialist Participant 8: Director Participant 10: Vice President Participant 13: Associate Director Participant 14: Assistant Dean Participant 16: Senior Administrator Participant 17: Chief Engineer

Number. Lincoln and Guba (1985) recommend to limit the sample size when the information reaches a point of saturation. This means that whenever redundancy in the information is encountered, or in other words, when no new information is provided, the collecting data process should stop. Before providing a number of informants Merriam (1998) advises that:

> If you are submitting a proposal to a funding agency, dissertation committee, or other oversight board for approval or support, you can offer a tentative, approximate number of units to be included (that is people, sites, cases, activities, and so on), knowing full well that this will be adjusted in the course of the investigation. (p. 64)

The tentative number offered in the proposal was 30 individuals for the three representative groups and Internet2 activities attendees, although at the end of the data collection, the final number was 17 because saturation was reached. Placement of participants in their respective group(s) is shown in Figure 6. As can be noticed, participants can perform more than one role or, in other words, they can be associated with more than one field of the university's activities. Due to the Internet2 specificities, I developed definitions for each role. Support-Services role was defined as one with the responsibility to provide, install and maintain Internet2 infrastructure and applications. The teaching role was defined as one who consciously uses Internet2 as a teaching tool. The research role was defined as one responsible for the creation or implementation of new Internet2 technologies or the use of Internet2 as a research tool.

Figure 6. Participants' Roles at Texas A&M University



Interviews. Before discussing the format and structure of the interviews, it is necessary to invest some time in the different options available. Creswell (2002) lists the following options with respect to the structure:

1. Structured Interviews: "The researcher asks the participant questions with close-ended response options. This is the form of interviewing frequently used in quantitative research" (p. 204).
2. Semi-structured: "The researcher asks some questions that are close-ended and some questions that are open-ended. The advantage of this type of interviewing is that the predetermined close-ended responses can net useful information to support theories and concepts in the literature" (p. 205).

3. Unstructured: “The researcher asks open-ended questions that permit the participant to create response possibilities. This type of interview represents the most frequently used for interviewing in qualitative research” (p. 205).

Regarding the decision about the number of participants per interview, Creswell (2002) also lists the following options from which to choose.

1. One-on-One Interview: “One-on-one interviews are ideal for interviewing participants who are not hesitant to speak, are articulate, and who can share ideas comfortably” (p. 206).
2. Focus Group: “The researcher asks a small number of general questions and elicits responses from all individuals in the group…. Focus groups are advantageous when the interaction among interviewees will likely yield the best information and when interviewees are similar to and cooperative with each other” (p. 206).
3. Telephone Interview: “It may not be possible to gather groups of individuals for an interview or visit one-on-one with single individuals. The participants in a study may be geographically dispersed and be unable to come to a central location for an interview. In this situation, a telephone interview is needed” (p. 206).

The design of the interviews was selected considering the exploratory nature of the study and the convenience sampling technique. Thus one-on-one, unstructured interviews were the type of interviews to pursue.

Observations. In combination with the interviews, observations were selected as another source of data. Lincoln and Guba (1985) explain what observation does for qualitative studies.

- Maximizes the inquirer's ability to grasp motives, beliefs, concerns, interests, unconscious behaviors, and the like.
- Allows the inquirer to see the world as his subjects see it, to live in their frames, to capture the phenomenon in and on its own terms and to grasp the culture in is own natural, ongoing environment.
- Provides the inquirer with access to the emotional reactions of the group introspectively --that is, in a real sense it permits the observer to use himself as the data source.
- Allows the observer to build a tacit knowledge, both his own and that of members of the group. (p. 273)

Merriam (1998), on the other hand, offers a detailed list of observable items that served as guidelines.

1. The physical setting: "What is the physical environment like? What is the context? What kinds of behavior is the setting designed for? How is space allocated? What objects, resources, technologies are in the setting"(p. 97)?
2. The participants: "Describe who is in the scene, how many people, and their roles. What brings these people together? Who is allowed here? Who is not here

who would be expected to be here? What are the relevant characteristics of the participants" (p. 97)?

3. Activities and interactions: "What is going on? Is there a definable sequence of activities? How do people interact with the activity and with one another? How are people and activities connected or interrelated (participants and researcher point of view). What norms or rules structure the activities and interactions? When did the activity begin? How long does it last? Is it a typical activity, or unusual" (p. 98)?
4. Conversation: "What is the content of conversations in this setting? Who speaks to whom? Who listens? Quote directly, paraphrase and summarize conversations" (p. 98).
5. Subtle factors: "Informal or unplanned activities. Symbolic and connotative meanings of words. Nonverbal communication such as dress and physical space. Unobtrusive measures such as physical clues. What does not happen? –especially if it ought to have happened" (p. 98).
6. Your own behavior: "How is your role, whether as an observer or an intimate participant, affecting the scene you are observing? What do you say and do? In addition, what thoughts are you having about what is going on? These become "observer comments" (p. 98).

Documents and Archives. The final source of information of this study was documents and archives. According to Yin (2003), documents can take the following forms:

1. Letters, memoranda, and other communiqués
2. Agendas, announcements and minutes of meetings, and other written reports of events
3. Administrative documents—such as proposals, progress reports, and other internal records
4. Formal studies or evaluations of the same 'site" under study
5. Newspapers clippings and other articles appearing in the mass media or in community newsletter (p. 86).

Archives, on the other hand, are said to take the form of computer files and records that may be of relevance such as:

1. Service records --number of clients served over a given period of time
2. Organizational records --organizational charts and budgets over a period of time
3. Maps and charts of the geographical characteristics or layouts of a place
4. Lists of names and other relevant items
5. Survey data –census records or data previously collected about a "site"
6. Personal records –diaries, calendars and telephone listings (Yin, 2003, p. 89).

Data Collection. One-on-one, unstructured interviews were used as the primary data collection technique. The interviews were audio-taped and transcribed for analysis. Field notes with observational details supplemented tape recordings. Archival information from meeting proceedings and minutes, strategic plans, and agendas were also of use. The Informed Consent Form, Interview Protocol, Observation protocol, Archival protocol guideline and the Sample Email Message for Requesting Participation from interviewees can be found in Appendix B.

Data Analysis Strategy

In order to select a preliminary data analysis strategy, Merriam (1998) provided various options available.

1. Ethnographic Analysis: It focuses on the culture and social regularities of everyday life.
2. Narrative Analysis: At the heart of narrative analysis are the ways humans experience the world.
3. Phenomenological Analysis: This type of analysis attends to ferreting out the essence or basic structure of a phenomenon.
4. The Constant Comparative Method: This method was developed as the means of developing grounded theory. A grounded theory consists of categories, properties, and hypothesis that are the conceptual links between and among the categories and properties.

5. Content Analysis and Analytic Induction: Both of these techniques are used implicitly in any inductive analysis of qualitative data. (p. 156)

In the case of ethnographic analysis, the culture and social regularities of Texas A&M were not related to the research questions.

The constant comparative method, on the other hand, aims to prove a hypothesis or at least imply a causal factor under a grounded theory design. As a consequence, it did not offer a viable instrument for this study due to the fact that this study was of exploratory nature.

Content Analysis and Analytic Induction have an implicit quantitative element that makes them similar to the constant comparative method in that of proving a causal factor, or in Altheide (1987) words, "Although categories and 'variables' initially guide the study, others are allowed and expect to emerge throughout the study" (as cited in Merriam, 1998, p. 160).

The phenomenological analysis aims to study a phenomenon in its entirety or in Merriam words (1998, p. 160), to study it "from several angles and perspectives." Since this study was focused only on the consequences and concerns of the Texas A&M organization, the phenomenological analysis was not helpful. It would have been useful in the event the research questions specified the understanding of Texas A&M at all levels (e.g., technological, economical, organizational, political, etc).

The narrative analysis, by means of storytelling or "ways in which human beings make sense of their experiences" (Riessman, 1993) offered a much more rich tool in the analysis of data of this study. Denzin and Lincoln's (2000) *Handbook of Qualitative*

Research dedicates an article to the case study design. In this article the value of narrative inquiry is recognized by stating, "Storytelling as cultural representations and as sociological text emerges from many traditions, but nowhere more strongly than oral history and folklore, and is becoming more disciplined in a line of work called narrative inquiry" (Stake, 2000, p. 445).

In addition, another important data analysis technique used in this study was the inductive-generative-constructive-subjective technique or analytic induction provided by Lincoln and Guba (1985). It consists of "scanning the data for categories of phenomena and for relationships among such categories, developing working typologies…" (p. 335).

Established Trustworthiness

As in any quantitative research design, it was necessary to incorporate mechanisms that ensure internal validity, external validity, reliability and objectivity. Under a qualitative methodology though, the equivalent alternatives are credibility, transferability, dependability, and confirmability. Lincoln and Guba (1985) offer a rich account of techniques that were incorporated in this study:

Credibility. This dissertation used the following mechanisms in order to ensure credibility:

1. Prolonged Engagement: Defined as the "investment of sufficient time to achieve certain purposes: learning the 'culture', testing for misinformation introduced by distortions either of the self or of the respondents, and building trust" (p. 301). I have participated in member

meetings and Internet2 activities for more than three years and was a student at Texas A&M for five years. A certain degree of rapport was already in place with a great number of identified potential participants.

2. Persistent Observation: Explained as a tool which purpose is "to identify those characteristics and elements in the situation that are most relevant to the problem or issue being pursued and focusing on them in detail" (p. 304). I made on-site visits to the interviewees.
3. Triangulation of Sources, defined as "multiple copies of one type of source or different sources of the same information" (p. 305), was in place for this study. As stated above, archival information, observation and interviews were the sources of data. Since there were three of them, triangulation of sources was established exactly in a "three sided" way.
4. Peer Debriefing, explained as the "process of exposing oneself to a disinterested peer in a manner paralleling and analytic session and for the purpose of exploring aspects of the inquiry that might otherwise remain only implicit within the inquirer's mind" (p. 308), was also incorporated thanks to the invitation and agreement to participate (as part of the dissertation committee) of an Internet2 expert member in the form of an special appointment. The peer debriefing memo can be found in Appendix C.
5. Member Checks, defined as the "data, analytic categories, interpretations, and conclusions tested with members of those stakeholding groups from

> whom the data were originally collected" (p. 314), were in place as well by means of requesting member check meetings with interested participants and by sending the transcripts to participants for their review and verification.

Transferability. Through thick description, explained as the only mechanism "to enable someone interested in making a transfer" (p. 316), transferability was developed due to the abundance of sources and participants.

Dependability and Confirmability. Through Audit Trail, defined as the "residue or records stemming from the inquiry" (p. 319), dependability and confirmability were incorporated by means of proper documentation of all interviews (audio-taped and transcribed), observations, and a reflexive journal.

All of the Above. Through the Reflexive Journal, explained as the overall technique that "provides a base for a number of judgment calls the auditor must make..." (p. 327), all of the above were part of this study. Since the beginning of the development of the proposal, I kept a reflexive journal in order to record all activities and ideas.

CHAPTER IV

RESEARCH FINDINGS

According to Dooley (2002), there are two important elements in case study research --the evaluation and analysis of data, and the report. This chapter will address both. At the beginning of the chapter, the university context is presented and archival information is analyzed with the purpose of finding evidence of Internet2 planning, development, and activities. The second section of the chapter will report the discoveries that took place while collecting data. Those discoveries and the corresponding adjustments constituted the emergent design attributable to qualitative methods. The third section will present the general categories analysis and the narrative analysis of the information provided during the interviews. The remaining sections are devoted to answering the specific research questions of this study.

University Context and Impact (Archival Analysis)

Texas A&M University is a RU/VH: Research University (very high research activity), according to the Carnegie Foundation classification (2006), with a land grant, sea grant and space grant mission. In the spring of 2006, the student body was around 41,000 (Office of Institutional Studies and Planning, 2006). Throughout this literature review, Texas A&M University has showed outstanding presence in almost all academic network initiatives (i.e. BITNET and CSNET). Evidence of Texas A&M University planning for Internet2 and other telecommunications initiatives will be presented.

Texas A&M University Plans. Vision 2020 and Strategic Plans. Vision 2020: Creating a Culture of Excellence is the overarching plan created in 1998. Internet2 and other initiatives are referred to in two documents of the Vision 2020, The Library and Information Technology Final Report and The Information Technology White Paper. The former refers to Internet2 specifically in the Explosive Network Growth section and in the Distance Education section. The emphasis is given to the expectation of "bringing high bandwidth applications like video conferencing to the desktop" (Texas A&M University, 2006a, p. 35) as well as the strong commitment to support "the development of Internet2 and its successors" (Texas A&M University, 2006a, p. 36).

The Information Technology White Paper, on the other hand, refers to the extinct Next Generation Internet and the vBNS. About the time Vision 2020 was written, it was stated the intent to participate in the Abilene project (now fully deployed). All references to Internet2 were framed in the understanding of the importance of allocating funds for the support of all Internet enhancements.

Strategic Plans are documents departments prepare encompassing a vision for the next five years. The institutional strategic plan is produced and published by the Office of the Provost. The current institutional strategic plan of 2002 is about to expire and the promise of the forthcoming one has been set. The strategic plan includes the operational tasks that give life to the Vision 2020, which is considered the University's master plan. It also represents the report of the actual objectives achieved. In this strategic plan titled "In Pursuit of the Vision" Internet2 is not mentioned at all. Despite this fact, in the section of quality of campus life for students, an increase in the wiring of

dormitories and off-campus Internet access has been reported. In addition, promise of more and better telecommunications services is given in the imperative 1 section (Elevate Our Faculty and Their Teaching, Research, and Scholarship).

Texas A&M Internet2 Activities. A thorough search conducted on in the University Website resulted in the finding of four major Internet2 activities. The first three refer to what Internet2 calls Internet2 days. Such Internet2 days are explained as "events that generate interest in advanced network applications at university campuses" (University Corporation for the Advanced Internet Development, 2006c, ¶1). Texas A&M University-Internet2 days have been three: On October of 2000 at the Bush Presidential Conference Center, on November of 2003 at a local hotel, and on February of 2005 at the same local hotel. The host entities of these days are listed here in order of appearance: The Academy for Advanced Telecommunications and Learning Technologies (The Academy), The Center for Distance Learning Research, Computing and Information Services, and Educational Broadcast Services (Trans-Texas Videoconference Network TTVN). It was found that most of the attendees at the Internet2 member meetings (initial source of participants in this study) are related to these four university entities.

The other major Internet2 activity is related to the Internet2 Technology Evaluation Center (ITEC) at Texas A&M University, the one focused on Voice over IP (VoIP-ITEC). Internet2 Website states:

> The ITEC program was created by Internet2, to establish national network-testing laboratories for users of the nationwide high-performance Internet2

> network infrastructure. The four ITEC sites are located at ITEC-Ohio at The Ohio State University, NC-ITEC at North Carolina State University's Centennial Campus, San Diego Supercomputing Center, and the Voice over IP ITEC at Texas A&M University. (University Corporation for the Advanced Internet Development, 2006d, ¶2)

By being one of the four national testing centers, one can assess the impact and relevance Texas A&M University has in the UCAID organization. Thus, Texas A&M VoIP ITEC has its own Webpage with introductory information as follows:

> Texas A&M University's ITEC supports the advancement and deployment of internet technologies, with special expertise in areas associated with Voice over Internet Protocol (VoIP) and Information Assurance. In accomplishing its mission, the ITEC will:
>
> - Work singly and in collaboration with other ITECs on technology deployment and investigation within Internet2;
> - Act with industry and standards bodies in areas that will make advanced technology open and interoperable;
> - Join in research initiatives of Internet2 member institutions as appropriate;
> - Provide educational venues to make leading edge technology accessible graduate and undergraduate students. (Texas A&M University, 2006b, ¶1)

Other less publicized activities and projects were reported during the interviews, but since most of them are not documented, require an advanced networking training in order to be understood, and by themselves are not of relevance to the research questions of the study, they will not be addressed in this report.

Findings during the Data Collection

The process of data collection was modified from the dissertation proposal in accordance to the Creswell (2002) statement, "Qualitative research is considered to be an emerging design. An emerging process indicates that the intent or purpose of a study and the questions asked by the researcher may change during the process of inquiry based on feedback or responses from the participants" (p. 147). The number of participants, the number of visits to the Council of Principal Investigators and the Technology's Council for the College of Education and Human Development were adapted from the proposal when saturation was achieved (for the case of the participants) and when lack of relevant information was encountered (for the case of the councils).

Council of Principal Investigators. As part of the first steps on the data collection, I attended one monthly session of the Council of Principal Investigators of Texas A&M University (Council of PIs). During that meeting, the agenda did not address matters connected to telecommunications services or Internet2. In addition, an exhaustive revision of the FY 2006 meeting minutes available on the Council of PIs website was performed, finding no Internet or Internet2 allusions at all. Such lack of

mentions, at the early stage of the study, provided also an early prediction of some of the future findings for the adoption of Internet2 at A&M as will be discussed later.

Technology's Council for the College of Education and Human Development. During the spring of 2006, I attended two meetings of the newly formed Technology's Council for the College of Education and Human Development. The main task of this council was said to be the provision of technology's direction for the College. The first meeting was an organizational session resulting in the formation of subcommittees, six of them, responsible for the collection of needs and concerns pertaining to the realm of the respective subcommittee. The subcommittees were (1) Universal infrastructure, (2) Administration, (3) Communication, (4) Research, (5) Instruction, and (6) Service. The similarities of these subcommittees and the organization of this dissertation are remarkable.

During the second meeting, a set of needs and concerns was brought to the table and only Internet2 was mentioned once as part of a group of new technologies that have not been used (or not consciously) in the College. From my initial presentation to this group, when I stated the purpose of my visit as well as a general explanation of my dissertation, I still wonder the extent of bias I exerted on the discussions of both, the way the subcommittees were structured, and the awareness of Internet2. Both visits to this council, in any case, provided the same prediction resulting from the visit to the Council of PIs. It was going to be difficult to find faculty members, instructors, and researchers, aware of Internet2 and fully engaged on Internet2 initiatives.

Redefinition of Participants' Roles and Interview Protocol. As also stated in Chapter III, two other major changes to the research proposal occurred during the data collection. The first was the modification to the interview protocol, taking place after the first interview. Participant 1, the first interviewee, repeatedly requested further explanation of the questions and the responses did not provide the information expected for the purpose of analysis. I decided to base my questions more on examples from the literature, and the resulting interview protocol (Appendix B) proved to elicit better responses for the rest of the participants.

On the other hand, when using the first part of the interview guide, participants' roles resulted to be different than expected, especially for the case of some service-related personnel who ended up being more research oriented. Another important case to take notice of is participant 12 (P12), a faculty member who was not aware of any Internet2 relationship with his work. Although the emphasis on participants' selection was given to those who were aware of Internet2, this participant who was expected to know more about Internet2, posed very important questions that are relevant to the findings of this study. His participation was decided to be kept and used.

One-on-one Interviews.

> A good case is generally taken from real life and includes the following components: setting, individuals involved, the events, the problems, and the conflicts. Because cases reflect real-life situations, cases must represent good and bad practices, failures as well as successes. (Dooley, 2002, p. 337)

It is a warm morning in the spring of 2006. I enter the glass door that so many times I have crossed in the past. This is a new building, recently constructed in the areas of the campus where "everything nonacademic" has been relocated. I would come to this building for three more interviews. My first participant (P1), who is also my friend, greets me and invites me to her office. She knows I want to talk about Internet2, so she is eager to tell me her insights. She is not happy with Internet2 as an organization but recognizes the importance of Internet2 infrastructure. She would love to see more inclusive Internet2 member meetings since she felt alienated as an administrator. She had also a terrible experience when submitting an NSF proposal; she had found that Internet2 had put sound universities together in a proposal for the same grant. She claims, "I don't see how we are less worthy to be invited to the partnerships on these proposals …That some members are equal but some more equal…" She also regrets not being an engineer in order to understand where the Internet2 boundaries are and still feels a great need for more communication about what Internet2 is. Participants 3, 6, and 16, are also people I know in that office. They are mostly researchers for the purpose of this study but also take support-services responsibilities. I have known them for a number of years as well, and we certainly share a good degree of rapport. Their suggestions are direct and explicit in the sense of better communication and engagement about Internet2. Participants 3 and 6, by the way, are some of the most knowledgeable at Texas A&M on Internet2 background, history, and mission.

Participant 2, another friend of mine, is located in a building off-campus. He is an Internet2's support-services personnel as well as researcher. His office is so full of

electronic gadgets that one can easily get lost. He knows first-hand the emotions of a frustrated Internet2 user. Participants 7 and 8 (both with teaching and support responsibilities) are located in the same building. I have met them recently, and despite this, they also shared direct suggestions.

Participant 4 is located abroad, and, before the interview, I had never met him. Perhaps the fact that we both are very related to a top administrator who referred him to me, I felt as if I've known him for years. The way he described the connections of his offices to Internet2 transported me to the remote lands of the Arabian Peninsula. We met in a local restaurant during lunchtime. The place was noisy and crowded, nevertheless, he provided one of the best interviews. Because of his knowledge about Internet2, the first two sections of Chapter II fell into place and, in conjunction with participants 3 and 6, provided the material for the narrative analysis that will be presented.

Participant 5, located in one isolated building on campus, had been one of my acquaintances for several years. He and Participant 7 were chosen because of their knowledge of the way Texas A&M conducts videoconferences. He was, without any doubt, the most assertive on what Internet2 is and is not.

Participant 9, one of the four females participating in this study, motivated me greatly since she represented the few faculty members that were fully engaged in Internet2 research and teaching. I had not met her before the interview, either; however, her attitude was welcoming and even warm. I certainly felt protected like never before in a computer science-engineering setting (where I often felt vulnerable). Her comments

were instrumental in understanding the way high bandwidth networks have been used as a research tool before and after the Internet2 foundation (vBNS and Abilene eras).

Participant 10, a decision maker in the adoption of Internet2, intrigued me with his concerns about how the study was presented, stating at the very beginning of the interview his preoccupation on the few number of researchers who might respond to my inquiries. I must acknowledge, though, his suggestion of adapting the theoretical models for the case of Internet2.

Participants 11, 12, and 15 are faculty members I have known since 2001. The three of them have activities that are directly linked to technology as a teaching tool. Participants 11 and 15 have actually engaged in videoconferences fully aware that Internet2 made them possible. Participant 12, on the other hand, gave voice to the group of faculty who are ignorant about Internet2.

Participant 13 and Participant 17 are located in one support-services dedicated building full of engineering manuals and devices. Participant 17 I did not know prior to the interview, but this participant, also welcomed me warmly. They both provided rich information regarding the Abilene connections and uses.

Participant 14, a top administrator at the University hired recently, also made me feel as if had known each other for a long time. He was very approachable and amicable. He knew about Internet2 because of his previous work and, despite the fact that his primary duties are not related to it, he provided very good recommendations for Internet2 promotion.

General Categories (Themes) Analysis

> Due to the nature of case study research, the researcher will generate large amounts of data from multiple sources. Time taken to plan prior to the research will allow one to organize multiple databases and set categories for sorting and managing the data. (Dooley, 2002, p. 341)

As stated before, analytic induction (Lincoln & Guba, 1985) and narrative analysis (Labov, 1972) were the analysis techniques. For the purpose of analysis and categorization of data (analytic induction), Lincoln and Guba (1985) provided a useful guideline. In their guideline the relationships that create categories are referred as semantic relationships and are explained as follows:

- Strict inclusion-X is a kind of Y.
- Spatial- X is a place in Y, X is a part of Y.
- Cause-effect- X is a result of Y, X is a cause of Y.
- Rationale- X is a reason for doing Y.
- Location for action– X is a place for doing Y.
- Function- X is used for Y.
- Means-end- X is a way to do Y.
- Sequence– X is a step (stage) in Y.
- Attribution-X is an attribute (characteristic) of Y. (Lincoln & Guba, 1985, p. 340)

With these relationships at hand, along with the transcriptions of the interviews, 20 were the general categories found. A new category was claimed when at least two units of data (from different participants) expose a relationship forming a pattern. Table 10 provides the definition of the general categories and the participants who made reference to them. They are presented in the chronological order they were found so the themes they consolidated are not grouped sequentially. The themes, which will be described in detail in the following paragraphs, are: (1) Texas A&M's use of Internet2, (2) the dilemma of the information sharing, (3) the influences of Internet2, (4) Internet2 Discussion, and (5) Internet2 Concerns. At the end of the section, the findings will be compared with the two theoretical frameworks.

Table 10. Audit Trail of General Categories of Analysis

Category	Definition	Participant referring to the category
Category 1: Transparency of Internet2.	Internet2 is and should be transparent to the end user.	P1, P2, P4, P5, P6, P7, P8, P10, P11, P13, P14, P17.
Category 2: Not clear what Internet2 is	People don't understand what Internet2 is.	P1, P2, P3, P4, P5, P6, P7, P12.
Category 3: Influence and Advancement	Internet2 advancements and technologies permeate inside and outside the realm of Internet2.	P1, P2, P3, P6, P7, P9, P10, P17.
Category 4: Need of engagement	Internet2 must engage more people.	P1, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15, P16, P17.
Category 5: National Lambda Rail (NLR) Discussion	National Lambda Rail should (or not) merge with Internet2.	P1, P3, P4, P5, P6, P8, P9, P10, P17.
Category 6: Need of Communication	The word and promotion of Internet2 should be better addressed.	P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15, P17.
Category 7: Better service-production	Internet2 (infrastructure or advancements) is used for production purposes.	P1, P2, P3, P5, P6, P7, P8, P9, P10, P11, P13, P17.
Category 8: Videoconference as a teaching tool.	Internet2 is used for videoconference as a teaching tool.	P2, P3, P4, P5, P7, P8, P10, P15.
Category 9: Research Use of Internet2.	Internet2 is used as a research tool.	P2, P3, P4, P5, P6, P8, P9, P10, P17.
Category 10: Quality of Service (QoS) Discussion.	Quality of Service is not implemented or limited implemented (inside Texas A&M) not for technology reasons but for political reasons.	P2, P3, P5, P10.

Table 10. (continued)

Category 11: Collaboration.	Internet2 has enable unprecedented collaboration among universities and institutions.	P2, P3, P5, P6, P8, P9, P10, P11, P13, P14, P15, P16, P17.
Category 12: More complexity in my job.	Internet2 has made my job more complex.	P2, P9.
Category 13: Guiding manufacturers and service providers.	Internet2 is influencing manufacturers and service providers in the design and implementation of technologies.	P2, P3, P6, P8, P10, P13, P17.
Category 14: No need for more information.	I don't need more information about Internet2.	P2, P3, P4, P5, P6, P7, P8, P9, P10, P13, P14, P17.
Category 15: Political Concerns.	I dislike the level of politics and bureaucracy in Internet2.	P1, P3, P6, P10, P12.
Category 16: Lack of Researchers.	There is a need of research and researchers in Internet2.	P3, P4, P5, P6, P10, P17.
Category 17: Concerns for the Future of Internet2	We have Internet2 now but what's next? We don't have a clear direction.	P4, P9, P10, P13, P17.
Category 18: International Impact of Internet2.	Internet2 has impact on and potential for collaboration at international scale.	P4, P6, P7, P8, P10.
Category 19: Concerns about free usage.	I have concerns about the way Internet2 is used.	P1, P7.
Category 20: Concerns of accessibility.	I have concerns for the have and have nots (digital divide) of Internet2	P8, P11, P15.

Theme 1- Texas A&M's Use of Internet2 (Categories 7, 8, and 9). Throughout the interviews with network and telecommunications personnel I came to the realization that all Texas A&M-related persons (either staff, faculty or students) have been a user of Internet2 infrastructure at least at one point in time when communicating with other Internet2 members (around 200 in the United States), or Texas A&M's campuses-offices abroad (e.g., Qatar or Mexico), or any other Internet2 partner around the world. The idea first came from one important input, participant 2 (P2- RS, related to network services at A&M), whose information was in the sense that most of Texas A&M-Internet2 shared capacity (155 Megabits per second as of the day this chapter was written) was already in full use for all kinds of network-communications possible over the Abilene (e.g., Email, videoconference, large files transfer) also known as "production" use of Internet2. Confirming this idea, participant 10 (P10- S, key decision-maker in the process of becoming a member of Internet2) explicitly stated, "The routing is completely automatic, everybody on campus uses Internet2 everyday but most of them don't know it. If your traffic goes to another Abilene-connected site or Abilene international in a peering sense, your traffic will automatically traverse over Abilene." With this information at hand, the next information to look for was the purpose of those communications traversing Abilene. In conversations with the rest of the participants, three categories emerged as the uses of Internet2, category 7, category 8, and category 9.

Category 7, titled Better-service production, was defined as the Internet2 use for production purposes. The best way to understand the "production" aspect of the definition is through participants' 2 and 3 explanations of their duties: "So, I had to take

multicast from researching and testing and bringing into production…" (P2), and "I was in charge of the early adoption of IPv6 at Texas A&M, creating a small network that worked separately from the production network" (P3). Production, then, can be understood as the day-to-day use of the network communications services. Participant 8, went further and provided detailed information by stating, "My understanding is that it is a much bigger transport pipe dedicated to education institutions in particular for large research I universities but not exclusive to that, and transport of data (video, voice, or whatever)." The better services part then makes reference to the increase of bandwidth, the "larger pipe" and the dedicated connection between "very high research universities" and other members. On the other hand, Participant 10 emphasized the boundaries of the production versus research use of Internet2 when stating: "Originally they set up both to run a network and hopefully supporting networking research and they certainly have run a really good production network, and the complaint over the years is probably that they haven't paid lot of attention to networking research." With this last statement, though, it is also perceptible that some tension exists between both uses and the extent of how much the production use has been intended. In that sense, I should say that around 1999 when I was first introduced to the Internet2 Mexican initiative (and in consequence to the American initiative), the emphasis was given to the research intent. Participant 10, moreover, established how this production use has compromised the research use when commenting, "Standard things you can do just fine on Abilene, but if you want to do a new protocol or implementing something nonstandard, then you can't do that on

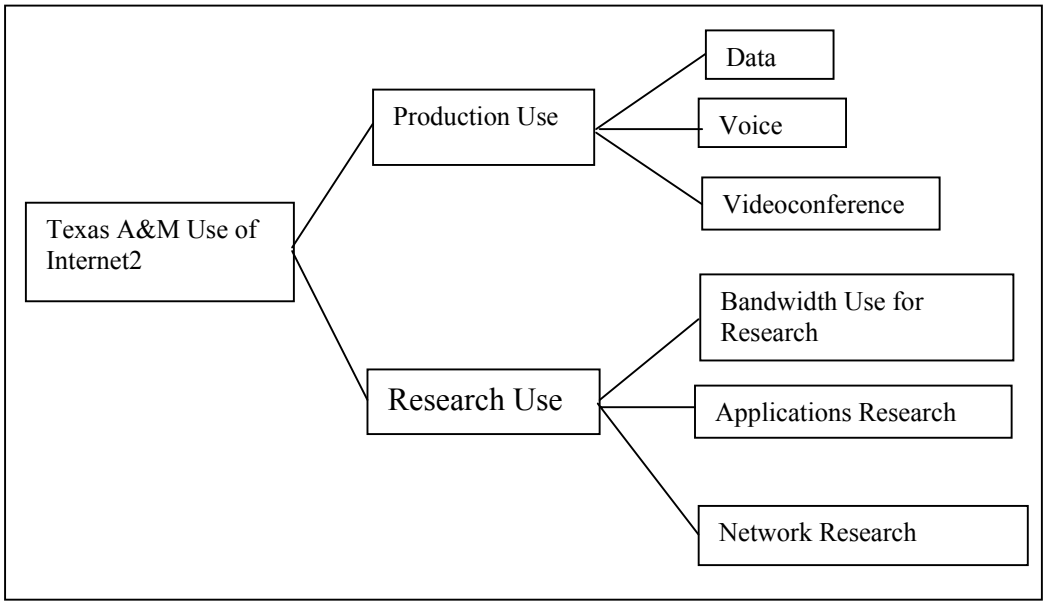
Abilene. You can't break it. People depend on it." This issue was also stressed in another category, the National Lambda Rail discussion, which will be described later.

During my exposure to the Mexican Internet2 initiative throughout a seven-year time span, I witnessed the emergence of another important production use, the videoconference. Since eight different participants described it along with its importance, it consolidated a category on its own. Participant 4, a Trans-Texas Videoconference Network (TTVN) employee, went beyond and stated, "Everybody knows what TTVN is and Internet2 is the backbone…. We wouldn't be in the videoconference business without it. It constitutes the Internet2 top use." Participants 5, 7, 10, and 15 attributed the success of videoconference to the increase in (1) its quality and (2) its reliability because Internet2 is a less crowded connection (limited to only members) and has a higher bandwidth. Videoconference was also said to be a teaching tool and consequently the distance education greatly favored from Internet2. This was the reason why category 8 was called videoconference as a teaching tool.

Category 9, the research use of Internet2, is perhaps the most difficult use to understand. Research is a vague concept for most people when referring to computer networks. When defining the new participants' roles, the research role was addressed as responsible for the creation or implementation of new Internet2 technologies or the use of Internet2 as a research tool. A network engineer would translate this into analysis and experimentation of protocols at lower and higher layers of the Open Systems Interconnection Reference (OSI) model and the use of the network for exchange of research-data unrelated to the OSI model. Examples are participants' 9 Optiputer

(Optical networking, Internet Protocol, computer storage, processing and visualization technologies) project and participants' 13 HOPI (Hybrid Optical and Packet Infrastructure) project with the intent to advance the physical, data link, and network layers (layers 1, 2 and 3 of the OSI model) or the Medical Middleware, located between the network and applications layers (layers from 3 to 7 in the OSI model). Regarding research non-related to OSI, a good example was provided by Participant 3 who uses Internet2 for exchange of huge amounts of meteorological data as part of the Southeastern Coastal Ocean Observing System (SCOOP) project. He also refers to himself as a "bandwidth user" which emphasizes his use of Internet2 based on its higher bandwidth characteristic but separate from the production use only because the data in reference are research related. For the purpose of a better understanding, Figure 7 portrays the uses of Internet2 at Texas A&M in the form of a tree diagram.

Figure 7. Use of Internet2 at Texas A&M



Theme 2- The Dilemma of the Information Sharing (Categories 1, 2, 4, 6, 14, and 16). Perhaps one of the most controversial topics of this dissertation is related to participants' assumption that Internet2 is and should be transparent to the user (P4, P5, P8, P10, P11, P13, P14). Interestingly, this assumption was presented at the same time with claims that Internet2 is not clear, and that there is need of better communication, promotion, and engagement specifically among researchers (P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15, P16, P17).

This contradiction might be understood based upon the Internet2 objectives to: "(1) Create a leading edge network capability for the national research community; (2) Enable revolutionary Internet applications; and (3) Ensure the rapid transfer of new network services and applications to the broader Internet community" (UCAID, 2005a, ¶1). This means that although Internet2 might be judged as just a facility, people know it is also a research and teaching tool that has great potential for the university. Participant 2 made evident the dilemma when stating, " Ahh, because it is so transparent to applications, a lot of people don't know it's there."

On one side of the discussion, participant 12, a faculty member already mentioned, asked a set of questions related to the lack of clarity about what Internet2 is (category 2). These questions are worthy of being reproduced:

- It's just too amorphous; I don't know where the first generation ends and the second starts. I've never seen anything offered to us as a different service or different resource. We are busy enough utilizing the current Internet and I never went beyond. I feel unaware and I wonder if there's

more to it and I am just unaware. Is it my responsibility to find them? Or A&M's?

- If the university is involved with public dollars, if it's going to end up controlling resources, I guess I could be concerned. Who is in charge?
- Yeah I need more information. I don't know where the Internet2 services are offered. Is it another kind of connection? Do I need a special wire to my desk?

Participant 3 stressed the need of more researchers involved in Internet2 (as part of category 16) by stating, "I really wish we had more Internet2 research, more faculty members interested in identifying and participating in research of Internet2. It's been very difficult finding collaborators for a number of ideas that I've had…" And participant 6 even described the profile of a "champion":

> If I find something of interest to the university, I will nurture the participation until I find a champion in campus. The champion takes over, and then I go back to something else. A champion is somebody who's willing to spend extra time, in a particular focus area, usually because the extra time benefit is going to significantly influence his own research/specialty. He volunteers, he proselytizes (he would go to another university and do presentations and invite)…

On the other side of the discussion, Participant 10 questioned the way the interview protocol was laid out since the vast majority of users at A&M did not have an option in the adoption of Internet2. And participant 13 even suggested to me that more indirect ways to measure the importance of Internet2 should be found, because it was his job to make it transparent. Both participants 10 and 13 are highly ranked in the support-services area of Texas A&M University. Interestingly, the participants who would welcome the provision of more information about Internet2 were participants 11, 12, and 15, who were part of the teaching realm.

With this controversy in mind, I compiled a set of eight suggestions for better communication, promotion, and engagement in the form of Table 13 located in the interventions for diffusion section.

Theme 3- The Influence of Internet2 (Categories 3, 11, 13, and 18). Category 11 entitled "Collaboration" was one of the most popular with 13 out of the 17 participants recognizing it. Participants 5 and 7 actually defined Internet2 in terms of the corporation of universities described in the literature review and participant 6 even stated, "The most important thing of Internet2 is the people networking rather than the physical IP network." In the same Internet2 social context, the International Impact of Internet2 was recognized (by five participants) originating the creation of Category 18. Participants 9 and 10 particularly explained the influence of Internet2 with the international Texas A&M campuses when saying, "It has opened up a lot of capabilities, for example, the connection between College Station and Qatar" (P9) and "All our connections to the Mexico City Center and the Qatar Campus traverse Internet2" (P10).

Categories 3 and 13, entitled Influence and Advancement and Guiding Manufacturers and Service Providers respectively, were also popular among the participants when referring to the influence of Internet2. Participant 10 explained the influence of Internet2 outside its sphere in the following manner:

> The streaming things are really making a big difference (Camtasia or the like). Certainly in some ways these changes are attributable to Internet2 because 5 years ago you could do those aps over Internet2 and you couldn't do those kinds of things over the commodity Internet. I think certainly some of the experimentation and things were done and now they are able to transition to the regular Internet.

Participants 3 and 7 recognized the influence of Internet2 in the creation of the Lonestar Education and Research Network (LEARN), and participants 2 and 17 expressed convictions that voice over IP (VoIP) advances on the Internet have been influenced by the Internet2 activities.

Theme 4- Internet2 Discussions (Categories 5 and 10). National Lambda Rail (NLR) was a recurrent topic for many participants. By October of 2006 (when this chapter was written), no official statement could be found on the Internet2 Website regarding the previously publicized NLR and Internet2 merger. According to participants 5, 6, 10, and 17, Internet2 withdrew from negotiations. Participants 10 and 17 informed me that the Next Generation of Abilene capitalized a lot of the National

LamdbaRail contributions, and that was the great motive of discordance. This NLR contribution was very well described by participant 10 when stating,

> The kind of beauty of NLR is what we call facilities based. We own the leases on the fiber; we own the op products that are in place. You can run production on one of your lambdas and you can run research, doing totally what you want on another lambda and so it can accommodate both research and production by owning your own facilities.

"Lambda", to clarify, is the Greek letter assigned by convention to the wavelengths of light. Different wavelengths or lambdas represent different colors. In optical networks they mean the channels of communication in an optical fiber. Now, resuming the discussion of production versus research use presented in theme number one, it can be noted that such merger would have had a positive and quick impact on the way Internet2 is currently used. Participants 3, 4, 6, 9, 10, and 17 also mentioned egos and politics of the leaders of both organizations as the sources of conflict in this merger.

Quality of Service (QoS) was a discussion present in the interviews as well. Participant 3 and Participant 5 mentioned how the QoS initiative was abandoned when more bandwidth became available. While Participant 2 expressed regrets on how politics took over technology progress, Participant 10 justified the abandonment because with no bandwidth restriction behind, there was no need for specifying priorities between applications.

Theme 5- Internet2 Concerns (Categories 12, 15, 17, 19, and 20). Political concerns (category 15) and Concerns for the future of Internet2 (category 17) were the

most frequently mentioned categories related to the theme of Internet2 concerns. Because of the importance of input from Participants 3 and 6 about politics, they are presented here: “Even the Internet2 engineering staff are involved in a lot of the political level discussions and decisions, and I believe that has some effect in some of the outcomes” (P3). Politics and Internet2 at the mantra level are very hard. A number of key people have left because of the politics. The leadership can be very set in the academic focus. It took a while to convince about incorporating K-20 and medical education (P6).

Concerns for the Future of Internet2 are also of great importance since they represent the preoccupations of the most knowledgeable people at Texas A&M University. These preoccupations range from possible provision of Internet2 facilities by the commercial sector to a lack of a clear future. Table 11 shows these concerns.

Table 11. Concerns for the Future of Internet2

Concerned Participant	Future of Internet2 Concern
Participant 4	Internet2 has been so successful that we need to do something else than Voice over IP or Videoconference.
Participant 9	I think Internet2 is good; the question would be what’s next? Perhaps more integration, better administration of the bandwidth, on the side of decision process.
Participant 13	Sustainability. What keeps it going? We don’t get a commercial rate of return on it. Why do the schools put their money into it? Sort of the current fight of NRL and Internet2. The commercial is moving into providing the same kind of services and if they do, why do I need Internet2?
Participant 17	There will be change in provider of Internet2 from Quest to Level 3 and changes are uncertain so there’s a concern there. They are also changing service structure. They are really completely changing their models.

Category 12, regarding concerns about more complexity in my job, were expressed by participant 2 and 9. These concerns can be understood as the researchers' lack of excuses for attending meetings since videoconference is widely available, and also researchers' lack of excuses for being on top of the advances since they have the best communication network available connecting them to the world.

Concerns about free usage from Participants 1 and 7 are expressed because they see students downloading music and videos. Participant 1 wonders, "Aren't we kind of undermining the goal?"

Finally, concerns for accessibility of the "have nots" shared by participants 8, 11, and 15 are better expressed (for category 20) in their own words as follows: "As much as I regret it, I feel I belong to an elite and I feel that is a problem. I think Internet2 contributes to the digital divide. Not everybody has access, and those who don't get frustrated" (P15).

Narrative Analysis on Internet2's Creation and A&M's Adoption. In order to elicit responses in the form of stories, questions 5, 6, and 7 in the interview protocol were formulated. They were: When was the first time you heard about Internet2 and how did you hear about it? What were your expectations? And what are your first hand experiences?

In narrative analysis a narrative or story,

> Requires, first, a means for emphasizing human action or agentivity-action direct toward goals controlled by agents. It requires, secondly, that a sequential order be established and maintained --that events and states be linearized in a standard

> way. Narrative, thirdly, also requires a sensitivity to what is canonical and what violates canonicality in human interaction. Finally, narrative requires something approximating a narrator's perspective: it cannot in the jargon of narratology, be voiceless (Bruner, 1990, p. 77).

Canonical means conforming to a general rule or acceptable procedure. Stories consequently require human action, sequential order, and sensitivity to an acceptable procedure in the perspective of the narrator. Participants 3, 4, and 6 provided such stories or narratives in the form of one specific theme, the rationale behind the creation of Internet2 and Texas A&M's adoption. Because of the importance of this topic and the unexpected coherence found in the three stories, narrative analysis was used as the tool of understanding of the system of beliefs or culture behind these stories (Linde, 1993). Structural analysis or Labov's method was used in this narrative analysis (Labov, 1972). The first step of such method is to reduce the narrative to the core narrative or skeleton plot. A fully formed narrative may show the following elements:

1. Abstract. One or two clauses summarizing the whole story.
2. Orientation. Identify in some ways the time, place persons, and their activity or situation.
3. Complicating action. Then what happened?
4. Evaluation. The means used by the narrator to indicate the point of the narrative, its raison de'entre, why it was told.
5. Result or resolution. What finally happened

6. Coda. Options open to the narrator for signaling that the narrative is finished. Codas may also contain general observations or show the effect of the events on the narrator (Labov, 1972, p. 364)

In this dissertation the three core narratives for the theme of Internet2' creation rationale and university's adoption are as follows:

Story 1: Participant 3

Abstract: I was told that it was the next generation of the Internet and that was less than accurate probably

Orientation: It was around 2000 when my boss informed me that I was attending an Internet2 members meeting

Complicating action: It's more the research and development version of the Internet.

Evaluation: I have been involved in a lot of theoretical activities and it was what I saw when we were playing with DARPANET in a lot of ways. New protocols, new technologies were created that were not necessarily ready for the masses to use and people would start working with them, characterizing them, reporting back their consequences, and that is more what I found Internet2 to be.

Resolution and Coda: The next generation Internet isn't exactly what it is.

Story 2: Participant 4

Abstract: But I remember the discussion quite from the beginning about whether or not A&M was going to be a player or a major contributor in this. The concern was,

this thing is gonna happen and if we get involved from the beginning, it will give us more influence to make sure it stirs in the way we think it ought to be stirred number one and it stirs to our needs as well. A&M was a partner from day one.

Orientation: It was 1995, 96 or 1997, I don't remember exactly

Complicating action: Before, the only people who where hooked in or tied in were educational institutions and once it was commercialized that traffic saturated the network and that opened space to reestablish what we had before.

Evaluation: Basically, it is large capacity and access to dedicated research and education activities, which was essentially what the Internet was until 1992 when it was commercialized.

Resolution and Coda: Which was dedicated access for research and education.

Story 3: Participant 6

Abstract: First time I heard about it was before it was formed and named. The first thing we were looking at was how we can participate and get A&M and Texas out of backwardness we were in. We are considered to be founders.

Orientation: I've heard it from a colleague in RICE in November or December of 1996.

Complicating action: The universities were talking about getting together and reestablish a research backbone after NSF and the Congress stabbed us in the back.

Evaluation: The first thing we were talking about was building a national footprint for high-speed network research to replace the one that have become the commercial network.

Resolution and Coda: That's why we jumped in the band wagon. That was an opportunity to grow Texas and A&M.

The second and last step in Labov's method is the interpretation. Riessman (1993) proposes to "attend the sequence both within and across stories" (p. 41) and Mishler (1986) proposes to focus on the question "what is this story about? The point of the story is one answer to this question" (p. 236). The Internet2's creation and A&M's adoption rationales were selected to be the theme of these stories. The former, Internet2 creation rationale, is explained to be a direct consequence of the need for research and education created after the commercialization of Internet just as the literature review suggests. The latter, A&M's adoption rationale, is explained to respond to the quest for a university's leadership position with an influence in the research and education agendas of the nation. Through this narrative analysis, and because I am an international student, this form of analysis proved to be very beneficial for my ongoing search of system of beliefs or culture (in my own words) in both the importance of research and education, and the importance of leadership positions in American society.

Analysis of Consequences

This section is devoted to respond to research question number 1 and part of research question 4, what have been the consequences of the diffusion of the innovation (Rogers, 2003), entitled "Internet2®", at Texas A&M University? And to what extent do the findings match or not match Roger's diffusion of innovation research?

Chapter II described Rogers' (2003) Diffusion of Innovations model in detail. As can be noted, the portion of the model this dissertation emphasized upon was the consequences of the innovation. Following the interview protocol, respondents were asked about the consequences and their attributions. Only 13 participants provided the information required. From those responses, category 11, Collaboration, emerged as the consequence of predilection with 11 interviewees identifying it. All 11 respondents considered it desirable, 4 considered it unanticipated, 7 anticipated, 3 indirect, and 8 direct. Category 7, Better service-production was mentioned 7 times and all giving desirable, anticipated and direct attributes. Category 13, Guiding manufacturers and service providers was mentioned 6 times all as a desirable consequence, 4 stating it was unanticipated versus 2 anticipated, and 5 providing it with direct attributes versus 1 indirect. Category 9, Research use of Internet2, was identified by 5 respondents, all of them attributing desirable, anticipated, and direct characteristics.

Videoconference as a teaching tool (category 8) was mentioned 4 times attributing only desirable, anticipated, and direct characteristics as well. Category 2, Not clear what Internet2 is, was mentioned twice, all as undesirable, 1 anticipated versus 1 unanticipated and 1 direct versus 1 indirect. Two respondents mentioned category 3, Transparency of Internet2, all stating it as desirable, anticipated and direct. One interviewee identified Category 12, more complexity in my job, as an undesirable, anticipated and direct consequence and another interviewee mentioned Category 18, the international impact of Internet2, as a desirable, anticipated and direct consequence. Figure 8 provides the graphic representations of those consequences that were mentioned at least twice.

Figure 8. Internet2's Consequence of Innovations Three Dimensional System

Part 1. Collaboration

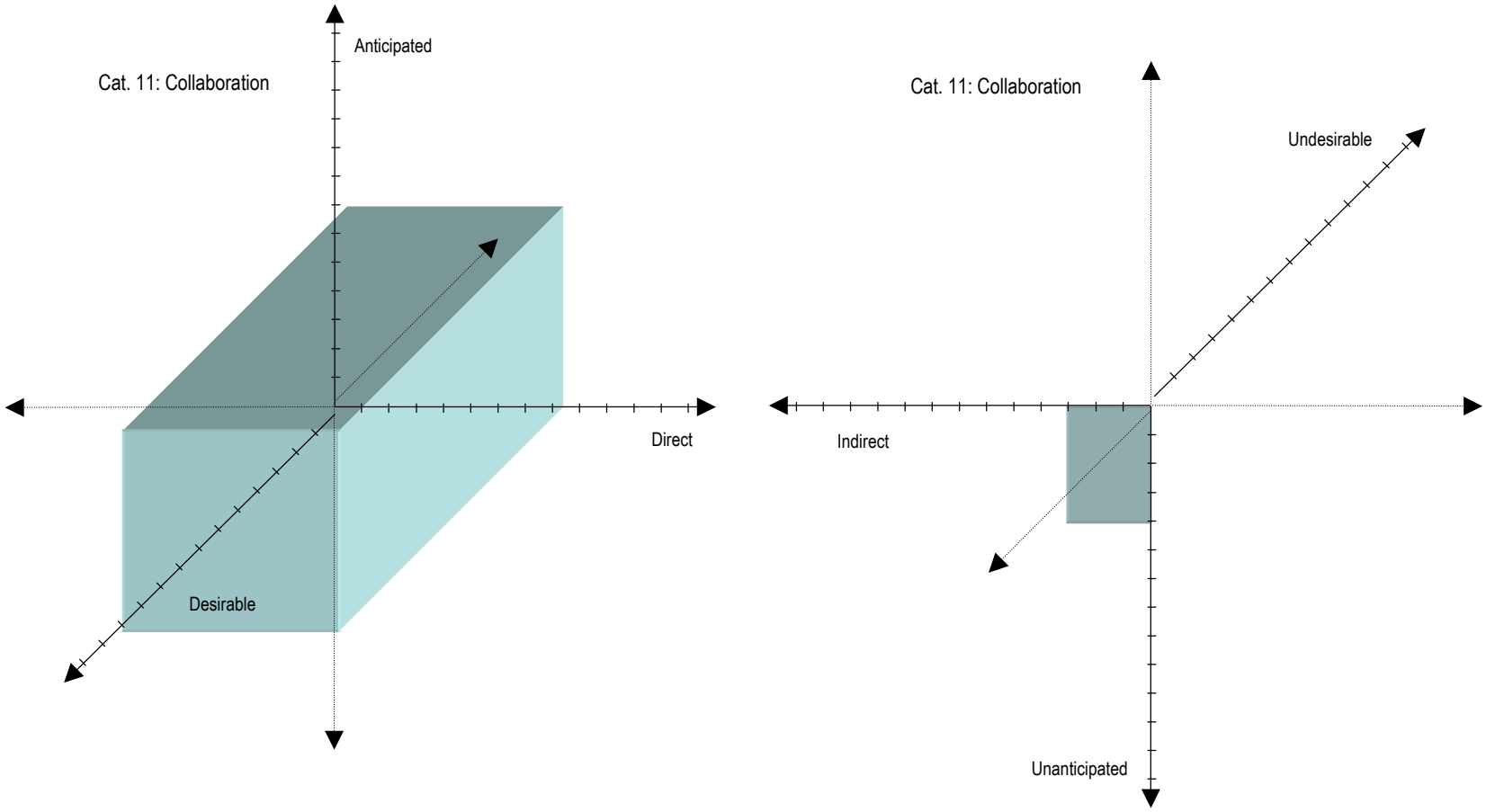
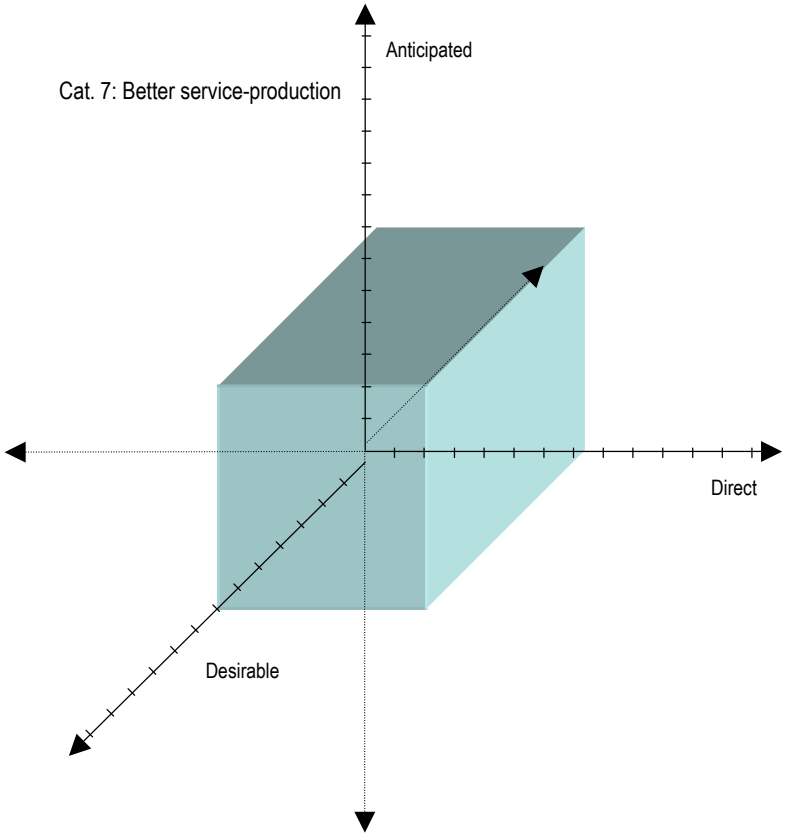


Figure 8. (continued)

Part 2. Better service-production



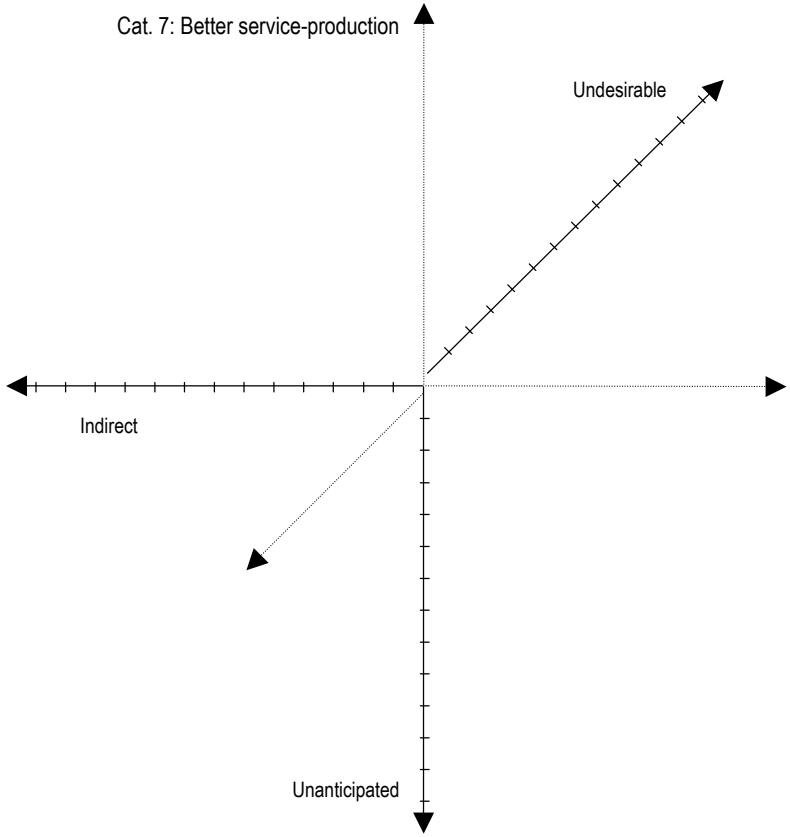


Figure 8. (continued)

Part 3. Guiding manufacturers and service providers

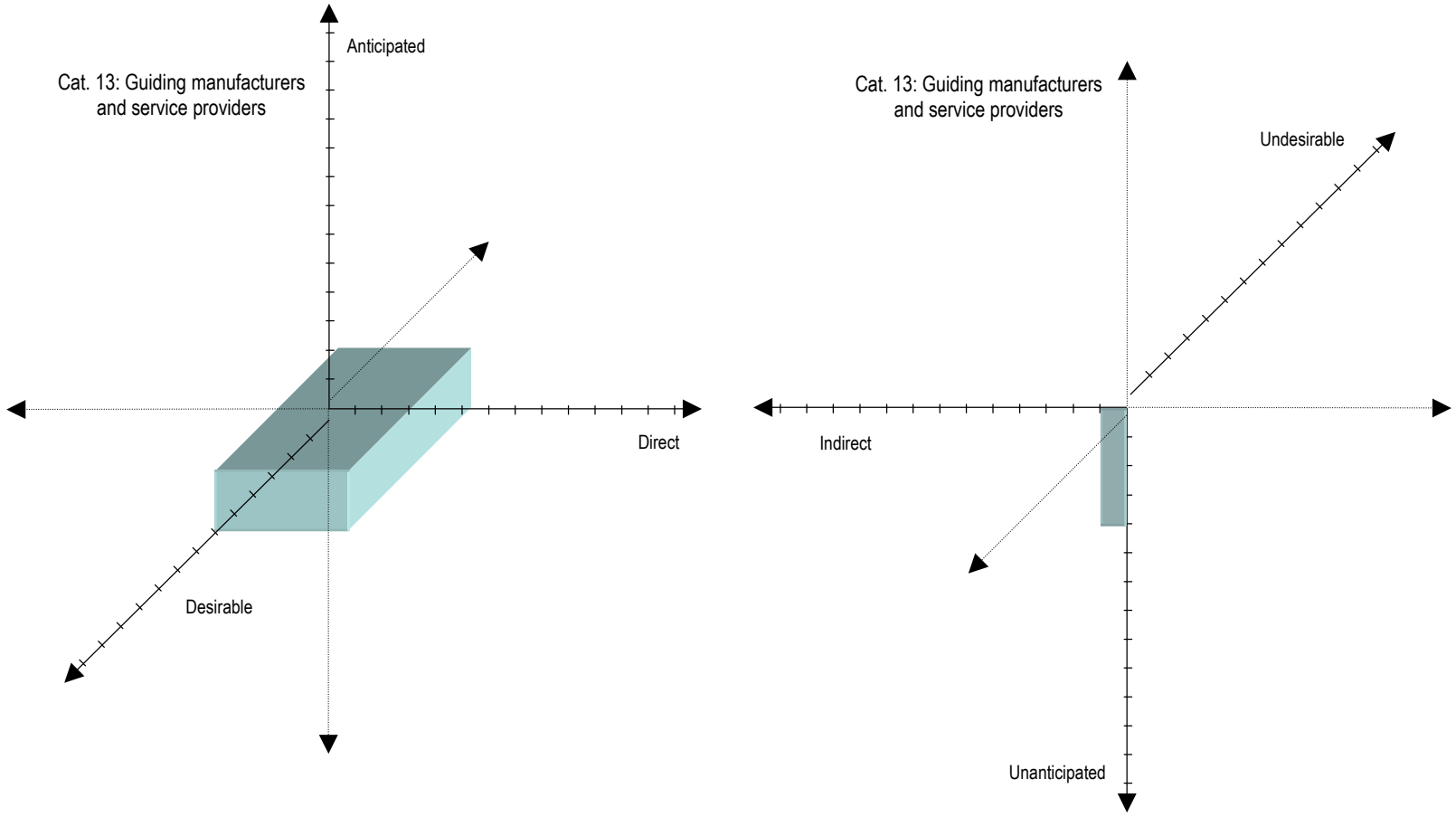
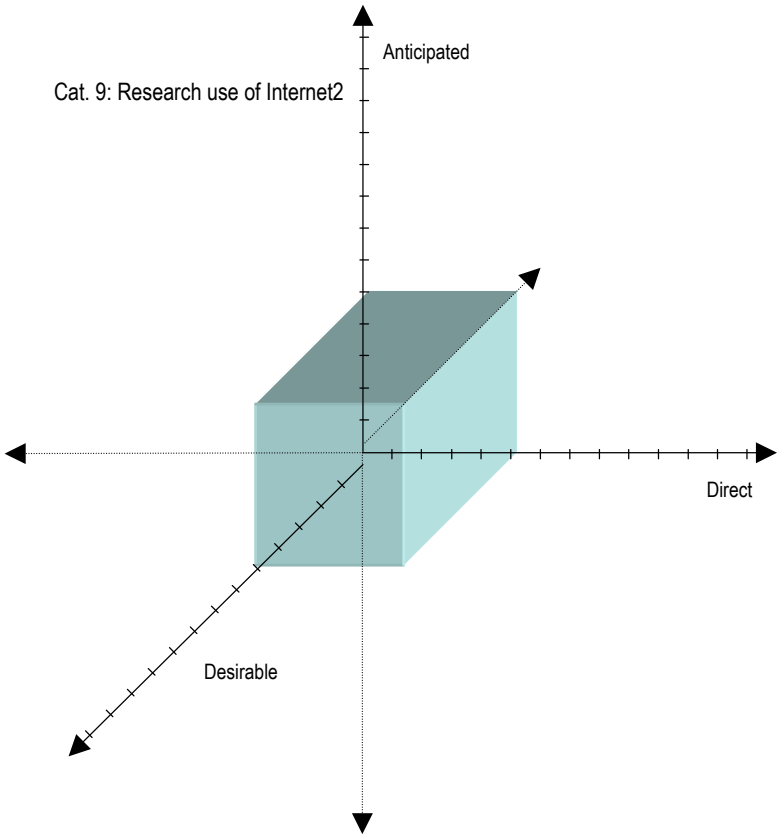


Figure 8. (continued)

Part 4. Research Use of Internet2



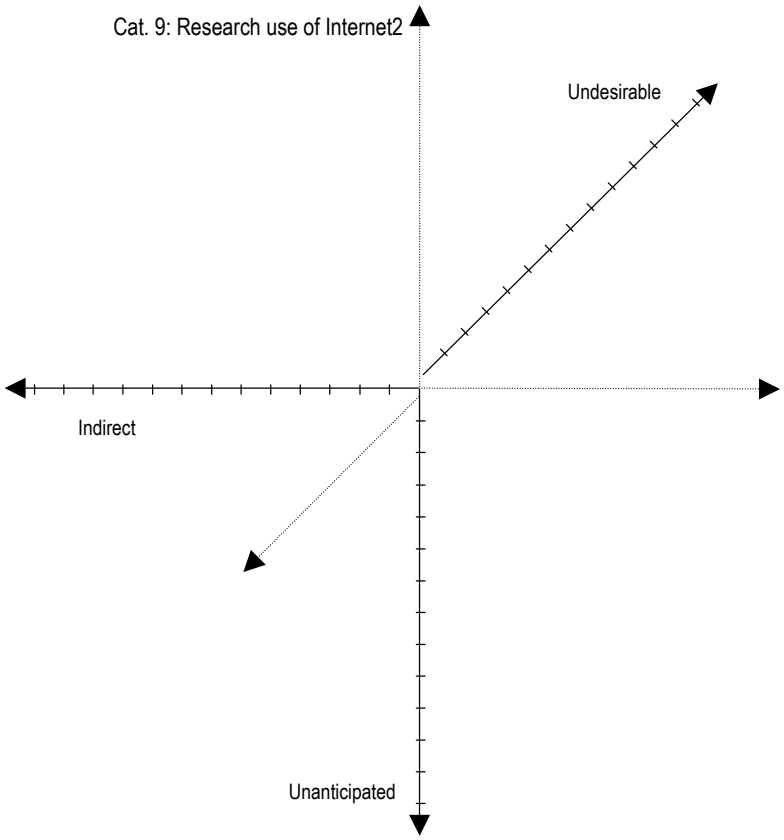


Figure 8. (continued)

Part 5. Videoconference as a teaching tool

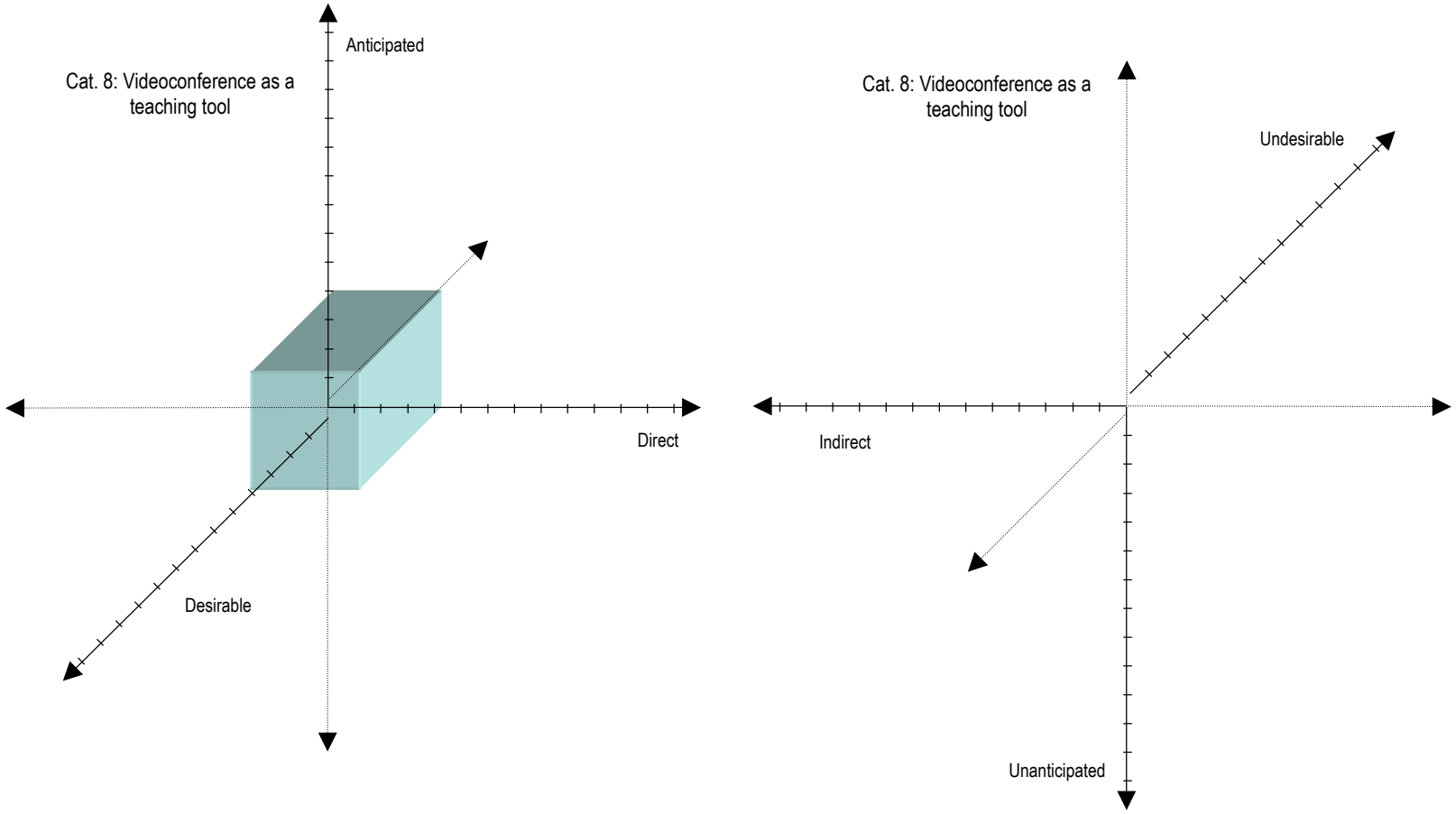
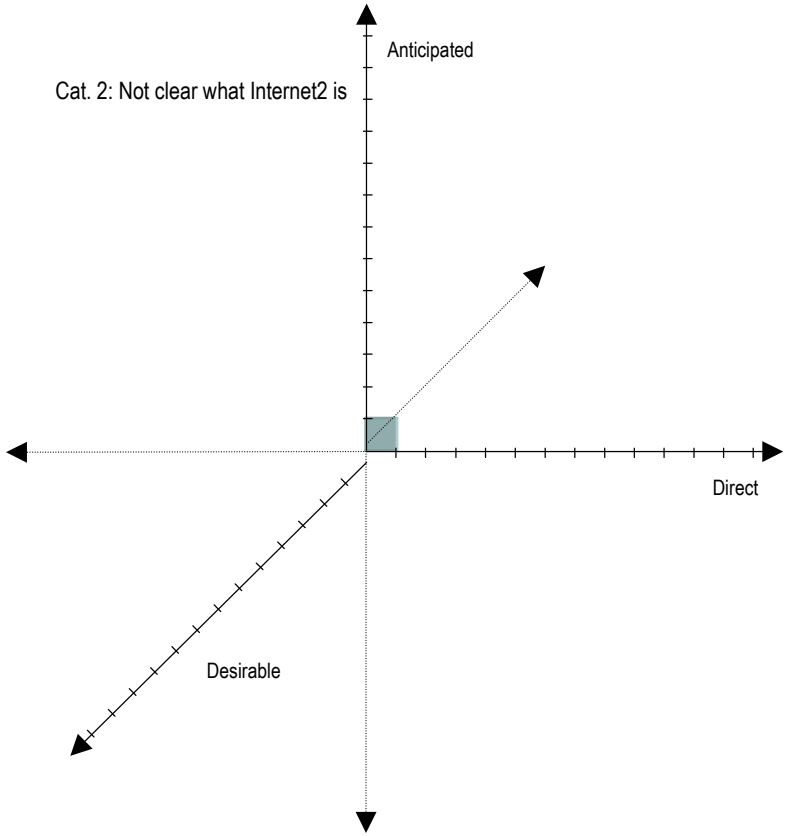


Figure 8. (continued)

Part 6. Not clear what Internet2 is



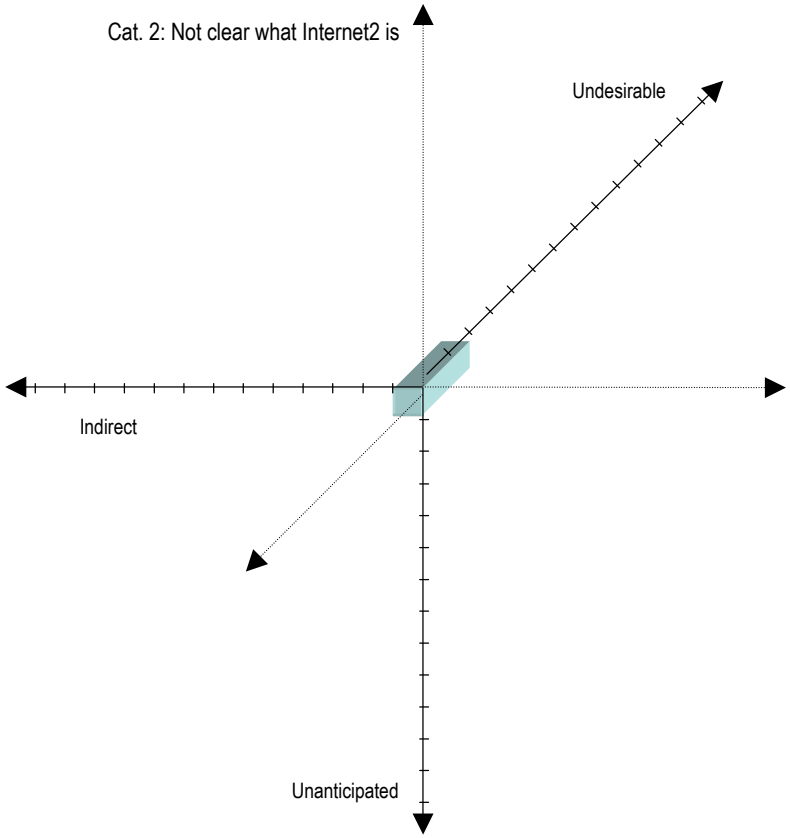
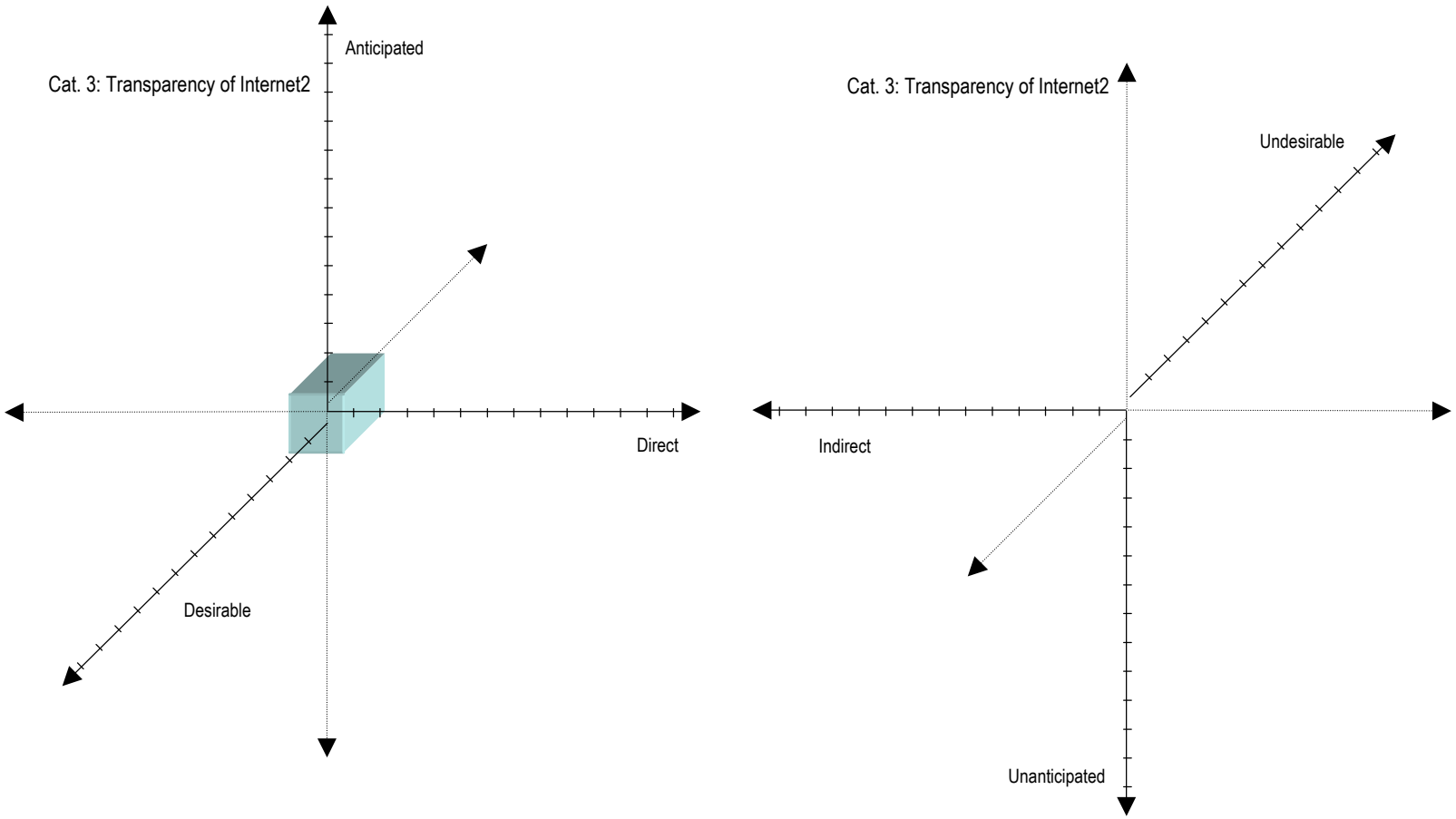


Figure 8. (continued)

Part 7. Transparency of Internet2



Analysis of Concerns

This section is devoted to respond research question number 2 and the other part of research question 4, what were the concerns (Hall & Hord, 1987) regarding the use of Internet2® at Texas A&M University? And to what extent do the findings match or not match the Concern-Based Adoption Model (Hall & Hord, 1987)?

Stages of Concerns, as stated in Chapter II, served as a reference model based on perceptions of the adopters. Interviewees were asked directly about their concerns, feelings, reactions, attitudes, and the effects of Internet2 in their lives and the lives of people they worked with. Categories 12, 15, 17, 19, and 20 emerged from the direct responses provided. They formed the previously discussed theme number 5, the Internet2 Concerns.

In an indirect way, Categories 1, 2, 4, 5, 6, 10, 11, 16, and 18 (which were not explicitly identified as concerns), represented another set that made most of Hall and Hord's model operational. The model, however, did not characterize the stage of a large Texas A&M group, the group that have not heard of Internet2 and had not been targeted in any informational campaign but because they unconsciously make use of Internet2 can still be considered adopters. In addition, part of this group, as stated by many interviewees, is of relevance for Intenet2 diffusion purposes since it represents the initial reason for Internet2 creation. The subgroup I am referring to is the researchers group. Internet2's diffusion thus, challenges the model and calls for its modification in accordance to these specificities.

The modified model can be understood in the following way. The initial stage would not be the awareness stage but the unawareness stage, category 1 (Transparency of Internet2) would be the associated category. The awareness stage would be related to category 2 (Not clear what Internet2 is). The informational stage would be connected to category 6 (Need of Communication). The personal stage would be associated with category 12 (More complexity in my job). The management stage would be related to categories 4, 16, and 19 (Need of engagement, Lack of researchers, and Concerns about free usage respectively). The consequence stage would be connected to category 20 (Concerns of accessibility). The collaboration stage would be associated with categories 11 and 18 (Collaboration and International Impact of Internet2). The refocusing stage would be related to categories 5, 10, 15, and 17 (NLR Discussion, QoS Discussion, Political Concerns, and Concerns for the Future of Internet2).

Table 12 portrays the modified stages of concern model as related to the categories of analysis. It also provides exemplary expressions of concern.

Contrary to what Hall and Hord (2006) state in the sense that the stages "reflect a quasi-developmental path to the concerns as a change process unfolds" (p. 141), Internet2 can be considered again an innovation on its own in the sense that multiple concern processes unfold at the same time. As can be noticed in Table 10, all participants expressed diverse concerns reflecting not only preoccupation on their own boundaries of action but on Texas A&M as a whole.

Table 12. Internet2's Modified Stages of Concern at Texas A&M

Area	Stage	Category of analysis	Expressions of Concern
Impact	Refocusing	Categories 5, 10, 15, and 17.	"I don't see communication about Internet2 on a positive light. I just see it as an organization, and just kind of a bureaucracy… I'm not even sure whom it benefits" (P1).
	Collaboration	Categories 11 and 18	"I see a lot of potential in the international emphasis" (P4).
	Consequence	Category 20	" My concern is in the have and have nots. People stay out because they can't afford it since colleges and K-12 schools are penny pinchers" (P8).
Task	Management	Categories 4, 16, and 19	"We do a lot of technology integration because researchers don't look outside their own discipline. We look at different disciplines and do that. If we cannot find the solution, then we create the solution. We do the engineering, the research, and the development"(P6). "Need to replicate collaboration in the university's micro-cosmos" (P16).
Self	Personal	Category 12	"It's a more complex on our network architecture, it has created some complications sometimes, and we have to keep an eye on it" (P2).
	Informational	Category 6	"We need to introduce more of the other IT professionals to the additional services that are possible on Internet2" (P13)
Unrelated	Awareness	Category 2	"I don't see anything that I directly recognize with Internet2. What I use is Internet" (P12).
	Unawareness	Category 1	"Obviously, there are research entities who use the Internet2 capabilities…In some cases, they might not be aware they are using Internet2…"(P7).

Interventions for Diffusion

This section is devoted to respond to research question number 3, how might Texas A&M University further enhance professional development and interventions for diffusion?

Participants were explicitly required to provide recommendations for improving the way Internet2 is used at Texas A&M University. The general intervention everybody mentioned was in the sense of doing a better promotion of Internet2 at Texas A&M University. The recommendations ranged from the formation of a university's committee in order to gather information from all colleges in the telecommunications services needed, to the formation of an Internet2 working group. Participant 7 commented on developing a central Website with all the projects and services that Internet2 enables, and Participant 8 recommended advertising electronically every service provided though Internet2 by stating for example, "this QoS is brought to you by Internet2." Participant 6 suggested providing information as part of the orientation to new faculty, staff, and students. Table 13 compiles the most important recommendations.

Table 13. Suggestions for Better Promotion of Internet2 at Texas A&M University

Proponent	Suggestion for better promotion, communication and engagement
Participant 2	You have to target each group with what they can do with it. In telemarketing we had to learn about the FAB, the features, advantages, and benefits of everything we sold.
Participant 3	It would probably be useful to create an Internet2 working group at Texas A&M, just of interested faculty to be able to throw ideas about, and seek collaboration, something like a brown bag lunch affair.
Participant 5	Engaging researchers, better job promoting the applications for example at the TTVN conferences…A lot of potential on bringing more researchers because collaboration is an aspect of grants that is evaluated.
Participant 6	An improvement would be a university sanction: "This is a good resource, go after it". We need a mandate. Maybe as part of the orientation for every new staff member, every new employee and every new freshman.
Participant 7	There must be a central website or something like which has Internet2 projects on our organization with investigators. Computer Services might know where huge amounts of data are coming from…
Participant 8	Perhaps it would be helpful to have individuals who are involved in Internet2 to get the word out, something like "this QoS is brought to you by Internet2" in order to understand the impact.
Participant 14	This university is missing a committee that comes out of every college and informs what's happening in that realm and has a sense of what's needed. As administrator you really don't know anything of what's going on in the trenches…
Participant 16	Collaboration success between Internet2 members should be replicated in the microcosm of Texas A&M.

Summary of Findings

Texas A&M University adopted Internet2 since its foundation. Archival information provides evidence of the planning and activities that have taken place. The

visits to one University's council and one college committee as well as the interviews with participants resulted in findings during the data collection that called for a redefinition of participants' roles. The interviews and the participant impressions were also part of the findings during the data collection.

From the interviews, a general analysis resulted in the finding of 20 categories encompassed in five themes. An additional theme was found from the narrative analysis of interviews. The consequences and concerns of the adoption of Internet2 at Texas A&M resulted to be quite close to Rogers' (2003) model and Hall and Hord's (1987) model.

The interviewees also suggested recommendations in the area of better promotion of Internet2, mostly targeting researchers.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This chapter gives me an opportunity to share my insights. The insights are on the faculty and staff perceptions of consequences and concerns after the adoption of Internet2 at Texas A&M University. Reflections are also shared regarding the interventions suggested by the participants of this study. Comments are provided on how the Rogers (2003) and Hall and Hord (1987) models have been applied or adapted to the specific circumstances of this inquiry. Recommendations for practice and research are also given based on pertinent literature.

Summary of Study

The purpose of this inquiry was to examine the consequences and concerns with the diffusion of Internet2 at Texas A&M University. The university is considered to be a founder of Internet2, so its adoption can be traced back to the end of the 90s decade. Therefore, the case of Texas A&M University is relevant to other institutions of higher education.

This dissertation reviewed the Internet Development and its relationship to universities. There were two theoretical models of change used, Diffusion of Innovations (Rogers, 2003) and Concerns-Based Adoption Model, or CBAM (Hall & Hord, 1987). Specifically, “the consequences of change” was the focus in the Diffusion model, and

"the stages of concern" was the focus in the CBAM. In addition, eight different studies informed this dissertation.

This study used qualitative methods of inquiry with three sources of information -- interviews, observations and archival information. Seventeen participants interviewed during the spring of 2006 were selected on the basis of convenience, homogeneous, and snowball sampling. In that way, appropriate representation of all university entities was ensured. The open-ended interviews allowed me to explore Internet2 without a predetermined set of mind. The first part of the interview was focused on the participant's job profile; that allowed me to properly place where the participant was to be located in the Venn Diagram (Figure 6). The second part of the interview evolved around the consequences and the third part around the concerns of Internet2 at Texas A&M University. The last portion of the interview was the request for recommendations.

The audit trail, peer-debriefing, and member checks were the mechanisms implemented to guarantee trustworthiness. Analytic induction and narrative analysis were the research strategies and the report was presented in the manner of case study and summary of findings.

Research Conclusions and Implications

In this section the research questions will be individually addressed providing the conclusions and implications that I drew from the interpretation of the findings.

Research Question 1: What have been the consequences of the diffusion of the innovation (Rogers, 2003), entitled "Internet2®", at Texas A&M University? Consequences are defined as the "changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation" (Rogers, 2003, p. 31). When participants were asked directly about those changes, they responded in the following manner:

- Category 11- Collaboration (11 participants)
- Category 7- Better service-production (7 participants)
- Category 13- Guiding manufacturers and service providers (6participants)
- Category 9- Research use of Internet2 (5 participants)
- Category 8- Videoconference as a teaching tool (4 participants)
- Category 2- Not clear what Internet2 is (2 participants)
- Category 3- Influence and advancements (3 participants)
- Category 12- More complexity in my job (1 participant)
- Category 18- International impact of Internet2 (1 participant)

The meaning of this information is that on the top of the list, participants recognize a change in the way the University is collaborating with other institutions. Thus, it can be concluded that the collaboration spirit behind the historical network initiatives such as BITNET, CSNET, NGI, and NREN, and academic organizations such EDUCAUSE is still prevalent in Internet2. This is worthy to be celebrated as an achievement although as the concerns described, this collaboration is limited to a certain

number of individuals. In the following paragraphs the stated consequences will be related conclusively with Internet2's intended goals.

Hanss and Van Houweling (2005) stated that Internet2 aims to "address the advanced networking needs and interests of the research and education community" (p. 120). The provision of better production services (Category 7) is a reported change that pertinently makes this objective real. Category 9, the change in the research use of Internet2, and Category 8, Videoconference as a Teaching Tool are also good examples of the achievement of this objective.

Internet2 also aims to "Provide leadership in the evolution of the global Internet" (Hanss & Van Houweling, 2005, p. 120). The influence exerted over manufacturers and service providers (Category 13) as well as the advancements that have permeated inside and outside the realm of Internet2 (Category 3) have made operational the evolution of the global Internet for the benefit of not only the Internet2 community.

Internet2 also aims to "implement a systems approach to a scalable and vertically integrated advanced networking infrastructure" (Hanss & Van Houweling, 2005, p. 120). This objective can be understood as operationalized due to the advancements that had permeated inside and outside the Internet2 community.

Internet2 also aims to "leverage strategic relationships among academia, industry, and government" (Hanss & Van Houweling, 2005, p. 121). This objective could also be considered achieved through the guidance given to manufacturers and service providers (Category 13), the advancements permeated inside and outside

Internet2 (Category 3), and of course the collaboration among universities (Category 11).

Internet2 finally aims to "catalyze activities that cannot be accomplished by individual organizations" (Hanss & Van Houweling, 2005, p. 121). This is also an objective that could be checked due to the collaboration among universities (Category 11) reported by participants.

In conclusion, all the missions of Internet2 can be said to be real for the case of Texas A&M University even with the limitation in the number of people fully aware of it. From the archival information and from the participants, the efforts of the instances in the University dedicated to telecommunications, networking services, and information technology advancements are evident.

Research Question 2: What were the concerns (Hall & Hord, 1987) regarding the use of Internet2® at Texas A&M University? This is perhaps the most valuable portion of the study. The concerns, however, were much more hidden in the narratives of participants. Fortunately, via the recommendations part of the interview, even the most elusive or optimistic of interviewees provided rich information about their inner most "feelings, preoccupations, thoughts, and considerations" (Hall & Hord, 1987, p. 58). The expressions of the participants (when directly asked about concerns) can be summarized as follows:

- Category 15- Political Concerns (5 participants)
- Category 17-Concerns for the Future of Internet2 (5 participants)
- Category 20- Concerns of Accessibility (3 participants)

- Category 12- More Complexity in my job (2 participants)
- Category 19- Concerns about free usage (2 participants)

The conclusions that can be drawn from these explicit concerns are that the level of politics and bureaucracy in the Internet2 organization is an issue (Category 15). One might wonder if the rest of the participants either feel comfortable as it is or simply had not been exposed to Internet2. Other participants do not see a clear future for Internet2 (Category 17). It is worthy to note that 4 out of these 5 participants also expressed comments about the National LambdaRail Discussion (Category 5). The conclusion is that after the failure of the NLR merger, they have been left preoccupied with what the future entails or what Internet2 will be able to offer now that the frank competition between both initiatives will start.

Regarding the concerns for the "have and have nots," with only three individuals with thoughts in this respect (Category 20), one can conclude that only a few people aware of Internet2 had reflected on the digital divide. On the other hand, once it is known how difficult is to separate Internet and Internet2 traffic in the network infrastructure (as expressed in the Category 1 about the transparency) as well as the capacity to aggregate more bandwidth, the concerns about the way Internet2 is used (either for downloading videos or for the purpose to update the Netflix queue), lose relevancy.

Perhaps the most expected concern, the personal concern that Internet2 has brought complexity to a participant's job (Category 12), was surprisingly mentioned only twice. The natural conclusion is that the rest of the participants engaged in Internet2

are quite comfortable with what Internet2's activities had brought to their lives (certainly not complications).

As an interesting exercise of interpretation, Categories 5 and 10 can be catalogued among concerns, because participants were not happy when referring to them:

- Category 5- National LambdaRail Discussion (9 participants)
- Category 10- Quality of Service Discussion (4 participants)

The conclusions drawn are in the sense that the aborted merger between National LambdaRail (Category 5) as well as the discontinuance of the Quality of Service network policy (Category 10) should be revisited by UCAID in order to maintain the spirit and motivation of its constituency.

A more challenging exercise of interpretation is in relation to Categories 4, 6, and 16. The recommendations part of the interview that was the place where most of the comments of these categories were gathered. The following list will help to maintain in perspective the interpretations and conclusions:

- Category 4. Need for engagement (15 participants)
- Category 6. Need for communication (15 participants)
- Category 16. Lack of researchers (6 participants)

One can conclude that although participants failed to recognize all these needs as "their concerns," the truth is that they feel moved by the lack of researchers involved, the corresponding lack of Internet2 research performed in the University, and the ignorance of Internet2 on campus. The lack of researchers involved and the corresponding lack of

Internet2 research performed in the University should be considered an opportunity that is getting lost, and the ignorance of Internet2 on campus will be addressed with the possible implementation of recommendations proposed by the participants.

Research Question 3: How might Texas A&M University further enhance professional development and interventions for diffusion? The flow of this conversation has gone to the categories that elicited recommendations. Table 12 collected the suggestions provided during the interviews, all in the sense of better promotion of Internet2 in the University. Recommendations for practice (below) will elaborate more about the interventions.

Research Question 4: To what extent do the findings match or not match Roger's (2003) diffusion of innovation research and the Concerns-Based Adoption Model (Hall & Hord, 1987)? Although the Innovation-Decision process in Rogers' model was not the focus of this dissertation, it seemed to be incomplete if only the stage of knowledge is considered at the beginning of the process. As in the case of Li (2004), a "No-Knowledge" stage is justified because Internet2 is used by all university people in a transparent fashion. One might conclude then that Rogers' Innovation-Decision process works and is actually enhanced at Texas A&M University for the case of the Internet2 innovation.

For the consequences portion of the model, respondents were confused when asked about the attributes of the changes. The desirability, anticipation, and directedness of those changes were not easy to comprehend. In some cases, it was necessary to provide the exact same examples given by Rogers (2003). The conclusion is that

although the model worked for the case of identification of consequences, it was limited or "ill implemented" in the interview guideline.

The CBAM-Stages of Concern model had to be modified and adapted for the case of Internet2 at Texas A&M University. The "Unawareness" pre-stage had to be added because of the transparency of this innovation. Innovations such as Internet2 (suitable to be implemented transparently), one might conclude, require an enhanced CBAM model.

Summary of Research Conclusions. In an overall summary, one might state that for the support-services and the research portion associated with the support-service personnel, Internet2 has been successful. However, for the sake of the faculty or instructors and researchers, they should get more attracted to Internet2, and the recommendations for practice should be oriented in that direction.

Recommendations for Practice

The recommendations provided by the participants are grouped in three categories; Internet2 must engage more people (Category 4), the word and promotion of Internet2 should be better addressed (Category 6), and there is a need for research and researchers in Internet2 that should be addressed (Category 16). These identified suggestions can qualify as the needs assessment Torraco and Hoover (2005) referred to when implementing change in their "Changes in Universities" monograph. Such needs assessment should serve as the foundation for the rest of interventions.

Top administrators at Texas A&M University can be considered engaged in Internet2, yet based on the sample of this study, unit administrators (especially of those units that are not related to technology) cannot be considered engaged and some not even informed. In accordance with Torraco and Hoover (2005), at least two positions above the unit administrator must be in agreement and fully support of the changes. On the other hand, I consider that the leadership role of faculty has been neglected and underestimated at Texas A&M University with respect to Internet2. According to Torraco and Hoover (2005), many times there is a tension between the administration and the faculty when attempting to implement change. My recommendation would be to install a system of incentives in order to make Internet2 more attractive to faculty members, that is, to develop a policy for "supporting faculty when managing technological change" (Bates, 2000, p. 95).

Finally, through the sample of participants, it was perceptible the presence of support-services personnel who also played a research role. Since they are not either faculty or top administrators, they can be catalogued as informal leaders. Informal leaders could "assist in building support from their colleagues and friends in the organization" (Torraco & Hoover, 2005, p. 435). More of these informal leaders should be recruited and rewarded.

Recommendations for Research

This study is limited to those faculty and staff members of Texas A&M University. Dooley (2002), however, suggested "the report should be presented so that

the reader could apply the same experience in his or her setting" (p. 343). In other words, the study should serve a purpose of transferability (Lincoln & Guba, 1985). The first recommendation for research would be to respond to "How transferable are the findings at Texas A&M University to other institutions in America?" A quantitative study based on these findings and applied on other Internet2's members is highly recommended.

Since this dissertation has been an exploratory study, it would also be beneficial to test the modified theoretical models, and general findings inside Texas A&M University with a larger sample. The provision for another quantitative design of inquiry is also recommended. Such a study would cement a progression of research that can also culminate in the Internet2's member study suggested in the previous paragraph.

The information from this study will be shared with the participants. Many of them hold positions that enable them to put the interventions in practice. Research informing practice is the desire of any investigator when conducting a study.

REFERENCES

Baker, P. R. (1985). Adoption of a computer software cataloging system at an elementary school. *School Library Media Quarterly, 13*(1), 208-214.

Barrett, R. (1998, May 4). Usefulness of Internet2 questioned. *Inter@ctive Week, 5(17),* 1.

Bates, A. W. (2000). *Managing technological change: Strategies for college and university leaders*. San Francisco, CA: Jossey-Bass.

Berger, J. I. (2005). Perceived consequences of adopting the Internet into adult literacy and basic education classrooms. *Adult Basic Education, 15*(2), 103-121.

Bolt, Beranek, & Newman (BBN). (2005). *The Arpanet: Forerunner of today's Internet*. Retrieved August 15, 2005, from http://www.bbn.com/Historical_Highlights/Arpanet.html

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Burrell, G., & Morgan G. (1979). *Sociological paradigms and organisational analysis: Elements of the sociology of corporate life*. London: Heinemann.

Cameron, D. (1999). *Internet2: The future of the Internet and other next-generation initiatives*. Charleston, SC: Computer Technology Research Corp.

Comer, D. (1983). The computer science research network CSNET: A history and status report. *Communications of the ACM, 26*(10), 747-753.

Comer, D. (2004). *Computer networks and internets*: *With Internet applications*. (4th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Cook, G. (1993). NSFnet privatization: Policy making in a public interest vacuum. *Internet Research, 3*(1), 3-9.

Creswell, J. W. (1997). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2002). *Educational research*: *Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Merrill/Prentice Hall.

Cyhist. (1999). *Community memory: Discussion list on the history of cyberspace*. Retrieved August 15, 2005, from http://www.as.wvu.edu:8000/clc/projects/cyhist/Cyhist%201999/Cyhist%20March%201999/cyhist2.txt%20889

Denzin, N. K., & Lincoln, Y. S. (2000). *Handbook of qualitative research*. Thousand Oaks, CA: Sage Publications.

Dooley, K. W. (1995). The diffusion of computer technology and telecommunications: A comparative case study of middle schools in the Texas Education Collaborative (Doctoral dissertation, Texas A&M University, 1995). *Dissertation Abstracts International, 56,* 09.

Dooley, L. M. (2002). Case study research and theory building. *Advances in Developing Human Resources*, *4*(3), 335-354.

Dugan, R. E., & Trump, J. F. (1999). Internet2: Separate and unequal. *Journal of Academic Librarianship, 25*(2), 127-131.

Ellsworth, J. B. (2000). *Surviving change: A survey of educational change models*. Syracuse, NY: Eric Clearinghouse on Information and Technology.

Futhey, T. (2005). Viewpoints: Life of lambda. *Educause Review, 40*(5), 80-81.

Gay, L. R., & Airasian, P. (2000). *Educational research: Competencies for analysis and application*. Upper Saddle River, NJ: Merrill.

Griffiths, R. T. (2005). *Chapter two: From ARPANET to World Wide Web*. Retrieved March 10, 2005, from http://www.let.leidenuniv.nl/history/ivh/chap2.htm

Hall, G. E, Wallace, R. C., & Dossett, W. A. (1973). *A developmental conceptualization of the adoption process within educational institutions*. Austin, TX: University of Texas, Research and Development Center for Teacher Education.

Hall, G. E., & Hord, S. M. (1987). *Change in schools: Facilitating the process*. Albany, NY: State University of New York Press.

Hall, G. E., & Hord, S. M. (2006). *Implementing change: Patterns, principles, and potholes*. (2nd ed.). Boston, MA: Pearson/Allyn & Bacon.

Hanss, T., & Van Houweling, D. (2005). The promise of truly advanced broadband. In R. D. Austin, & S. P. Bradley (Eds.), *The broadband explosion: leading thinkers on the promise of a truly interactive world* (pp. 119-135). Boston, MA: Harvard Business School Press.

Heterick, R. C. (1998). Educom: A retrospective. *Educom Review, 33*(5), 42-47.

Higgins, K. J. (1999). Full stream ahead. *Internet World, 5*(30), 83-85.

Hobbes, R. (2005). *Hobbes' Internet timeline v8.1*. Retrieved March 5, 2005, from http://www.zakon.org/robert/internet/timeline/

International Telecommunications Union. (2005). *Internet indicators: Hosts, users and number or pc's 2004*. Retrieved March 9, 2005, http://www.itu.int/ITU-D/ict/statistics/at_glance/Internet04.pdf

Internet Society. (2005). *A brief history of the Internet.* Retrieved March 9, 2005, from http://www.isoc.org/internet/history/brief.shtml

Labov, W. (1972). The transformation of experience in narrative syntax. In W. Labov (Ed.), *Language of the inner city: Studies in the Black English vernacular* (pp. 354-396). Philadelphia, PA: University of Pennsylvania Press.

Leitner, B. M., Cerf, V. G., Clark, D. D., Kahn, R. E., Kleinrock, L., Lynch, D. C., et al. (2003). *A brief history of the Internet*. Retrieved August 15, 2005, from http://www.isoc.org/internet/history/brief.shtml

Li, Y. (2004). Faculty perceptions about attributes and barriers impacting diffusion of web-based distance education (WBDE) at the China Agricultural University (Doctoral dissertation, Texas A&M University, 2004).

Lin, N. (1993). Diffusion of information technology: A case study of computer network and the role of government, industry, and academia in developing the Internet/NREN. *Dissertation Abstracts International*, *54*(12). (UMI No. 9413537)

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.

Linde, D. (1993). *Life stories: The creation of coherence*. New York, NY: Oxford University Press.

McClure, C. R., Bishop, A. P., Doty, P., Rosenbaum, H. (1997). *The national research and education network (NREN): Research and policy perspectives*. Norwood, NJ: Ablex Publishing Corporation.

McGarvey, J. (1999). Internet2 arrives, but is it still relevant? *Inter@ctive Week, 6(9),* I-5.

McLoughlin, G. J. (1998). Next generation Internet. *The Journal of Academic Librarianship, 24*(3), 237-239.

Merriam, S. (1998). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass Publishers.

Mishler, E. G. (1986). The analysis of interview-narratives. In T.R. Sarbin (Ed.), *Narrative Psychology: The storied nature of human conduct.* (pp. 233-255). New York, NY: Praeger.

National Coordination Office for Networking and Information Technology Research and Development (NITRD). (1997). *Next generation Internet initiative, concept paper*. Retrieved November 11, 2005, from http://www.nitrd.gov/ngi/pubs/concept-Jul97/pdf/ngi-cp.pdf

National LambdaRail (NLR). (2006). *About National LambdaRail*. Retrieved February 22, 2006, from http://www.nlr.net/about/

National Science Foundation (NSF). (2006). *The launch of NSFNET*. Retrieved February 6, 2006, from http://www.nsf.gov/about/history/nsf0050/internet/launch.htm

Neas, B. M. (2004). *Regional networks: Educause Evolving Technologies Committee*. Retrieved August 20, 2005, from http://www.educause.edu/ir/library/pdf/DEC0405.pdf

Norman, J (2005). *From Gutenberg to the Internet: A sourcebook on the history of information technology*. Retrieved August 10, 2005, from http://www.historyofmedicine.com/G2I/docs/timeline/index.shtml

Oberst, D. J., & Smith, S. B. (1986). BITNET: Past, present, and future. *Educom Bulletin, 21*(2), 10-17.

Office of Institutional Studies and Planning. (2006). *Demographic Summary*. Retrieved August 25, 2006, from http://www.tamu.edu/opir/reports/ep/epsp2006.pdf

Olsen, F. (2003, May 16). Internet2 at a crossroads. *Chronicle of Higher Education, 49*(36), A32-36.

Paulson, L. D. (2003). News briefs: Researchers plan experimental optical network. *Computer, 36*(12), 24-26.

Rapoza, J. (2002). It's time for the next Internet. *eWeek, 19(28),* 58.

Riessman, C. K. (1993). *Narrative analysis*. Newbury Park, CA: Sage Publications.

Rogers, E. M. (1993). *Difussion of innovations*. (4th ed.). New York, NY: Free Press.

Rogers, E. M. (2003). *Difussion of innovations*. (5th ed.). New York, NY: Free Press.

Rogers, E. M. (2004). A prospective and retrospective look at the diffusion model. *Journal of Health Communication, 9*(1), 13-19.

Rogers, E. M., Daley, H. M., & Wu, T. D. (1982). *The diffusion of home computers: An exploratory study*. Stanford CA: Institute for Communication Research Stanford University.

Simonson, M., & Sparks, K. (2001). Learning at a distance in South Dakota: Evaluation of the process. *TechTrends, 45*(3), 38-43.

Singer, B., Hall, C., & Upton, J. (2000, April). *A study of faculty concerns and developmental use of Web-based course tools*. *Paper presented at the annual meeting of the American Educational Research Association.* New Orleans, LA.

Smith, J. (1998). An examination of the consequences of electronic innovations. *Journal of Interlibrary Loan, Document Delivery & Information Supply, 8*(4), 71-78.

Sta. Maria, R. F., & Watkins, K. E. (2003). Perceptions of learning culture and concerns about the innovation on its use: A question of level of analysis. *Human Resouce Development International, 6*(4), 491-508.

Stake, R. E. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd ed.). (pp. 435-454). Thousand Oaks, CA: Sage.

Sterling, B. (2006). *Short history of the Internet*. Retrieved February 10, 2006, from http://w3.aces.uiuc.edu/AIM/scale/nethistory.html

Swanson, R. A., & Holton, E. F., III. (1997). *Human resource development research handbook*. San Francisco, CA: Berrett-Koehler.

Tanenbaum, A. (2003). *Computer networks*. (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Texas A&M University. (2006a). *Vision 2020.* Retrieved June 30, 2006, from http://www.tamu.edu/vision2020/groundwork/groundwork.pdf

Texas A&M University. (2006b). *Texas A&M University Internet2 Technology Evaluation Center (ITEC).* Retrieved June 30, 2006, from http://voip-itec.tamu.edu/

The Carnegie Foundation for the Advancement of Teaching (2006). *Classifications*. Retrieved October 1, 2006, from http://www.carnegiefoundation.org/classifications/

Torraco, R. J, & Hoover, R. E. (2005). Organization development and change in universities: Implications for research and practice. *Advances in Developing Human Resources 7(*3), 422-437.

Torraco, R. J. (2005). Organization development: A question of fit for universities. *Advances in Developing Human Resources, 7*(3), 303-310.

University Corporation for the Advanced Internet Development (UCAID). (2005a). *About Internet2*. Retrieved March 14, 2005, from http://www.internet2.edu/about/aboutinternet2.html

University Corporation for the Advanced Internet Development (UCAID). (2005b). *Internet2 and NLR Group B report*. Retrieved August 10, 2005, from http://whodunit.uchicago.edu/groupb-report.pdf

University Corporation for the Advanced Internet Development (UCAID). (2006a). *Abilene FAQ*. Retrieved February 15, 2006, from http://abilene.internet2.edu/about/faq.html

University Corporation for the Advanced Internet Development (UCAID). (2006b). *Teaching and learning special interest group*. Retrieved February 15, 2006, from http://www.internet2.edu/teach/

University Corporation for the Advanced Internet Development (UCAID). (2006c). *Hosting an Internet2 Day*. Retrieved June 30, 2006, from http://apps.internet2.edu/host-Internet2-day.html

University Corporation for the Advanced Internet Development (UCAID). (2006d). *Internet2 Technology Evaluation Centers (ITECS).* Retrieved June 30, 2006, from http://www.internet2.edu/about/itecs/

University Corporation for the Advanced Internet Development (UCAID). (2006e). *University Membership Application Requirements.* Retrieved September 29, 2006, from http://members.internet2.edu/university/RegularRequirements.html

University Corporation for the Advanced Internet Development (UCAID). (2006f). *Internet2 Universities*. Retrieved September 29, 2006, from http://members.internet2.edu/university/universities.cfm

Watkins, K. E. (2005). What would be different if higher educational institutions were learning organizations? *Advances In Developing Human Resources, 7*(3), 414-421.

Watkins, K. E., Ellinger , A. D., & Valentine, T. (1999). Understanding support for innovation in a large-scale change effort: The manager-as-instructor approach. *Human Resource Development Quarterly, 10*(1), 63-77.

Well, J. G., & Anderson, D. K. (1997). Learners in a telecommunications course: Adoption, diffusion, and stages of concern. *Journal of Research on Computing in Education, 30*(1), 83-106.

Yin, R. K. (2003). *Case study research: Design and methods*. (3rd ed.). Thousand Oaks, CA: Sage.

APPENDIX A

GLOSSARY/INDEX

GLOSSARY/INDEX

ACRONYM	DESCRIPTION	LOCATION IN TEXT
Abilene	A high-performance network developed by Internet2 in partnership with Juniper Networks, Nortel Networks, Qwest Communications, and Indiana University	p. 18
ARPA	Advanced Research Projects Agency	p. 8
ARPANET	Advanced Research Projects Agency Network	p. 5
BBN	Bolt, Beranek & Newman Technologies	p. 9
BITNET	Because its Time Initiative	p. 10
BITNIC	Bitnet Network Information Center	p. 10
CAUSE	CAUSE Inc. EDUCAUSE precursor	p. 13
CREN	Corporation for Research and Education Networking	p. 11
CSNET	Computer Science Network	p. 10
DARPA	Defense Advanced Research Projects Agency. Known until 1972 as ARPA.	p. 11
DARPANET	Defense Advanced Research Projects Agency	p. 80
DoD	Department of Defense	p. 8
EDUCAUSE	EDUCOM and CAUSE joint organization	p. 13
EDUCOM	Interuniversity Communications Council Inc.	p. 10
GPN	Great Plains Network	p. 13
HOPI	Hybrid Optical and Packet Infrastructure	p. 71
ITEC	Internet2 Technology Evaluation Center	p. 57
LEARN	Lonestar Education and Research Network	p. 76
MERIT	MERIT Network. Non-profit corporation governed by Michigan's public universities	p. 12
NASA	National Aeronautics and Space Administration	p. 14
NGI	Next Generation Internet	p. 14
NII	National Information Infrastructure	p. 14
NLR	National LambdaRail	p. 3
NREN	National Research and Education Network	p. 13
NSF	National Science Foundation	p. 2
NSFNET	National Science Foundation Network	p. 5
NTNC	Northern Tier Network Consortium	p. 13
Optiputer	Optical networking, Internet Protocol, computer storage, processing and visualization technologies	p. 71
OSI	Open Systems Interconnection Reference Model	p. 71
QoS	Quality of Service	p. 77
RAND	RAND Corporation. Nonprofit organization	p. 8
SCOOP	Southeastern Coastal Ocean Observing System	p. 72

TELENET	First commercial network	p. 9
TERENA	TransEuropean Research and Education Networking Association	p. 14
TTVN	Trans-Texas Videoconference Network	p. 57
vBNS	Very high speed Backbone Network Services	p. 2
VoIP	Voice over IP	p. 57
WICHE	Western Interstate Commission for Higher Education	p. 12

APPENDIX B

PROTOCOLS FOR COMMUNICATION WITH PARTICIPANTS AND DATA COLLECTION

Informed Consent

"Perceived Consequences and Concerns in the Diffusion of Internet2® at Texas A&M University"

This study seeks to investigate the aspects involved in consequences and concerns in the diffusion of the Internet2® project in Texas A&M University. Noemí V. Mendoza-Díaz is a doctoral student at the Texas A&M University College of Education and is the principal investigator in this research. 30 people who had attended the Internet2 member meetings recently or who had been referred by those attending the Internet2 meetings have been contacted in order to participate in interviews. The researcher will audiotape the interviews, analyze the content, and store the tapes for a year. At the completion of the year, audiotapes will be destroyed. Completion of this study is part of the dissertation research to receive a Ph.D. in Educational Administration and Human Resource Development in Texas A&M University.

I understand that participation in this study is completely voluntary and that I will not receive any benefits from participating. I understand I can withdraw from the study at any time without penalty. Additionally, I understand that I may refuse to answer any questions that make me feel uncomfortable.

I understand the principal investigator will not use my name in the final report to insure confidentiality. In case of publication, the researcher will change all the information that may reveal my identity.

I understand that I may contact Noemí V. Mendoza-Díaz, Dept. of Education Administration and Human Resource Development, College of Education, Texas 77843-4226, 979-458-3935 or by email at nmendoza-diaz@cdlr.tamu.edu. I understand that this research study has been reviewed and approved by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding participant's rights, I can contact the Institutional Review Board through Ms. Angelia M. Raines, Director of Research Compliance, (979) 458-4067, email: araines@vprmail.tamu.edu. Or you may contact my advisors, Dr. Kim Dooley (979) 862-7180, email: k-dooley@tamu.edu and Larry Dooley (979) 845-5300, email: l-dooley@tamu.edu.

I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

I have been given a copy of this consent form.

_____ _____

Participant's Name (Type) and signature Date

_____ _____

Noemí V. Mendoza-Díaz Date

I would like to receive a copy of this research once it is completed (please check):

__Yes__No

Interview Protocol

Job Profile

1. What is your job in Texas A&M? What specific duties do you have to comply?
2. Please, describe the activities that you perform related to Internet2. How do you use Internet2?
3. To what extent would you say you are engaged in Internet2 activities? (percentage)

Consequences of Diffusion

4. What TAMU Internet2 projects are you aware of? Who is involved?
5. When was the first time you heard about Internet2 and how did you hear about it?
6. What were your expectations?
7. What are your first hand experiences?
8. What changes have you seen attributable to Internet2?
9. What are the consequences of adopting Internet2? (Please list at least five)?
10. How would you classify each of them in a scenario of Desirable vs. Undesirable, Anticipated vs. Unanticipated, and Direct vs. Indirect.

Stages of Concerns

11. How do you feel about Internet2?
12. Any problems or concerns you have about it?
13. How does Internet2 affect you?
14. How does Internet2 affect others you are involved with? How does it affect TAMU?
15. What are your reactions and attitudes toward Internet2?
16. Would you like any information about Internet2?

Ending of interview

17. If you could improve the way Internet2 is used in Texas A&M, what would you recommend?

Observation Protocol

1. The physical setting

Time:
Place:
Length of the observation:
Roles of the observer (participant, not participant, other____)

2. The participants

Time:
Place:
Length of the observation:
Roles of the observer (participant, not participant, other____)

3. Activities and interactions

Time:
Place:
Length of the observation:
Roles of the observer (participant, not participant, other____)

4. Conversation

Time:
Place:
Length of the observation:
Roles of the observer (participant, not participant, other____)

5. Subtle factors

Time:
Place:
Length of the observation:
Roles of the observer (participant, not participant, other____)

6. Your own behavior

Time:
Place:
Length of the observation:
Roles of the observer (participant, not participant, other____)

Descriptive notes:

Archival Information Protocol

1. Is this information relevant in the analysis of consequences of Internet2 diffusion in Texas A&M?

2. Is this information relevant in the analysis of concerns of Internet2 diffusion in Texas A&M?

3. What historical contexts this information can provide for the purpose of answering this study's research questions?

4. What key participants can be identified from this archive?

5. What key activities can be identified from this archive?

Sample Email Message for Request for Participation of Interviewees

Following is the email message to be sent to the interviewees of this study.

Greetings!

I am conducting a study entitled "Perceived Consequences and Concerns in the Diffusion of Internet2® at Texas A&M University", which constitutes my doctoral dissertation. Participation in this study will involve an individual interview of a maximum of 90 minutes in your area of work.

Attached is the consent form for the study "Perceived Consequences and Concerns in the Diffusion of Internet2® in Texas A&M". If you agree to participate in the research, please attach your consent form with your name entered on the signature line. Then I will send you the questions that I plan to ask you. Thanks for considering helping me with my research!

Noemí V. Mendoza-Díaz
PhD Candidate
Texas A&M University

Attachment: Informed Consent Form

APPENDIX C

PEER DEBRIEFING MEMO

Peer Debriefing Memo 7/3/2006

PERCEIVED CONSEQUENCES AND CONCERNS IN THE DIFFUSION OF INTERNET2® AT TEXAS A&M UNIVERSITY

General Trends (First round)

P1

- Conference very closed (The members meetings seem to me very closed)
- Transparency of Internet2 (…what I needed to understand was by default we are on Internet2…)
- Not clear what I2 is (.. a lot of frustration trying to understand what it was and what is its benefit…) (The only concern with the infrastructure is that is just that it is such a hot commodity, and is so easy for us at work to access, and aren't we working counter to the goals?)
- Concerns about personal beliefs (…and he wanted to make sure he had the bandwidth to support his research and he knew that Internet2 was less crowded than the Internet…)
- Concerns about free usage (…I mean, aren't we kind of undermining the goal?)
- Influence and advancement (…everybody is learning how to do more on the Internet and more and applications that were not dreamed of five years ago…)
- Disappointment-Frustration (Disappointment with the membership meetings)
- Need of engagement (… I have concerns about how Internet2 engage people in my position…)
- Classism in Internet2 (…These guy's are asking us to pay membership fees…)
- NLR Discussion (…why should we have both?)
- I2 is a Bureaucratic organization (…I don't see Internet2, I don't see communication about Internet2 on a positive light…)
- Need of communication (…and just more communication about what is and why is so good and how we need to respect it…)
- Better service-production (As an infrastructure, sure, I mean anytime you get a better microwave you are always astounded with how well it works and I kind of see them as a better rattrap I think is the way that they use to say it in engineering)

P2

- Better service-production (Internet2, they're working to get performance and quality and for applications…) (So, I had to take multicast from researching and testing and bringing into production…)

- Videoconference as teaching tool (videoconferencing work so the people who are running Internet2 are concern about these types of applications working…)
- Transparency of Internet2 & Not clear what Internet2 is (People don't know they are using Internet2 when they use Internet2...) (Ahh, because it is so transparent to applications, a lot of people don't know its there)
- Research use of I2 (I am closer to a researcher that puts the discoveries or the research in place. Yes, I do some research)
- QoS Discussion (So the two debates on quality of service are, you give it a pipe? And the quality <inaudible>. Or you actually can dedicate bandwidth to different applications)
- Collaboration (And Internet2 is a place to do this because everybody wants to collaborate)
- Influence and Advancement (…but the hope for that is the Verizons, the Cablemodems, the Coxes and everybody would see the need for this better connection and maybe make a shift to move to better quality…) (Well there has been some applications that have been develop because internet2 was available on block, it was built on block, the access grid, and some stuff, ITEC…) (We had to do some major upgrades or changes when we started doing videoconferencing over IP to make sure that we use I2 as much as possible because I2 was the best connection…)
- Consequences:
    1. Synergy (It has forced people to work together…) (One plus one equals three, that's the definition of synergy…)
    2. Complexity in my job (…it's a more complex on our network architecture, but that is not a consequence, it has created some complications sometimes…)
    3. Very emotional for people to use (It can be very emotional for people, like I said it's an expensive high speed dedicated connection and people want it, they want it to work, they want to use it when they want it, so it has emotional attach to it…)
    4. Guiding manufacturers and providers (we started telling the manufactures where their problems were…)
- Concerns:
    1. Complexity in my job and emotional for people (If it is not working and, somebody will eventually find out, it adds complexity, and we always have to keep an eye on it…)
    - NO NEED MORE INFORMATION
    - Recommendation: Make it more marketing oriented

P3

- Production and Research separation (, I was in charge of the early adoption of ipv6 at Texas A & M, creating a small network that is network that works separate from the production network)
- Research use of Internet2 (Another aspect of internet2 is that I am involved with is as a user a bandwidth user through the research work I do so that the services that Texas A&M provides to the atmosphere sciences community) (right now we are the second largest user on campus of bandwidth overall and the largest Internet2 user)
- Changes in protocols (changes in protocols, in development of new protocols)
- QoS Discussion (the idea of adopting increased bandwidth instead of doing quality of service work is more practical in pragmatic approach to handling quality of service)
- Influence and advancement (think the Engineering associated with the learn network, The LoneStar, Education and Research Network has drawn from that experience and capitalized on it, so A & M having to be involved to learn the two experiences were certainly incorporated, they were not forgotten) (We come back to capitalization within the networking at A & M here you can see changes, the implementation of Voice over IP is a good example, we have a number of organizations here with Voice over IP for their telephone, that would not have happened if we had not seen the work come out of the working group at Internet2).
- Not clear what I2 is (I think the social change has been a number of researchers unfamiliar with networks, bandwidth and communications requirements, have heard of Internet2, and have decided that they got to have it even if they don't know what it is)
- Guiding manufacturers and providers (We can contrast that with let's say, University of Texas sought what the Voice over IP installation originally in their business school based on sales information from CISCO, and lost almost a full semester of productivity because it didn't work right. This was the early days of Voice over IP).
- Consequences:
    1. Development of Protocols (see above-change in protocols). Desirable, Anticipated, Direct.
    2. Capitalization of experiences and research in LEARN (see above-influence and advancement). Desirable, Unanticipated-Unexpected, Indirect.
    3. Assumptions on researchers (see above-not clear what I2 is). Undesirable, Anticipated, Direct.
    4. Capitalize on VoIP-ITEC (see above-influence and advancement). Desirable, Unanticipated, Direct.

5. Better connectivity to extramural collaborators (I have, I do have better connectivity to external collaborators in other applications users). Desirable, Unanticipated, Direct.
6. Investigate sales claims (We investigate the sales and marketing claims, we don't always believe them). Desirable, Unanticipated, Indirect.
7. Videoconference as teaching tool (for the distance education, I believe there are positive consequences, so I think that is a very good thing. It allows us to reach more students, the students appear to appreciate it, and if they don't have to come to a regular, frequent order institution to take their classes, they can get the same contact from the class that they would get from seating in that classroom in most cases). Desired, Anticipated and Direct.

- Better service-production (No, I know I am better connected because I can track outages on the commodity Internet, those outages on the Abilene network, we actually have fewer service outages on Abilene) (I go back up to better reliability, high bandwidth by collaborators at other institutions, and it offers me an opportunity to play…) (It provides us with a better avenue for reliable communication and data communications)
- Concerns:
    1. Political Concerns (…even the Internet2 engineering staff are involved in a lot of the political level discussions and decisions, and I believe that has some effect in some of the outcomes, overall I think the Internet2 concept is a good idea and needs to be nurture).
    2. NLR Merge (…I don't believe the two organizations could have ever met and that we put a lot, we Internet2 put a lot of effort into, trying to get NLR to join forces with Internet2 when once again no one looked at the actual social interactions that we had to occur to that to be successful…)
    3. Lack of researchers (…I really wish we had more Internet2 research, more faculty members interested in identifying and participating research of Internet2, it's been very difficult finding collaborators for a number of ideas that I had…)
- Recommendations:
    1. More engagement (We probably need to see more of the faculty, more of the research oriented faculty attending both, the members meeting to get an overview, a broad overview and to joint-techs meetings to get a hand on the pragmatic aspects of the researching network).
    2. It would probably be useful to create an Internet2 working group at Texas A & M, just of interested faculty to be able to throw ideas about, and seek collaboration, something like a brown bag lunch affair.
- No more information (Probably not, I think I've got access virtually to all the information I need)

P4

- Personal concerns (I attend the meetings in order to create relationships and get contacts. In order to increase communications with people all over the world)
- Not clear what I2 is but transparency of it (Average juniors don't have a clue of what I2 is "and they don't need it").
- Videoconference as teaching tool (Everybody knows what TTVN is and I2 is the backbone…) (We wouldn't be in the videoconference business without it. It constitutes the I2 top use)
- Good communication among IT people (Dr. XXX has done a very good job communicating and informing the upper administration in order to support resources…)
- Better services for R&D (I2 is consistent with the mission, it reestablished priorities in research and education).
- Research use of I2 (Second top use application for access to supercomputing) (Researchers share large amounts of data making use of more bandwidth) (Researchers demand same resources as if they were in their home campuses-Doha)
- Transparency of Internet2 (Day to day faculty would use email without knowing it might go over Internet. There is transparency for service for videoconference as well)
- Consequences:
    - Increase Connectivity (see above). Desirable, Anticipated, Direct.
    2. Increase Capacity (see above) Desirable, Anticipated, Direct.
    3. Dedicated Capacity (see above) Desirable, Anticipated, Direct.
    4. Enhanced Communication (see above) Desirable, Unanticipated, Indirect.
    5. Helps ensure faculty access (see above) Desirable, Unanticipated, Indirect.
- Concerns:
    - NLR Discussion (Death of the merge and not because of technology but because political problems, both very different cultures and perceptions. NLR perceive that I2 is not innovative anymore but just service oriented, too political and too bureaucratic. I2 perceive that NLR have no production emphasis projection, that is, it is not production ready. In addition, the two leaders have huge egos) (It won't be salvaged at CEOs levels but at presidents and provosts)
    - Lack of research (I2 has been so successful that we need to do something else than VoIP or Videoconference)
    - Need of communication (There's a need to state where is the benefit of it. There is a lot of lack of communication and leadership is not understanding the significance)
    - International potential (potential of more international emphasis)
    - No more information (I have all the information I need)
    - Recommendations:

- People need to understand how I2 is related to you.

P5

- Not clear what I2 is (I2 is confusing to a lot of people…) (Most people don't understand I2, some do not know anything about it)
- Need of communication (That's why I feel the need to promote it better) (That's a shortcoming of this campus, not to promote it).
- Production use of Internet2 & Transparency of Internet2 (Abilene, People don't know they are using it because technology makes it transparent. I don't think they need to know.
- Research use of Internet2 (User group in collaborative projects)
- Lack of research opportunities (I don't personally think we have the same number of researchers involved at A&M than other peer institution).
- Collaboration (I am participating on a 2% of a lot of diverse groups and there's a lot of collaborative opportunities for people in this university…)
- Videoconference as teaching tool (I think the biggest change from support directly associated with Abilene is Videoconferencing…Any VC that is to another university outside A&M is over I2)
- Better service-production (The commodity Internet does not work reliably for real time applications such as videoconferencing)
- Consequences:
    1. Benefits of Network Design and Technology. Desirable, Anticipated, Direct.
    2. Collaborative opportunities (Personally I have benefited from the collaborative opportunities and efforts in my knowledge, experience, awareness) (The working groups were not planned, they just evolved from social networks). Desirable, Unanticipated, Indirect.
    3. Videoconference application. (We were expecting the Abilene to solve the problem of IP videoconferencing…). Anticipated, Direct and Desirable.
- QoS Discussion (QoS has been disappointing… it is suffering for coming to consensus or agreement…there are two kind of users with different wants and needs, the research type and the production…there are different ways of solving the problem, throwing more bandwidth at the problem, and they have been able to do that or QoS. You can overcome QoS with massive amounts of bandwidth).
- NLR Discussion (Created a network infrastructure to solve disadvantages of the Abilene network)
- Concerns:
    1. NLR (I have concerns with the conflict between NLR & Internet2…The merged has been blown up…It would be better to focus on getting the merger back on track).

2. More engagement (Engaging researchers, better job promoting the applications for example at the TTV conferences…) (A lot of potential on bringing more researchers because collaboration is an aspect of grants that is evaluated)

- No more information (I don't need more information. I know where to go…)
- Recommendations:
    1. We need to do a better job on promotion. The Internet2 day once a year is not enough, it should be an ongoing thing.
    2. To UCAID, the message is try this NLR & I2 merger work and capitalize on what Internet cannot offer…

P6

- Need of engagement & Need of communication. (We do a lot of technology integration because researchers don't look outside their own discipline. We look at different disciplines and do that. If we cannot find the solution, then we create the solution. We do the engineering, the research, and the development).
- Collaboration. (The most important thing of Internet2 is the people networking rather than the physical IP network).
- Lack of researchers (If I find something of interest to the university, I will nurture the participation until I find a champion in campus. The champion takes over and then I go back to something else) [A champion is somebody who's willing to spend extra time, in a particular focus area, usually because the extra time benefit is going to significantly influence their own research/specialty are. He volunteers, he proselytize (he would go to another university and do presentations and invite…)]
- Need of engagement and Lack of researchers. (It's hard to find champions) (Application projects are scarce)
- Not clear what Internet2 is. (A lot of ignorance on this campus. Most researchers in campus are ignorant about how the topology works and how the connectivity works. They very often ask to me if they can get connection to Internet2 and I respond "you got one")
- Need of communication (A lot of people use Internet2 who don't realize the criticality and that it depends on I2) (Internet2 is probably the largest unrealized asset that the campus has and people use it everyday and just don't know about).
- Better service-production & Research Use of I2. (Internet2 is a long-haul high speed capacity network, a high speed research network)
- Guiding manufacturers and providers (It has significantly affected the cost of the communications by bringing it down because we built multiple consortia) (The cost demand, the cost requirements were really going up and if you tried to negotiate as individual university, you were screwed but 20 or 30 of the regional

universities could beat up the regional provider then you get a much better deal and then you start doing that on a national level)

- Consequences:
    1. Building consortia
    2. Funding. 7.5 million dollar for the funding of the LEARN backbone.
    3. This is supposed to be K-20 not just higher education
    4. Cost reduction (unanticipated)
    5. Success of Internet2 beyond expectations, specially on the side of the health science centers and memberships through the SEGP (unanticipated)
- Lack of teaching opportunities at TAMU (The departments of education haven't caught up with Internet2) (Some things we do in K-12 or K-20 is will be the bridge between a particular school district and say mechanical engineering and leave the college of education out completely because the school district has gone through the College of Education and they are not ready to do a program on that area…)
- Concerns:
    1. Politics and Internet2 at the mantra level are very hard. A number of key people have left because of the politics. Dr. XXXX is very set in his academic focus. The leadership can be very set in the academic focus. It took a while to convince about incorporating K-20 and medical education. (NLR consists of CIOs and Internet2 of primarily presidents. NLR board members are elitists as hell and did not want other players in. XXX has a massive ego so I am not sure if they (NLR and I2) ever come together.
- International Impact. (Internationally, the relationship with CUDI spin off through I2).
- I don't need any more information about Internet2
- Recommendations:
    1. Increase the average university employee's knowledge about it.
    2. An improvement would be a university sanction: "This is a good resource, go after it". We need a mandate. Maybe as part of the orientation for every new staff member, every new employee and every new freshman.
    3. To Internet2, get back to the basics, get back to the applications. It's a proven fact, I2 is not a networking research backbone anymore. For that is the NSF-GENI (multilambda). The philosophy is now: What are the applications you want to run and how does the network need to change and evolve to support the applications instead of we built I2 and vBNS and we dragged applications to it. Internet2 can be and integral part of it.

P7

- Not clear what Internet2 is. (The line between Internet2 and the Texas A&M internal system resource network is very blur) (There's a very blur line between what really is Internet2) (Internet2 is really a consortium of universities and business and other organizations who promote the use of reliable, high-bandwidth so when we are talking about Internet2, we are more talking about people rather than infrastructure in a lot of cases, and that's my philosophy when looking at it)
- Videoconference as a teaching tool. (And one of the things that I2 has allowed us to do is to have more bandwidth, more reliable bandwidth to do videoconferencing and other associated instructional technologies that we support like streaming video which may not use as much bandwidth as videoconferencing but still there's the reliability factor in there). (The infrastructure of Texas A&M TTVN covers pretty much the entire state of Texas with reliable high-bandwidth and this gives access to all campuses to Abilene). (Almost 100% of Videoconferencing at TAMU is IP based either traveling on our own network or Internet2 or Commodity Internet. We just keep 3 ISDN sites in campus)
- Concerns about free usage. [All our staff, faculty and students have access to this high-speed reliable network (even if they are using for downloading videos and music)]
- Influence and advancement. (We have another step forward and that is LEARN which is a consortium of 33 institutions in Texas and theoretically another Internet2)
- Transparency of Internet2. (Obviously, there are research entities who use the Internet2 capabilities…In some cases, they might not be aware they are using Internet2…)
- Need of communication. (There must be a central website or something like which has Internet2 projects on our organization with investigators. Computer Services might know where huge amounts of data are coming from…)
- Better service-production. (There's been an increase of confidence in Videoconference and probably data transfer meaning no slowdowns) (No more complains anymore of slowdowns from the teachers)
- Consequences:
    1. Planning for the future (Desired, Anticipated, Direct)
    2. Matter of prestige (Desired, Anticipated, Indirect) Good reputation for A&M with high profiles as far as Internet2 such as Walt and Willis
    3. Confusion and misconception (people thinking we have unlimited resources) (Undesired, Unanticipated, Indirect).
- International impact of I2. (It has opened up a lot of capabilities, for example, the connection between College Station and Qatar)
- I've got a very good stream of information. I don't need more.
- Concerns: NONE

- Recommendations:
    1. There could always be more promotion of the University's capabilities so that faculty members know what can be done and cannot be done.
    2. It's a matter of education and promotion.

P8

- Need of communication & Need of engagement. (Few people know about Megaconference and Internet2 meetings)
- Videoconference as a teaching tool. (As a part of my job I needed to know about very important issues affecting distance learning and particular videoconference, QoS and that type of thing).
- Better service-production & Research Use of Internet2. [My understanding is that it is a much bigger transport pipe dedicated to education institutions in particular for large research I universities but not exclusive to that and transport of data (video, voice, or whatever)].
- Need of engagement. I have attended Internet2 subcommittees where conversations were much more technical that I can keep up with.
- Collaboration. I've seen through Megaconference (and junior) that there is a true pulling together of national stakeholders
- International Impact of I2. They are also bringing in Europe and all over the world.
- Better service-production. Increase of participating in the cause on a nation-wide level to bring a higher quality service on the nation.
- NS Discussion. NLR is a hot potato
- Consequences:
    1. Nationwide collaboration. Desired, Anticipated, Direct
    2. Powerful networks. Desired, Anticipated, Direct
    3. Competition. Desired (something good for the consumer) and Undesired (as stakeholder), Unanticipated (short term) and anticipated (long term anticipated), Indirect.
- Universities, colleges, and schools can have their own pipes (away from the public) for teaching, learning and research.
- Concerns:
    1. The have and have nots. people stay out because they can't afford it since colleges and K-12 schools are penny pitchers.
    2. NLR Discussion. (Perhaps it would be a big concern. A potential in partnership is thrown away because they cannot come to an agreement.
- Transparency of Internet2. Good to keep technology in the background. The wires in the back, as a user you don't need to know about that.
- I don't think so. I know where to get information. I've been into their website often.
- Recommendation:

- Perhaps it would be helpful to have individuals who are involved in I2 to get the word our, something like “this QoS is brought to you by Internet2” in order to understand the impact.

P9

- Better service production (We have the access grid node with uses multicast over I2. We use it in order to have research meetings with other students and faculty at other universities).
- Research use of Internet2 (… and then we have a project called optiputer (based on optical networks). (I expected stability and persistence from Interent2 based on my experience with vBNS. Stability depending on the usage and not competing for the bandwidth. And persistence is availability whenever you want to use it. It was a big pain schedule at vBNS). (Internet2 has made available distributive computer resources. Now, in addition to computer resources, you have data resources, and you have also collaborative resource). (Prior to I2, you didn’t have the bandwidth needed –for what is stated before in this paragraph).
- NLR expectations (When we get in place the LEARN network to connect to NRL, we’ll go through that in terms of the protocols and services)
- Concerns of better services (A&M is part of the LEARN network and so that interconnecting the sites at multiple locations based on I2, but its supposed to get optical links between the sites).
- Consequences:
    1. Collaboration. Desired, Anticipated, Direct. People and places (indirect)
    2. Data. Desired, Anticipated, Direct.
    3. Computing. Desired, Anticipated, Direct.
    4. Dynamic Low Balancing. Desired, Anticipated, Direct.
- Concerns:
    1. Placing of higher load on researchers: (For the publications, there is no need to go anymore to the library, there are no excuses for not to participate). (At one point when you said collaboration, it meant you had to be in the same room having a discussion. So if you couldn’t make it to a meeting, you couldn’t participate. Now, you can’t say that so you become connected all the time.
    2. Concerns for future advancements. (I think I2 is good, the question would be what’s next? Perhaps more integration, better administration of the bandwidth, on the side of decision process.
    3. Cost (It will become an issue when it comes to home usage)
- Influence and advancement and NLR Discussion. (Here’s the interesting thing, you have I2, which is the services, and you have NLR, which is the layer. The conflict between the two is because of personality and egos at a point of time when they should be working together because if they don’t start working together somebody else will and then they’ll become outdated.
- No more information (I know where to get the information)

- Recommendations:
    1. I2 must work with NLR. It's a shame…

P12

- Need of communication & Not clear what I2 is. I don't see anything that I directly recognize with Internet2. What I use is Internet
- Not clear what I2 is. It's just too amorphous; I don't know where the first generation ends and the second starts. I've never seen anything offered to us as a different service or different resource. We are busy enough utilizing the current Internet and I never went beyond.
- Need of engagement. I feel unaware and I wonder if there's more to it and I am just unaware. Is it my responsibility to find them? Or A&M's?
- Political concerns. (If the university is involved with public dollars, if its going to end up controlling resources, I guess I could be concerned). (Who is in charge?)
- Yeah, I need more information.
- I have to confess I was aware of I2 days but didn't attend.
- Need of communication. (I don't know where the Internet2 services are offered. Is it other kind of connection? Do I need a special wire to my desk?)

Initial general Categories (Second round)

Category 1. Transparency of Internet2
Definition: Internet2 is and should be transparent to the end user.

Category 2: Not clear what Internet2 is
Definition: People don't understand what Internet2 is

Category 3: Influence and advancement
Definition: Internet2 advancements and technologies permeate inside and outside the realm of Internet2.

Category 4: Need of engagement.
Definition: Internet2 must engage more people.

Category 5: National Lambda Rail (NLR) Discussion
Definition: National Lambda Rail should (or not) merge with Internet2.

Category 6: Need of communication
Definition: The word and promotion of Internet2 should be better addressed

Category 7: Better service-production
Definition: Internet2 (infrastructure or advancements) is used for production services

Category 8: Videoconference as a Teaching Tool
Definition: Internet2 is used for videoconference as a teaching tool

Category 9: Research Use of I2
Definition: Internet2 is used as a research tool

Category 10: Quality of Service (QoS) Discussion
Definition: Quality of service is not implemented or limited implemented (inside A&M) not for technology reasons but for political reasons.

Category 11: Collaboration
Definition: Internet2 has enable unprecedented collaboration among universities

Category 12: More complexity in my job
Definition: Internet2 has made more complex my job

Category 13: Guiding manufacturers and providers
Definition: Internet2 is influencing manufacturers and providers in the design and implementation of technologies and their cost.

Category 14: No need of more information
Definition: I don't need more information about Internet2

Category 15: Political concerns
Definition: I dislike the level of politics and bureaucracy in Internet2

Category 16: Lack of researchers
Definition: There is a need of research and researchers in Internet2

Category 17: Concerns for the Future of I2
Definition: We have Internet2 now but what's next? We don't have clear the direction.

Category 18: International Impact of I2
Definition: Internet2 has impact and potential for collaboration at international scale.

Category 19: Concerns about free usage
Definition: I have concerns about the way Internet2 is used

APPENDIX D

AUDIT TRAIL

Audit Trail of General Categories of Analysis

Category	Definition	Participant referring to the category
Category 1: Transparency of Internet2.	Internet2 is and should be transparent to the end user.	P1, P2, P4, P5, P6, P7, P8, P10, P11, P13, P14, P17.
Category 2: Not clear what Internet2 is	People don't understand what Internet2 is.	P1, P2, P3, P4, P5, P6, P7, P12.
Category 3: Influence and Advancement	Internet2 advancements and technologies permeate inside and outside the realm of Internet2.	P1, P2, P3, P6, P7, P9, P10, P17.
Category 4: Need of engagement	Internet2 must engage more people.	P1, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15, P16, P17.
Category 5: National Lambda Rail (NLR) Discussion	National Lambda Rail should (or not) merge with Internet2.	P1, P3, P4, P5, P6, P8, P9, P10, P17.
Category 6: Need of Communication	The word and promotion of Internet2 should be better addressed.	P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15, P17.
Category 7: Better service-production	Internet2 (infrastructure or advancements) is used for production purposes.	P1, P2, P3, P5, P6, P7, P8, P9, P10, P11, P13, P17.
Category 8: Videoconference as a teaching tool.	Internet2 is used for videoconference as a teaching tool.	P2, P3, P4, P5, P7, P8, P10, P15.
Category 9: Research Use of Internet2.	Internet2 is used as a research tool.	P2, P3, P4, P5, P6, P8, P9, P10, P17.
Category 10: Quality of Service (QoS) Discussion.	Quality of Service is not implemented or limited implemented (inside Texas A&M) not for technology reasons but for political reasons.	P2, P3, P5, P10.
Category 11: Collaboration.	Internet2 has enable unprecedented collaboration among universities and institutions.	P2, P3, P5, P6, P8, P9, P10, P11, P13, P14, P15, P16, P17.

Category 12: More complexity in my job.	Internet2 has made more complex my job.	P2, P9.
Category 13: Guiding manufacturers and service providers.	Internet2 is influencing manufacturers and service providers in the design and implementation of technologies.	P2, P3, P6, P8, P10, P13, P17.
Category 14: No need for more information.	I don't need more information about Internet2.	P2, P3, P4, P5, P6, P7, P8, P9, P10, P13, P14, P17.
Category 15: Political Concerns.	I dislike the level of politics and bureaucracy in Internet2.	P1, P3, P6, P10, P12.
Category 16: Lack of Researchers.	There is a need of research and researchers in Internet2.	P3, P4, P5, P6, P10, P17.
Category 17: Concerns for the Future of Internet2	We have Internet2 now but what's next? We don't have a clear direction.	P4, P9, P10, P13, P17.
Category 18: International Impact of Internet2.	Internet2 has impact and potential for collaboration at international scale.	P4, P6, P7, P8, P10.
Category 19: Concerns about free usage.	I have concerns about the way Internet2 is used.	P1, P7.
Category 20: Concerns of accessibility.	I have concerns for the have and have nots (digital divide) of Internet2	P8, P11, P15.

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