The Integration of Technology Theory and Business Analysis: A Pedagogical Framework for the Undergraduate MIS Course in Data Communications and Networking

Michael Gendron
A.T. Jarmoszko
Central Connecticut State University,
New Britain, CT USA
gendronm@ccsu.edu jarmoszkoa@ccsu.edu

ABSTRACT

One of the fundamental challenges of information systems education within a school of business is to integrate technology theory and business analysis. Information systems as an academic discipline must contain a theoretical component, for theory development is, after all, the essence of academia. However, model curricula for IS education (e.g., IS'2002.6) have been incorporating a growing number of applied, hands-on topics. This is especially true of the undergraduate course in data communications and networking (DCN). While we do not negate the value of a lab experience in network configuration, we posit that applied DCN topics can be effectively taught via the business case method as well. Toward this end, our article proposes a pedagogical framework.. This type of framework can also be used in other Information Systems courses to maintain an appropriate balance between technology theory and business analysis..

Keywords: pedagogy, data communications, networking, network design, IS'2002

1. INTRODUCTION

The field of management information systems (MIS) has undergone many significant transformations over the last two decades. What began as a support function -- within the domain of broadly defined operations -- has become a strategic capability and an essential dynamic in business and government organizations. Originally, the main objective of MIS discipline was to train the traditional data-processing-center personnel. Although this is clearly no longer the approach, the integration of technology and business topics in MIS courses still creates tension and raises questions about proper proportions.

Information systems are complex and to design, develop, and manage them, technical as well as organizational skills are needed to ensure their success. The academic MIS discipline affords individuals the opportunity to develop that technical and organizational expertise. As an academic field of study, MIS encompasses several broad areas:

1. acquisition, deployment, and management of information technology resources and services (the information system function);
2. development of infrastructure, systems, and processes (the systems development function) (Davis, Gorgone, Couger, Feinstein, & Longenecker., 1997); and
3. the informed use of technology to enhance the competitive advantage of the enterprise (the management function).

Today these areas are integral to enterprise strategy and are vital to maintaining competitive advantage (CCSU-MIS, 2001).

The common perception is that data communications and networking (DCN) courses are primarily about technology. This is reflected especially in the content of DCN textbooks available to instructors today. Our view of the MIS discipline is that it must combine the technical and organizational foci and that future business professionals being educated today must strive to integrate business and technology topics to achieve competitive advantage for the enterprise.

The approach presented here provides for teaching business school students the following requisites:

1. the ability to analyze the business needs of an organization and apply the correct networking solutions (business modeling has been covered in prerequisite courses and is employed in the DCN course);
2. a high-level technical background that allows students to conceptualize a network and specify its components;
3. the ability to design and document a large network, and to convey that design to managers in an understandable way; and
4. the ability to work with network engineers and technicians to ensure the successful implementation and ongoing maintenance of a network.

1.1 Framework Overview

Below we propose a pedagogical framework for teaching introductory DCN concepts to MIS undergraduate majors within a business school setting. This is based on the combined experience of the authors, which spans over 45 years in the information systems industry and academia. The framework offers innovation in a) the selection of topics to cover; b) a novel juxtaposition of DCN technology theory and business analysis c) the use of network analysis and design (NAAD) methods.; and d) the focus on problem-based, case-oriented learning. Our framework's primary purpose is to integrate a thorough introduction to the technical aspects of DCN with an understanding of how networks can enhance the organization.

1.2 Curricular Guidelines

The content of IS'2002 (Gorgone et al., 2002) model curricula for undergraduate degree programs in information systems (IS) specify that a DCN course should be part of all IS curricula. That intuitively makes sense since today's information systems normally contain a network component which may determine whether a system succeeds or fails. IS'2002.6 states:

> Students who are knowledgeable of and have developed personal information systems will gain an in-depth exposure to information technology hardware and software components and their interaction. A systems view of computer systems will be utilized in identification of computer and telecommunication system components. (Gorgone et al., 2002).

If you read further, the recommendations call for a fairly large amount of hands-on training within the DCN component of the IS curriculum.

There are at least two issues with the recommended hands-on training:

1. To the authors' best knowledge, there is no established framework for teaching DCN concepts in an undergraduate MIS curriculum, and,
2. It is not clear whether the level of hands-on training suggested by the IS'2002 guidelines is necessary, desirable, or even possible for many business schools teaching DCN courses.

In this article, we propose a framework that allows business schools to educate undergraduates in the technology of networking as well in the business analysis of networking, at a conceptual level, without the need for a networking lab. For us teaching technology means teaching the theory of what technology is and teaching application means primarily teaching how technology is applied in a particular business-case environment.

The DCN course is included in all known model curricula for IS education, specifically IS'2002, on which our framework is modeled. While we believe that the level of hands-on training specified by these standards is not necessary or possibly even desirable, we do feel that the IS'2002 guidelines provide a good basis against which to measure content. DCN course recommendations for these guidelines are shown in Table 1. Our proposed framework substantially covers the recommended curriculum and extends it to include structured methods for network design.

MIS undergraduate DCN textbooks generally present technical/theoretical material well and sometimes supplement it with mini-cases, which often do not provide a unifying linkage between technical theory and business analysis. This linkage is required to meet the IS'2002 recommendations. While we believe that these recommendations provide foundational precepts on which to base a DCN course, the need to provide the type of hands-on training (installation, configuration, and operations experiences) suggested in IS'2002.6 is not supported in the literature. For example, IS practitioners feel that network-planning skills are the most important topic in a senior-level DCN course, while academics rated it third after awareness of transmission control protocol/Internet protocol (TCP/IP) and the ability to use the Internet (Johnson, Stallard, & Tanner, 1999). Our framework is designed to provide needed planning and design skills. Further, we believe that emphasizing these skills is appropriate in a business school setting.

2. PEDAGOGICAL APPROACH

2.1 Placement of the DCN Course

Before further discussing methods for teaching the DCN course in an MIS program, we would like to make some comments regarding where the DCN course should be placed within the MIS curriculum These comments are in agreement with the IS guidelines.

We assume that the DCN course is taught at the junior/senior level and that it is required for all MIS majors. Further, in many programs it is the only required DCN course. In that case, MIS students should come to the course with a strong set of prerequisites, including an MIS survey course, and at least one programming course. Additionally, students should have a general business course background and an undergraduate general education core. This allows us to make certain assumptions about their skills and knowledge.

2.2 Course Objectives

The objectives of this course are to:

1. provide an overview of business data communications;
2. discuss the impact of distributed systems on the business enterprise;
3. analyze the features of centralized, decentralized, and distributed systems
4. explore the technology implications as they relate to analysis, design, and development of distributed processing systems within the enterprise.

2.3 The Approach

Our approach to teaching DCN is driven by our experience, the IS'2002 guidelines, and our belief that students should possess both technical theory and business oriented networking practical knowledge at the completion of this course. We accomplish these goals by juxtaposing a solid technical DCN foundation along side a methodology to analyze and design a network to meet the needs of the enterprise. The technical material is fairly straightforward in that it is handled very well in many undergraduate DCN textbooks. Through lectures, in-class activities, and testing, we can be fairly sure that the students comprehend the technical material. The practice of network design is another matter since we have not found its treatment to be very complete in any of the undergraduate DCN textbooks that we have reviewed or used in class. We filled this gap by creating a simulation which require business analysis to determine network needs, juxtaposing it with technical theory so that one supplements and supports the other, and introducing students to a network analysis and design methodology which has grown from our years in industry.

2.4 The Simulation

The DCN course has been taught for many years at our university. During that time, the standards and expectations for DCN course content have evolved, and it has become necessary to add a practical component which will strengthen our students DCN business analysis skills. We have designed a business case simulation to teach the practical material for several reasons:

1. since we are in a business school, the case method is a teaching style with which students are familiar and which would be readily understood;
2. it allows students to gain experience and insight into how large assets are often procured (i.e. the request for proposal cycle discussed below)
3. it allows us to integrate technical theory and business analysis while presenting students with a real-life problem to solve; and
4. it provides an appropriate vehicle for teaching NAAD methods.

The simulation consists of a company, Ticket Sales, Inc. (TSI), which needs a metropolitan-area network (MAN) implemented using virtual private network (VPN) technology, a main office site network, several satellite office site networks, Internet connectivity for all locations, and an Internet presence. They have just received a large amount of venture capital as startup funding and have developed a request for proposal (RFP), which it has sent to a number of potential vendors (student team are formed to act as potential vendors). The RFP contains instructions that the vendors are to respond with a proposal containing a network design, cost, and other pertinent information. The specifics of this RFP will be discussed in a case being prepared for future publication.

Between the time the RFP is sent to the vendors and the time the proposal is due, two informational sessions (bidders' conferences) are held. Students submit questions in advance of the bidders' conferences (BC). The course instructor uses those questions to prepare a brief presentation, which is used to start the BC. After the presentation students are allowed to ask questions pertinent to the topic of the conference. Table 2 shows the flow of this process.

Table 1 - DCN Course Recommendations from IS'2002

Catalog	Principles and application of telecommunication and computer systems hardware and software will be presented through lecture, installation, configuration, and operations experiences.
Scope	This course provides an in-depth knowledge of data communications and networking requirements, including networking and telecommunications technologies, hardware, and software. Emphasis is upon the analysis and design of networking applications in organizations. Management of telecommunications networks, cost–benefit analysis, and evaluation of connectivity options are also covered. Students learn to evaluate, select, and implement different communication options within an organization
Topics	Telecommunication configurations; network and Web applications; distributed systems; wired and wireless architectures, topologies, and protocols; installation, configuration and operation of bridges, routers, switches, and gateways; network performance tuning; privacy, security, firewalls, reliability; installation and configuration of LAN and WAN networks; monitoring of networks; management of telecommunications; and communications standards.

Students are randomly placed into teams, which act as vendors that are to respond to the RFP. They are told they can make appointments with the company representative (the course instructor) to ask questions and solicit information as well as have time at the bidders' conference to do so. More details about the simulation are presented below.

Table 2 -RFP Cycle

Week 1	Week 4	Week 8	Week 16
Students given RFP first week of class.	First BC and Q&A about industry.	Second BC and: Q&A about technical needs.	Final proposal due.

2.5 Course Evaluation
Course evaluation is summarized in Table 3. Evaluation is done through a large group project, several assignments, and two multiple-choice exams. The large group project allows us to evaluate the students' ability to move from a businesses problem to a business solution and allows students to develop teamwork skills. The assignments reinforce concepts taught in class and allow us to evaluate student progress through the course material as well as their understanding of the NAAD process. The two multiple-choice exams (midterm and final) evaluate students' grasp of technical theoretical concepts.

2.6 Modules
The course is broken into modules with two concurrent threads: the first thread is composed of technical material, and the second is composed of network business analysis techniques taught by applying NAAD to the simulation. The threads are coordinated so the student is presented with the theory that is necessary to understand the applied material. These are both reinforced by assignments and supplemental materials developed for this course.

One to two weeks is spent on each module; however, it is often necessary to modify the amount of time spent on any one module, depending on the mix of student technical ability. Technical material is presented using a networking and telecommunications textbook,[2] while the applied (business analysis) materials and assignments are based on NAAD methodology material developed specifically for this course.

[2] *Business Data Networks and Telecommunications (Panko, 2002).*

Table 3 - Course Evaluation

Evaluative Component	Used to Evaluate…
Semester Project	Ability to move from a business problem to a business network solution.
Assignments	Currency with and understanding of course concepts.
Midterm Exam	Specific technical concepts.
Final Exam	Specific technical concepts.

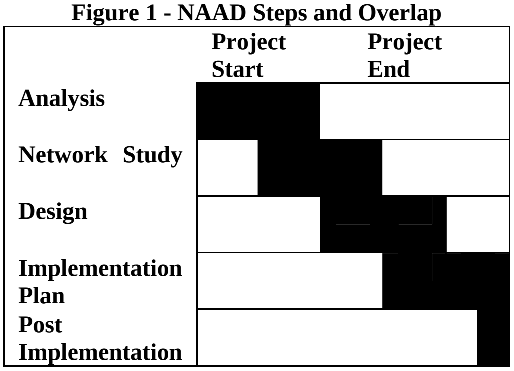
3. NETWORK ANALYSIS AND DESIGN

If we look at the advances in systems analysis and design over the past 30 years, we see several methodologies that have emerged. (Chen, 1976; Iivari & Koskela, 1987; McGregor, 1998; Yourdon & Constantine, 1979) Today, it is common to see large systems diagramed using data flow diagrams (DFDs), entity relationship diagrams (ERDs), or unified modeling language (UML) to name but three methods (Dobing & Parsons, 2000). The established diagramming techniques have symbolic representations for their constituent parts that allow systems analysts to quickly understand the design of a system, even if they did not create the original diagrams. This sort of standardization is needed for network design. While this article does not include a discussion of an actual symbolic language for network design, it will introduce NAAD techniques for the creation of business-oriented networks. NAAD has its roots in systems design theory and is a technique we have developed and adopted for network design instruction.

Network analysis and design comprises a set of techniques we teach that includes business analysis, study of technical networking needs, design of topologies and configurations, and development of an implementation plan. These skills will allow a student to determine enterprise requirements and to create a realistic and implementable design. NAAD is presented in a series of steps, which may appear like a waterfall approach, but in reality there is a fair amount of overlap, as seen in **Error! Reference source not found.**. A brief description of each step is given below.

3.1 Analysis
The analysis step requires that students understand the company in the simulation (TSI) and the industry TSI is a part of (automated retails ticket sales). A successful network design must take into account the general needs of the industry as well as specific needs

Figure 1 - NAAD Steps and Overlap



and characteristics of the company. Using the RFP, the first BC student should document a thorough description of TSI, including locations, number and type of employees, and characteristics of the facilities. Additionally, several standard business-modeling tools are used to analyze company needs and to develop a background on the industry. Students must create competitive forces (Figure 1), value chain (Figure 2), and supply chain models (Figure 3) and do a comparative strengths, weaknesses, opportunities, and threats (SWOT) analysis (Figure 4). The utilization of those models in the network design process is summarized in Table 4. While some of the models may seem to be manufacturing related, they can be easily modified for the service or professional enterprise.

The simulation involves the retail ticket sales industry, and students are given the names of the three major competitors of TSI. Student consulting companies do research on the retail ticket sales industry and the competitors. They use this information to create the models. They also have the RFP, which includes some information about TSI and its facilities. In addition, the first BC focuses on these issues.

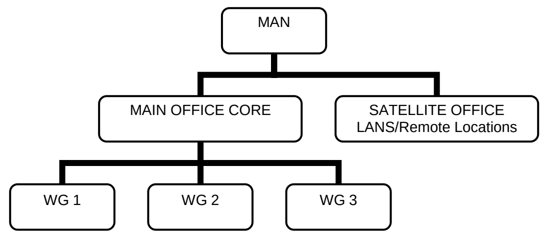
Students report that using the business models greatly enhances their ability to conceptualize TSI's needs and to develop network specifications. In the experience of the authors, design submissions for TSI greatly improved with the use of these models.

3.2 Network Study

During the network study step, students develop inventories and hierarchies, determine support and ongoing maintenance requirements, and develop growth and upgrade projections. The inventories include lists of network services (e.g., printing, file services, database services, client- and server-based applications). These are listed by location. Before the actual design is performed, a hierarchy is developed. **Error! Reference source not found.** shows a sample for TSI. The MAN is on the top of the hierarchy because it connects all the other locations together; it also provides Internet connectivity to all locations. The main office has a core and three workgroups, and the satellite offices are shown only once since they are all identical. If satellite office had different network configurations they would be shown separately on the hierarchy.

Bandwidth needs are calculated by location, and decisions are made regarding the level of connectivity necessary. Once that is complete, communications topologies can be selected (e.g., Ethernet, "T" services, digital subscriber line {DSL}). We do not list workstations or servers in this diagram, but the backbone for interconnecting sites (cores), satellite locations, and workgroups (WG).

Figure 2 - Sample TSI Network



4.3 Design

The first step in developing a design is to decide on a nomenclature for the network, that is, how things are going to be named for ease of identification and later troubleshooting. Students must decide how to name locations, equipment racks, cable drops, wall jacks, communications hardware, workstations, and servers. A structured wiring plan is started. The specifics are completed once the communications hardware decisions are made. Bandwidth assumptions are reaffirmed. Preliminary design documents are created, subject to change after hardware is selected.

For TSI, hardware is selected to support the topologies, network services, desktop workstations, printing, and additional online and offline storage. Decisions are made about the location of all equipment, locations are assessed for necessary AC power, and selections are made for equipment racks, uninterruptible power supplies, extra cable runs, virus protection, network management software, and backup solutions.

The decisions made regarding hardware, software, topologies and their implementation, and other components are used to create design documents—one design per block in the hierarchy. Students are shown samples of network designs and given some simple rules to use in their own design projects. These rules include that:

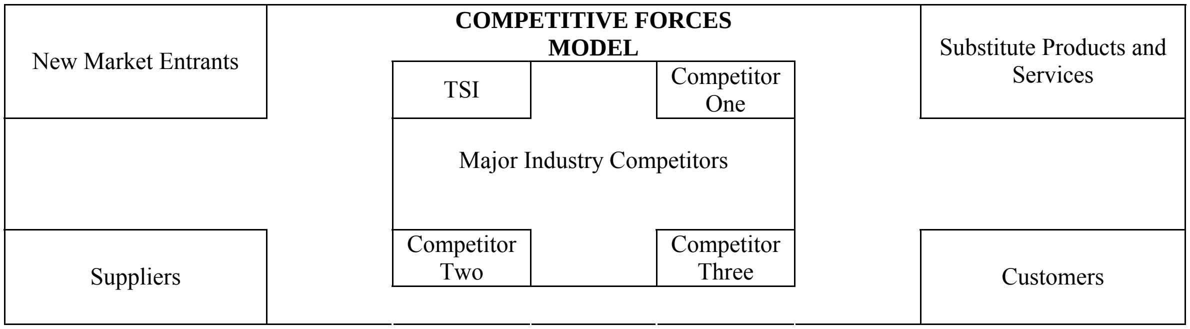


Figure 1

Sample Value Chain Model					
Support Activities	Administration and Management				
	Human Resources				
	Technology				
	Procurement				
Primary Activities	Inbound Logistics	Operations	Sales and Marketing	Service	Outbound Logistics

Figure 2

Supply Chain Model				
Supplier	Manufacturer	Distributor	Retail Outlet	Customer

Figure 3

Comparative SWOT Analysis					
	Major Competitor 1	**Major Competitor 1**	**Major Competitor 3**	**TSI**	**Comparison of TSI to Competitors**
Strengths					
Weaknesses					
Opportunities					
Threats					

Figure 4

Summary of Business Model Utilization		
	Identification of …	**Network Analysis Usage**
Competitive Forces Model	all stakeholders	assist in making recommendations that will enhance competitive advantage
Value Chain Model	departments and processes	promotes recommendations that can enhance value propositions influenced by network design
Supply Chain Model	major stakeholders	assist with making supply chain management recommendations
Comparative SWOT Analysis	strengths, weaknesses, opportunities and threats of the enterprise and its major competitors	facilitates recommendations that will enhance competitive advantage.

Table 4

1. all locations, racks, and communications, desktop, and server equipment must be indicated and named according to the predetermined nomenclature;
2. all cable runs must be shown from core to workgroups, from core to interconnectivity points (MAN, WAN, "T" carrier, etc.);
3. the nomenclature must be used to name everything on the diagrams;
4. communications links from blocks in the hierarchy must be numbered and connect to another diagram or a demarcation point (e.g., ISP, other organization); and
5. there must be a title block on every diagram showing the diagram title, a key to symbols used, and a key to the connections between equipment (e.g., 10/100 Ethernet, 100 Ethernet, fiber optic, unshielded twisted pair {UTP}, etc., must all appear as different line types on the diagrams—color or line thickness can be used).

3.4 Implementation Plan

The implementation plan includes a cabling list showing how the selected equipment connects together. This is used either for the company's network technician to build the network or by subcontractors.

3.5 Post Implementation

Once implementation has been completed, the network must be thoroughly tested. That includes servers, workstations, and communications gear. It might also include the testing of application software. Once testing is complete, the network is ready to hand over to the customer. At this point, information gathered during the network study about expected growth can be used to create a plan for network upgrades. While this is not an expected learning outcome in this class, it is covered so that students understand the need for follow-up to the design of a network.

4. COURSE STRUCTURE

As stated above, modules are used to break the course into easy-to-assimilate topics which makes an introduction to this highly technical area much less daunting. A brief description of each course section, summarizing its technical theoretical and business analysis material, along with a description of the assignment will be given here. The material is presented in two threads—one technical oriented and one business analysis oriented. NAAD techniques are used to emphasize and teach the business analysis threads. These can be seen in Table 5. Table 6 - describes the materials provided in addition to the textbook.

4.1 Assignments

Throughout the semester, assignments are used to maintain student currency with the analytical aspects of the course. The assignments used are summarized in Table 5.

4.2 In-Class Activities

In-class activities include bidders' conferences and reinforcement of NAAD methods. The content and purpose of the bidders' conferences are described below. The NAAD techniques taught through lecture and reinforced through assignments are also discussed.

4.3 Module 1 - Course Introduction

Technical: Students come into this course with varying backgrounds. Some have had no networking experience but desire to gain an introduction; others have had substantial experience and want to validate their "in-the-field" training; some are taking this course only because it is required within the MIS curriculum. Because of this variability, this first module attempts to create a baseline of knowledge and to make sure that students have the same understanding of core concepts.

Business Analysis: The semester project allows students to utilize knowledge gained in prior courses and in this course. At the start of the course, students are provided information about the semester project, and project teams are formed. The groups are to act as consultants bidding on a network design contract for TSI and are to submit a network design proposal using NAAD. The proposal must adhere to a specific outline, which can be seen in **Error! Reference source not found.**. The sections of the outline are discussed in class as indicated in Table 5. Students are given the TSI RFP at the start of this module.

4.4 Module 2 - Standards

Technical: Most network hardware today is based on the TCP/IP–open systems interconnection (OSI) hybrid model (Panko, 2002). This model is introduced and discussed extensively in the DCN class. If students can understand this model and the functions of its five layers, they will be better able to understand network switching and routing. Because this material is complex and usually foreign even to students with networking experience, this module will take longer to cover than the other ones; therefore extra time is allotted.

Business Analysis: In preparation for the upcoming bidders' conference, the next assignment is for students to submit questions about TSI and its industry. Questions submitted by students are to involve planning, marketing, financial, and operations areas. Once students submit questions, a class session is used for the conference; the session is opened with a

Table 5 - Course Summary

Module	Technical Thread	Business Analysis Thread *Report Section Discussed*	NAAD	Supplemental Material Distributed	Assignments *In-Class Activity*
1	Course Introduction	Introduction to semester project	ANALYSIS	Request for proposal, floor plans, detailed network design outline, sample business models	*Review of models used to understand the company and industry involved in the simulation – SWOT, value chain, supply chain, competitive forces*
2	Standards	Business needs *Introduction* and *Requirements*	ANALYSIS, NETWORK STUDY	Description of question content acceptable for first bidders' conference	Submit questions for bidders' conference *First bidders' conference*
3	Physical Layer	Design concepts *Design*	NETWORK STUDY, DESIGN	NAAD Overview	Draft of Introduction and Requirements
4	Small Single-Switch LANS	Diagramming nomenclature *Design* and *Cost*	DESIGN	NAAD Nomenclature, Diagramming	Questions for second bidders' conference *Start LAN/MAN Project*
5	Larger Multi-Switch LANS	Throughput diagramming *Cost*	DESIGN, IMPLEMENTATIO	NAAD: Bandwidth	NAAD Working Documents *Complete LAN/MAN project* *Second bidders' conference*
6	Telephony and WANS		IMPLEMENTATIO		Draft network design
7	WANs VPNs		IMPLEMENTATIO, POST		Draft implementation plan
8	Internetworking		POST		Draft hardware list and costs

Table 6 - Supplemental Course Material

Material Provided	Description
Initial RFP	This is a typical RFP that a consultant might receive for network design and implementation. It provides the basis for the semester project.
Floor Plans	Floor plans for the building described in the RFP.
Network Design Outline	A detailed outline for a network design report.
Sample Business Models	A sample of a comparative SWOT analysis, supply chain, value chain, and competitive forces models.
NAAD: Overview	An overview of the Network Analysis and Design Process
NAAD: Bandwidth Calculation	Instruction to calculate bandwidth requirements for the RFP.
NAAD: Nomenclature Handout	Worksheets used to develop a network nomenclature.
NAAD: Diagramming Handout	Guide to network design and a sample symbolic language to be used for diagramming a network.
LAN/MAN Project	Describes a company and its needs for a network within its main office and between its satellite locations. This project is used to teach nomenclature, design, and diagramming.
Slides	PowerPoint slides are available for the theoretical thread in all modules.

1. Executive Summary
2. Introduction
    a. Description of the company (TSI)
    b. Description of the industry and how the company fits into the industry
3. Requirements
    a. Industry requirements
    b. Company requirements
    c. Personnel serviced by the network and how they are impacted, by department.
4. Design
    a. Nomenclature
    b. Diagrams
        i. Enterprise-level design diagram
        ii. Core diagrams
        iii. Workgroup diagram(s)
    c. Justification narratives
    d. Cabling list (not a normal RFP submission)
5. Cost
    a. Costs for all equipment and services
6. Equipment Literature
    a. Technical literature must be included for all equipment selected. This is usually available on the Web and ensures that the instructor has the information to grade the project.

Figure 7 - Semester Project Report

brief presentation by the instructor based on the questions submitted, then students are able to ask additional. Students are urged to take notes or record the bidders' conference since it moves very fast. The goal of the first bidders' conference is for students to learn about the business needs of TSI so that they can prepare Assignment 2.

Prior to question submission and the upcoming bidders' conference, a brief lecture is given. The purpose of the Introduction and Requirements sections of the report is discussed.. The RFP gives some information about TSI, but the students are expected to research the automated retail ticket sales industry. A DCN solution cannot be properly designed until you understand the need of the industry, as well as the needs of the individual company management. The banking industry is used as an example: the industry has a need for security and is highly regulated, while an individual bank may have a specific set of needs that have to do with a document management solution they wish to use.

4.5 Module 3 - Physical Layer

Technical*:* Students are introduced to analog and digital signaling, media types, different types of transmission (copper, fiber optic, radio signaling, etc.) and various physical layer topologies. The concept of a structured cabling plan is introduced since it will be thoroughly discussed in the next module.

Business Analysis: A discussion of the Design and Cost sections of the proposal is begun, with an emphasis on design; students are given a handout which provides an overview of NAAD. Students use their own research, the original RFP, and the information gathered form the bidder's conference in the assignment for this module—they must submit a draft of the Introduction and Requirements sections of the semester project report (proposal). This assignment is the students' first attempt at documenting the analysis and study phases of the network design and development process. In the draft they are to document the following:

1. A thorough description of TSI, including physical, management, and logistic characteristics.
2. The retail ticket sales industry, including an analysis of the competition.
3. Special network needs a retail ticket vendor would have (the industry requirements).
4. TSI management requirements for the network.
5. TSI personnel impacted by the network.

These analyses are done, in part, using the four standard business models mentioned earlier (SWOT, value chain, supply chain, and competitive forces). These models are covered in detail in prerequisite courses. Once understood, they give a good overview of the ticket sales industry, the competitive nature of that industry, and the operations of TSI, which is essential to good design and implementation of a large network. Students are given the names of the three major competitors for TSI to use in the creation of these models.

Students report that using these models helps them understand TSI's DCN needs and what should be included in the final design. This is a different approach from just interviewing the company and having students determine its network needs—as consultants, students do research and make informed recommendations.

4.6 Module 4 - Small Single-Switch LANs

Technical: This module presents Ethernet switching and relates it to the TCP/IP–OSI hybrid model. Encapsulation is presented. The small single-switch LAN is discussed, as are switching tables and techniques, as well as switch pricing. Design and diagramming concepts are introduced.

Business Analysis: Students are given handouts that discuss NAAD nomenclature and design techniques, including symbolic techniques to represent network components and structured cabling plan development. Both diagramming and nomenclature are presented in class and are used for this module's in-class activity, This activity (LAN/MAN Design) spans 2 modules and includes the creation of a nomenclature and design for the LANs during the first module and a WAN to interconnect the LANS during the second module. Questions for the second bidders' conference are due; this conference focuses on the technical needs of TSI.

4.7 Module 5 - Large, Multi-Switch LANs

Technical: The goal of this module is to take the concepts learned thus far and extend them to a multi-switch environment. Ethernet, wireless, asynchronous transfer mode (ATM), and legacy LANs are presented. Wide-area networking is also introduced. Techniques are presented for calculating bandwidth requirements. The discussion of the semester project continues with the Design and Cost sections.

Business Analysis: We continue with NAAD design techniques and hold the second bidders' conference discussing technical needs and issues. The in-class activity continues from the last module and is to design a WAN. Students use the design and nomenclature techniques presented earlier. The bidders' conference is held, giving students a chance to inquire about technical issues. Students must also submit NAAD working documents for review and comment.

4.8 Module 6 - Telephony and WANs

Technical: This module reinforces the idea that most wide-area networking is based on telephone carriers as well as the integration of voice and data carriers. Public switched telephone networking is discussed and how it affects our ability to create WANs and LANs.

Business Analysis: Students must submit a draft network design for the TSI project. This is the first attempt at NAAD design documentation. This assignment is reviewed and quickly returned so comments can be incorporated into the final report. The draft must include the following:

1. A network hierarchy.
2. The nomenclature used in diagrams.
3. A structured wiring plan.
4. Selection of topologies used for WANs and LANs.
5. Preliminary design diagrams using the hierarchy.
6. Selection of hardware/software.

4.9 Module 7 - WANs and VPNs

Technical: Wide-area networking is continued, and the ability to build a private network versus using carrier-leased lines and the Internet is presented. VPNs are also discussed. The assignment for this module is to submit a preliminary hardware and cost list.

Business Analysis: A draft implementation plan is submitted for this assignment. It includes a cabling list. While this is not normally included in a response to an RFP, it is used in the DCN class to make sure students know how the telecommunications equipment interconnects.

4.10 Module 8 - Internetworking

Technical: Routers tie together networks. In this module, routing is introduced, along with forwarding table creation, TCP/IP standards used in routing, and TCP handshaking. Additionally, Layer 3 and Layer 3 Ethernet switches are discussed. All of this material is held to the end since it is not necessarily needed for the semester project.

Business Analysis: The goal of this module is for students to submit an assignment which includes preliminary cost estimates and a post implementation plan. This assignment submission must include the following:

- Cost estimates (from vendors) for all hardware/software, communications gear, and all interconnection services.
- A post implementation plan for testing of network servers, workstations, communications gear, and applications;
- A network upgrade and growth plan.

Post implementation and network upgrade practical material are not a focus of this course, but it is included for completeness. It is assumed that the students will submit brief statements regarding the NAAD post implementation phase.

5. CONCLUSION

It is not difficult to teach DCN courses with an emphasis on technology, but teaching the integration of business analysis and technology is a challenge. Our experience using the two-thread framework presented in this paper has been that business analysis for a network design can be effectively taught in the problem-based learning environment. We feel that this approach gives an appropriate mix of skills needed by business school undergraduates.

Although we claim no statistical proof of our framework's success, the anecdotal evidence has been positive. For example, several students report that they have gone on to obtain further network credentials (e.g., Cisco CCNA and Microsoft MCSE) as a result of this DCN course. Other students claim that skills learned in the DCN course largely affected their choice of networking as a career path. Following graduation, one student group even formed a consulting company in which – as they report – techniques learned in the course are very much utilized. We know of no such reports from students who took this class under the former method of presenting the material.

The success or failure of our framework notwithstanding, there is a larger issue at stake -- the mix of technology and business topics in IS courses taught within business schools. At the undergraduate level, students are very much interested in acquiring technology skills and those skills are often what determine their first IT job. Such pressures can lead some IS programs to become skills focused to the detriment of business analysis. The extent to which this is happening and the long-term effect of curriculum content on career paths need to be studied and better understood by the IS community. Further study on the issue of analytical skills for entry level IS employees and their effect on long term career growth are also needed.

Note: Those interested in obtaining the TSI case should contact the authors directly.

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AUTHOR BIOGRAPHIES

Michael Gendron is an associate professor in the Department of Management Information Systems, School of Business, Central Connecticut State University (CCSU). He also holds an appointment in the interdisciplinary MS program in Computer Information Technology at CCSU. His research and teaching interests include networking and data communications, data and information quality, Internet DNS governance and healthcare informatics. Prior to joining CCSU faculty, Dr. Gendron has been an instructor at The University at Albany, Chief Information Officer for a health maintenance organization, technology coordinator for a state health bureau, as well as being a networking and telecommunications consultant. He has over 27 years of industry and academic experience.

Andrzej Tomasz Jarmoszko is also an associate professor in the Department of Management Information Systems, School of Business, Central Connecticut State University. His primary teaching areas are systems analysis and design, and data communications and networking. Prior to joining CCSU faculty, Dr. Jarmoszko was manager for strategic planning at a major mobile communications company in Central Europe. His research interests include information systems curriculum, mobile information systems, aligning knowledge management with the strategy process, and strategic management in the communications industry.

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