

Using Case Studies to Teach Engineering Technology

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Abstract

Employers have often communicated to the educational community the need for graduates entering the workforce who have a thorough understanding of how to integrate technologies and solve real-world problems. Critical thinking and problem solving skills are required essentials and are not optional. Currently, the focus of a typical engineering technology curriculum is aimed at developing skills for students in particular areas. While we do focus on building critical thinking skills, we often have a “silo” approach to technology education that primarily emphasizes discipline specific knowledge opposed to integrated learning across curricula. We must do more to give the student experience that is relevant to the complex problems they will face in the real world. This paper explores the use of problem-based case studies to help solve this problem.

Collin County Community College has begun using a problem-based case study approach to give students experience solving real-world problems in the new Convergence Lab. Students work in teams to design and implement solutions that combine and integrate equipment from different manufacturers as well as various types of technology to create a real solution, all under the supervision of one or more instructors and advisory council members as indicated. Students must document their design and findings, and this documentation becomes a part of the students’ portfolios.

Each project requires the students to perform several or all of the following functions:

- Survey the site, interviewing employees of the company and determining the characteristics of the problem being addressed
- Perform feasibility studies
- Design a solution
- Evaluate the design
- Test the solution
- Implement the solution
- Document the solution in a form suitable to present to a customer
- Present the solution to the class

While the Convergence Lab includes a variety of high-technology equipment ranging from ATM switches to SONET rings, to DSLAMS, a college could set up a more limited lab with available equipment to accomplish different but similar types of case study learning events. This paper details essential elements that are present in the Convergence Laboratory as well as the methodology for using those elements to accomplish the objectives of using case studies as teaching tools.

I. Introduction

The efficacy of the traditional educational paradigm where students are primarily exposed to conceptual and theoretical based instruction is being re-evaluated by members of the academy as well as from the community of industry leaders. Specifically, members representing the corporate world have opined that they have observed that recent technology graduates have considerable technical skills, but lack the experience and background in approaching and solving real-world problems. Industry leaders have also expressed the thought that the modern technologist skill-set should include technical and non-technical abilities such as communication and leadership development along with critical thinking and problem solving capabilities. In this paper, we present a case studies pedagogical framework to facilitate a project-oriented curriculum model. The convergence laboratory located at Collin County Community College District's (CCCCD) Preston Ridge Campus in Frisco, Texas, is the "tool" that we are employing as the platform to support this initiative.

II. Convergence Laboratory

The current baseline configuration for the convergence laboratory is shown in Figure 1. The laboratory design features four (4) virtual offices with their detailed description and features following below:

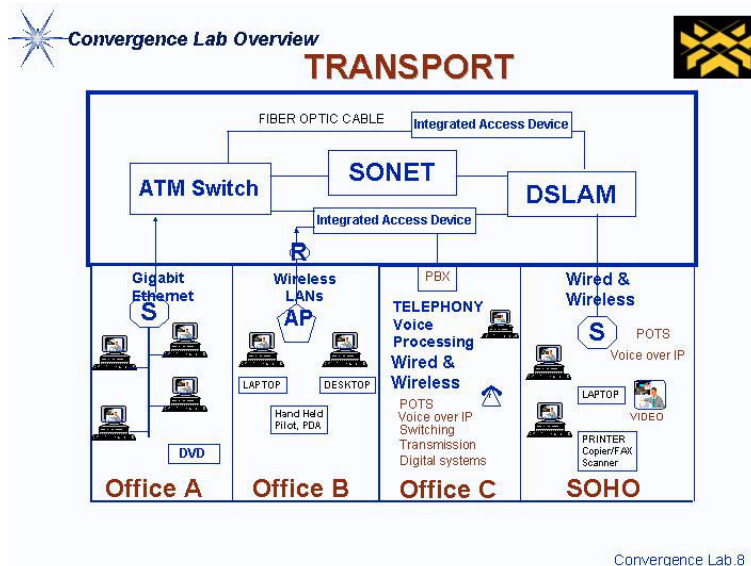


Figure 1: Overview of Convergence Lab with virtual offices.

- Office A: Ethernet LAN.
 - Various configurations and topologies.
 - Fast/Gigabit Ethernet.
 - Voice/video over IP.
 - Multimedia applications.

- Office B: Wireless LAN.
 - LAN, Personal Information Machines (PIMs)/mobile terminals.
 - 2G, 2.5G, 3G, 4G, IR.
 - Voice/video over IP.

- Office C: PBX - Hybrid Telephony – Wired and Wireless.
 - Digital telephony, VoIP, wireless.
 - Transmission, Signaling System 7 (SS7), ISDN, traffic engineering.
 - Voice processing: voice mail, IVR, auto attendant.

- SOHO: Small Office/ Home Office.
 - Switch, wired, wireless.
 - Voice: analog, digital, over IP/DSL.
 - Streaming video, conferencing, and entertainment over IP/DSL.
 - Bluetooth applications.
 - H.323/H.225/H.235.
 - POTS.

Several devices depending on the level and type of service grant access to the network^{1, 2, 3}. However, the PC allows primary user access to the network environment. There are currently twenty (20) computers in the lab each equipped with Pentium 4 processors with an operating speed of 1.50 GHz. The computers have CD ROM drives with memory and storage capacity of 512 MB and over 40 GB respectively. Each workstation has an interface box that supports several types of connectivity including Fast/Gigabit Ethernet along with individual ports for single mode (SM) and multi-mode (MM) fiber optic application. Twisted copper pair wiring at each desktop is specified high bandwidth capacity CAT 5 and CAT 6 cabling. Finally, the computers are equipped with IEEE 802.11b wireless transceivers; the Infinity Project Technology Kit fitted with the advanced Texas Instruments digital signal processor (DSP) is installed on selected computers in the lab⁴. A set of eighteen (18) laptop computers installed with wireless (IEEE 802.11b) transceivers is deployed in the data network. User access is also gained through the operation of several digital wired and wireless IP telephones^{5, 6, 7, 8}. A suite of call processing configurations is established in the database with the ability to originate/terminate calls in both wired and wireless fashion via IP, ATM, DSL, POTS, and IEEE 802.11b protocols and facilities. Two servers are used to interconnect the workstations together in a LAN environment (see Figure 2).

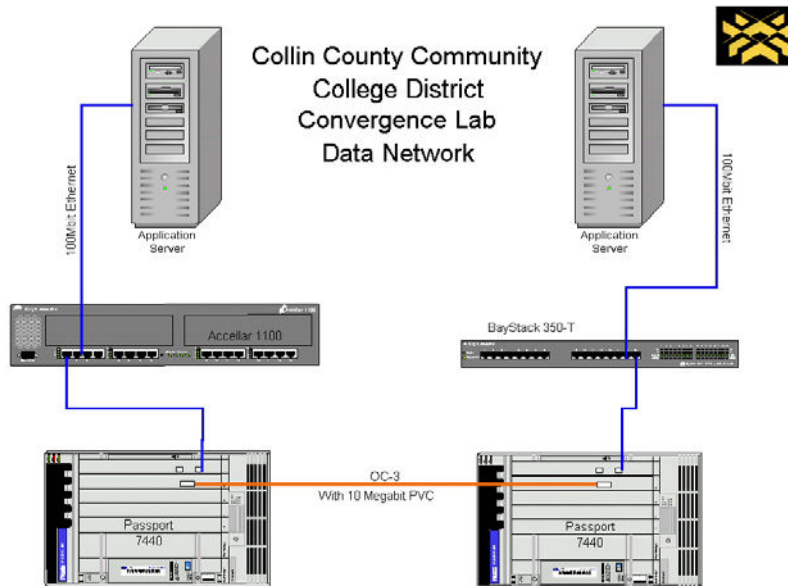


Figure 2: Server level Convergence Lab data network.

At the transport layer of service, there are a number of devices and equipment that promote both broadband and feature rich quality of service (QoS). A SONET (Synchronous Optical Network) Transport Node provides optical carrier 12 (OC-12) rings in the long haul while supporting OC-3 drops. A DSL Integrated Multiple Access System (IMAS) 2300 is the backbone for symmetrical/asymmetrical (SDSL and ADSL) DSL deployment providing services for commercial and home end users. The Passport 7440 is the enabling technology for ATM, frame relay (FR), and SONET applications (see Figure 3).

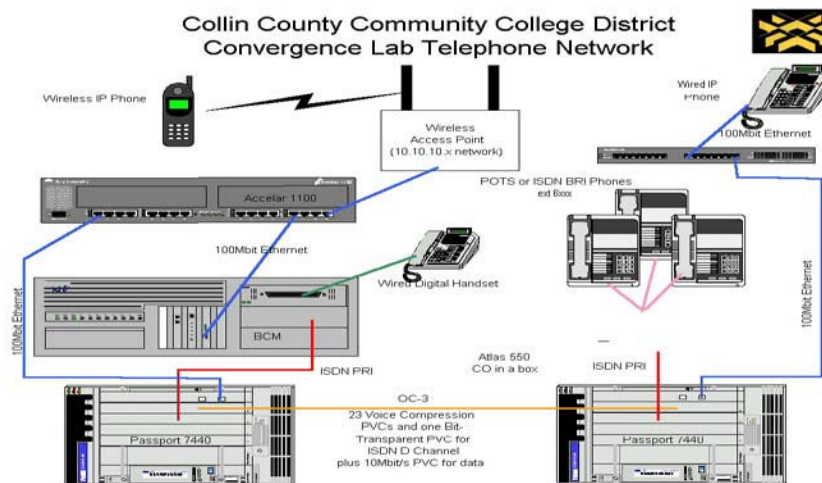
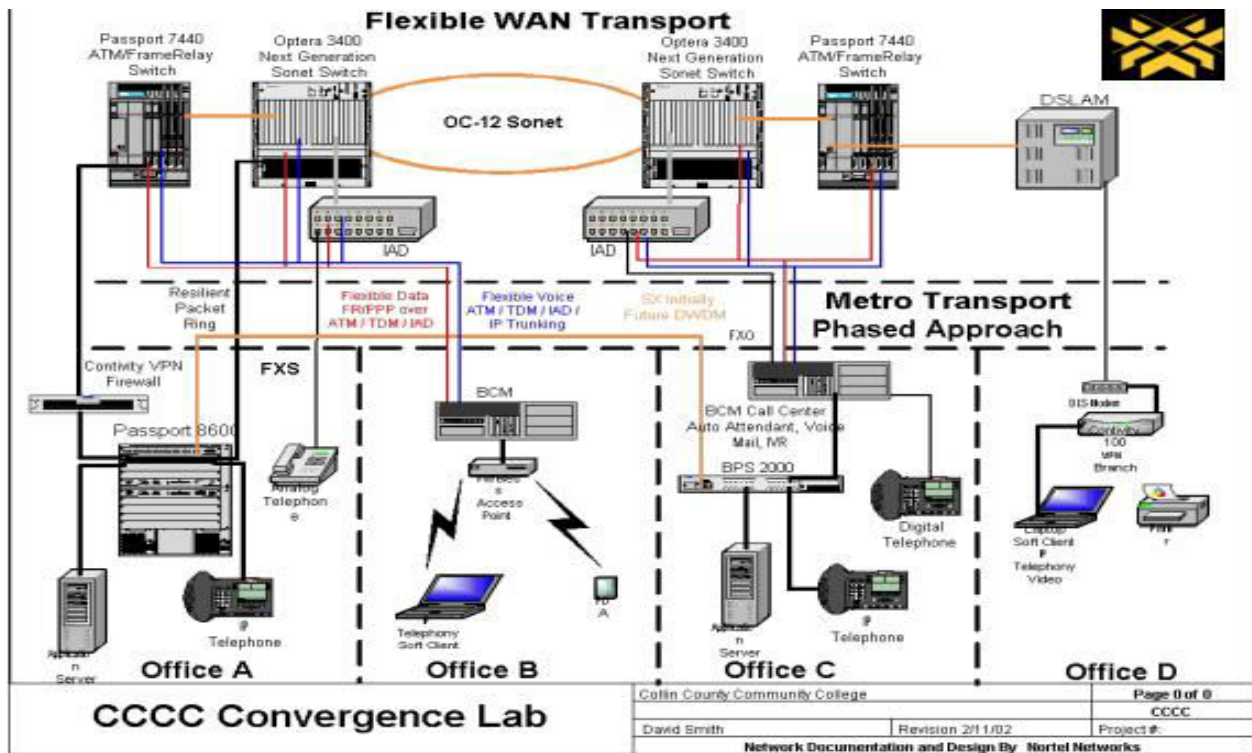


Figure 3: Convergence lab telephony network.

The Atlas 550 functions as an Integrated Access Device (IAD) where T1, Basic Rate Interface (BRI), and POTS lines can be terminated. Virtual Office C has a Private Branch Exchange (PBX); here, the Business Communications Manager offers a number of useful features including automated attendant, unified messaging, voicemail, fax, and call center functionality. Future expansion at the broadband level envisions the addition of the Dense Wave Division Multiplexing equipment (see Figure 4).

Figure 4: Convergence Lab future network expansion.



III. Problem – Oriented Instructional Methodology – Wireless Telephony

The first example of a case study employing problems based instruction is from our Wireless Telephony (EECT 2437) course in the Division of Engineering Technology. This project is entitled the *Mars Pictures Case Study*, and in this “simulation” the NASA Mars Visual – Space Discovery Group (Johnson Space Center) has contracted a company (students) to configure a Wide Area Network (WAN) that is capable of effectively and efficiently disseminating digital images transmitted back to Earth by the Mars space rover. The problem identification and charge by NASA to the company is described below:

- *Identify and converge the various networking technologies (ATM, Frame Relay, ISDN, DSL, Wireless, VoIP and Gigabit/Fast Ethernet) into a single but flexible network with the capability of efficiently delivering digital images to NASA’s associated groups in Texas and across the country within a short time frame while holding bandwidth utilization to a minimum.*

For this project, the company is required to disseminate images to the following groups that are assisting the Johnson Space Center with the processing of the rover images:

- NSF, at Washington, DC
- NASA, at Moffett Field, California
- JPL, at Pasadena, California
- Collin County Community College District, Frisco, Texas
- Texas Tech University, Lubbock, Texas
- University of North Texas, Denton, Texas
- University of Texas at Dallas, Texas
- University of Texas at Arlington, Texas
- Texas A&M University at College Station, Texas
- University of Texas at Austin, Texas
- Baylor University, Waco, Texas
- University of Texas of Tyler
- Rice University, Houston, Texas

The students identify the type of transport technology that maximizes network efficiency as seen in Figures 5 and 6 below:

Figure 5: ATM Transport Technology.

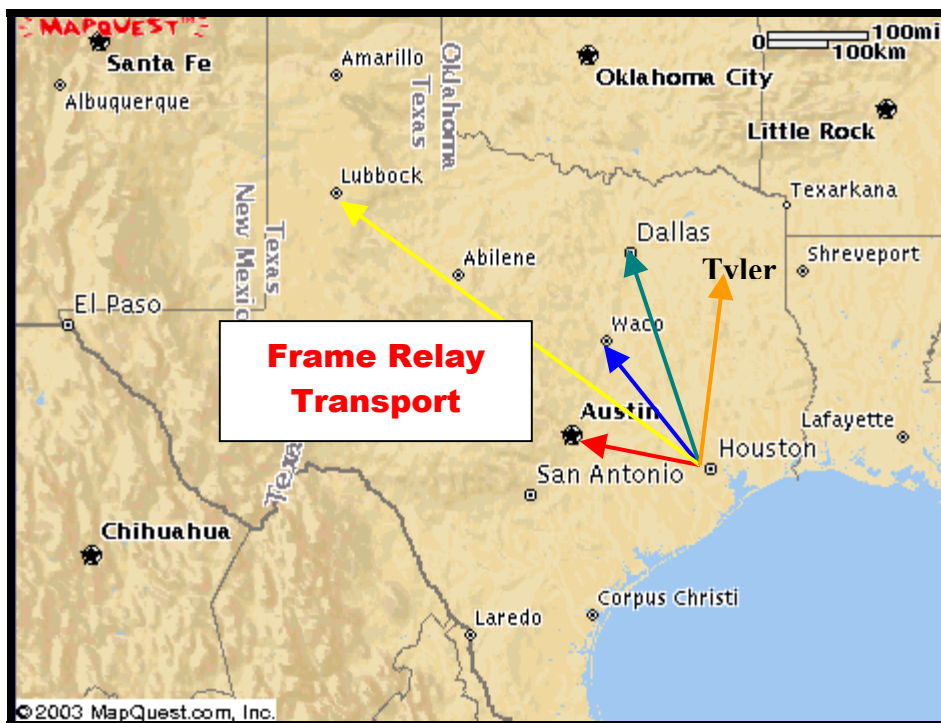


Figure 6: Frame Relay Transport Technology.

Students working in groups are responsible for the design, configuration, implementation, test, and documentation of each project component. As was commented in an earlier statement above, the convergence laboratory is equipped with the necessary baseline facilities that enable students to realize such a project. The proposed network configuration architecture for this study is shown in Figure 7.

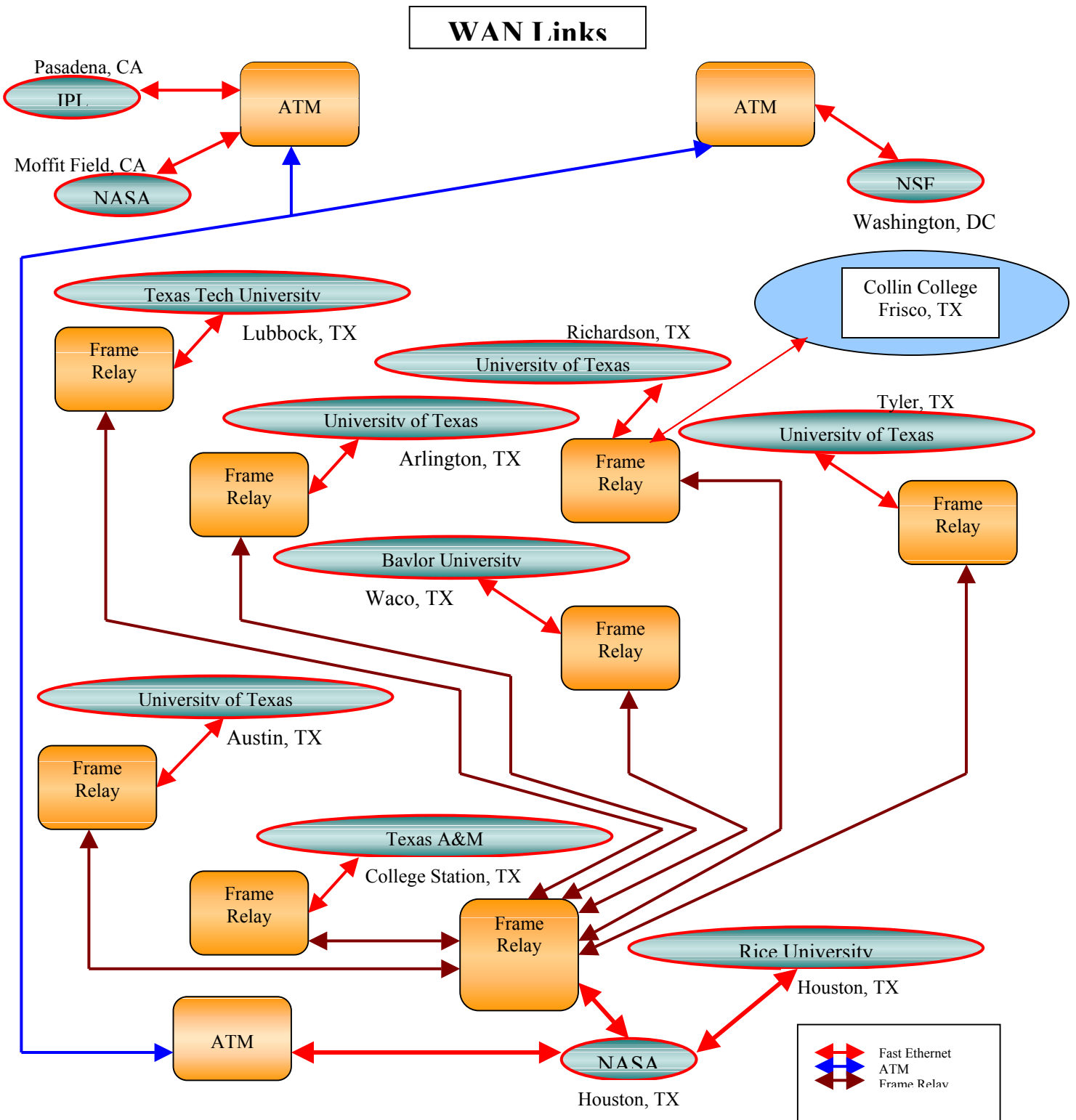


Figure 7: Network Configuration for Mars Pictures Case Study.

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IV. Problem – Oriented Instructional Methodology – Computer Aided Design and Drafting

The next case study originates from the Computer Aided Design and Drafting (CADD) area (DFTG 2319 – Intermediate Drafting). In this project, students investigate and simulate real-time distance communication issues utilizing the convergence lab. The problem identification and scenario is a company who has contracted an out of state architectural firm to create a set of CAD drawings for an anticipated business expansion in the near future. The architectural firm is located in Frisco, TX, and the contracting business main office is located in New York, but also has units in Detroit, Florida, and California that require an avenue to communicate with the architects in Texas in real-time and simultaneous with the other company units. Each of the units also requires an inexpensive means to allow their executives and engineers viewing privileges and access to the CAD files.

In preparation for this assignment, students assessed the essential elements to fulfill this project by first analyzing the type of network configuration needed specifically in terms of transport mechanisms for the files and for the real-time communication link. Dissemination of the actual CAD files is accomplished by an attachment to an email or via FTP (file transfer protocol) depending on the size of the file. For the communication link, students utilize the IP (Internet Protocol) network (Fast/Gigabit Ethernet) for the “physical” connection and employ Net meeting software to establish both voice and video capability. Within this environment, employees at the contracting firm situated at various locations across the country have the ability to interactively participate in the review of the plans proposed by the firm. Access to the AutoCAD files is made available through a freeware product known as Visio. Visio facilitates file-viewing functions recommended for the videoconference without requiring the contracting company to have a specific CAD program loaded on their computers. Here, the students have improved flexibility for their client without increasing costs significantly. Listed below is the fundamental procedure and highlights of the *CADD Case Study*:

- CADD instructor and lab prime discuss CADD problem with possible lab solution.
- DFTG 2319 (Intermediate CADD) is the course currently utilized.
- Students create CADD drawings and transport to the customer over protected network.
- Customer marks changes using software-editing tool.
- Students and customer confer through videoconference to clarify changes.
- Secure storage protects business client from competition.
- Lab checklist utilized to prepare lab with instructor signoff.

V. Conclusion

In summary, the implementation of projects based, case studies approach to technology education is a viable model to enhance educational outcomes and provide students with a more meaningful and relevant academic experience. Graduating students acquire and develop the skill-sets that corporate employers have reported to be the necessary essentials required to improve job seekers employability. The need to focus on problem-solving, critical thinking,

communication, and documentation skills has been verified through skills validation with regional industry.

While a lab as elaborate as the convergence laboratory is not required to present basic project based case studies, the convergence laboratory is the tool that we are utilizing to realize this model. It has several attractive attributes that are vital to the Engineering Technology Division at Collin County Community College: 1) The convergence lab is essential in revising and refocusing our current curricula. 2) The lab acts as a magnet and attracts current and prospective students and promotes interdisciplinary interaction. 3) The lab is also a viable platform for businesses to justify involvement with educational entities in order to form collaborative joint ventures.

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Biography

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Ann Beheler is currently dean and executive director of the Division of Engineering Technology at Collin County Community College District in Frisco, Texas. She is also the Primary Investigator for a National Science Foundation grant that focuses on convergence technology. She received the M.S. in Computer Science from Florida Institute of Technology and is currently pursuing a Ph.D. in Community College Leadership. Prior to joining CCCCD, she held director positions at both Raytheon and Novell. She has presented at numerous League for Innovation and American Association of Community College conferences regarding effectively teaching technical subject matter in the community colleges.

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Wayne A. Jones is currently associate dean and professor at Collin County College District in Frisco, Texas. He received the B.S. in Electrical Engineering from Southern University with Honors before matriculating to L.S.U. and earning a M.S. degree in Electrical Engineering where his research focused on the semiconductor physics of III-V compounds. His thesis is titled "Emitter Size Effects in InAlGaAs/InGaAs Heterojunction Bipolar Transistors".