

# Connecting Theory and Practice in an Undergraduate Telecommunications Course

*David Patton<sup>1</sup>, Chetan S. Sanka<sup>2</sup>, and P.K. Raju<sup>3</sup>*

## **Abstract:**

This project was designed to improve telecommunications education for undergraduate students. This was done through the development of a new teaching methodology that integrated real-world issues and practice with telecommunications theory. This methodology was named MARCA, for **M**ultimedia **A**ctive **R**ead-World **C**ase-Study **A**pproach. We found that by using this method students were able to significantly improve their knowledge of telecommunications topics as evidenced by the

- A) Improvements in results from the Pre and Post Tests
- B) Perception of a real gain in ability as evidenced by their e-journals
- C) Development of quality materials as evidenced by their coursework

According to Holt: "Research has found that traditional classroom methods are more expensive and less effective than self-paced training videos, CDs or intranet courses (Holt, 2001)." The MARCA method helps to bring traditional lectures together with the new technologies in education.

## **Definition of MARCA:**

- A) **Multimedia:** This methodology integrates lectures, a textual case study, videos of people, products and processes in the case study, internet-based exercises and creating presentations.
- B) **Active:** The students are required to work with the material in the labs, in teamwork exercises and in presentations. These exercises require that each student integrate the knowledge from the content modules to complete the task that connects theory with the real-world. Students are not allowed to passively attend and then sit for an exam, they must take an

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<sup>1</sup> Department of Management; College of Business; Auburn University, AL; 36849

<sup>2</sup> Department of Management; College of Business; Auburn University, AL; 36849

<sup>3</sup> Department of Mechanical Engineering; Samuel Ginn College of Engineering; Auburn University, AL 36849

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active role in their education. Additionally, students complete E-Journals that document their responses to the material presented in the course.

C) **Real-World:** The students are presented with material that reflects real-world problems that a real company faces. This material comes from the case study and lab assignments, which require that students bring in outside research of current topics and technologies in order to answer the assignment.

D) **Case Study:** The case study is integral to the MARCA method because it brings the issues faced in industry into the classroom in a direct way. The case study incorporates multimedia content where company representatives describe the problems and present issues the company faces and define a problem for the students to solve.

This methodology is employed by creating modules within the course. These modules could cover two chapters from the textbook, one segment from the case study, lab assignments requiring active work and a small test or e-journal to evaluate the module. These modules are linked together in that subsequent modules build on the knowledge gained in earlier modules and to complete a module the student must employ the skills gained in the current module with previously learned skills. These skills are reinforced through the lab assignments that require the student to search for information not contained within the course materials and integrate this information into his or her assignment. In later lab sessions the students work together as teams, further enhancing the active component of the MARCA method.

This active search and collaboration for information combined with the lecture and case study material help students solve real-world problems presented to them in the case study.

### **Major Educational Objectives:**

Students need to develop deep technical skills and “value skills” such as coordination, teams, and Business and Entrepreneurship (Denning & Dunham, 2001) to have maximum value to employers. Therefore, the educational objectives of this course are to help students gain:

- A) Solid introduction to the technical basics of business data communications
- B) Knowledge of how technology connects with business needs

### **Level of Students:**

The experiment was performed in a course that was directed at undergraduate students beginning their concentration in MIS, typically at the start of their junior year in college. These students have completed the University core and business foundation courses. They had not taken any advanced courses in MIS covering either strategy or technology, and as such all information had to be taught at a fundamental level. The students had only basic instruction in business principles and none in MIS or Telecommunications topics save for a survey course that covered the entirety of the MIS curriculum. This required that the students who had no technical instruction master a complex set of knowledge in a new field.

### **Number of Students:**

Thirty students took this during the second summer term of 2001. This was the first telecommunications course for these students, and many of the students had a limited knowledge of telecommunications.

### **Innovative and Unique Features:**

The innovative and unique features of this approach are the use of the MARCA method. MARCA, for **M**ultimedia **A**ctive **R**eal-World **C**ase-Study **A**pproach, enables students to apply technology basics to real-world issues. It does this using the following principles:

- A) Multimedia case study to bring real-world telecommunications issues into the classroom
- B) Structured laboratories to apply theory learned to practice directly and gain hands-on experience with IT systems
- C) Interactive presentations to focus teamwork, hone communications skills and sell their proposals to management
- D) Team Work to focus real-world business skills such as communication and work distribution
- E) Web-based learning system (WebCT) to enable students to integrate IT into presentations, feedback and team work

The true innovations come in the way that these elements were integrated into the standard textual material and team working. These techniques enabled students to increase their knowledge of telecommunications topics as evidenced by the improvements in the skills survey results and student content generated with the WebCT system. This improvement in telecommunications domain knowledge couples with skills gained from working in teams. These elements combine into the MARCA method, helping students to achieve macro skills (Turner, Sankar & Rainer, 2001) such as problem solving and interpersonal skills.

### **Content:**

This course combined a traditional business telecommunications textbook with a case study that focused on the business and telecommunications issues facing a real company. We focused the instructional methodology on the technical side of telecommunications. As illustrated below, we divided the content into two areas with key topics under each area.

- I. Technology Basics
  - a. Explain how voice, video and data are transmitted across the network (protocols)
  - b. Differentiate between satellite and terrestrial networks
  - c. Explain the different types of satellite networks (LEO & GEO)
  - d. Differentiate between circuit switched and packet switched networks
- II. Technology Integration
  - a. Explain how a time-based transaction is performed in a networked environment
  - b. Explain how to use technology to create a compelling experience for the end user

In order to cover these topics, we employed the MARCA method to integrate the standard textbook with the AUCNET case study. The AUCNET case study details the real-world example of AUCNET USA and their online auto auction system along with their network for conducting auctions. We used a telecommunications textbook that covered the basics of modern telecommunications at a collegiate level (The Management of Telecommunications, Carr & Snyder, 1<sup>st</sup> Edition). This textbook, combined with the lecture, provided a solid theoretical background for telecommunications technology. It did not, however, connect the theories to the real world problems faced by a company. To provide this real-world link we employed the AUCNET case study so that students could apply their technical theory to solving real-world business problems.

### **Organization:**

The course was organized in three modules (Discussion of Technology and Telecommunications; Discussion of Data Communications; Telecommunications Models, Emerging Technologies and Solving Business Problems with TC) covering basic telecommunications principles with five lab sessions that focused on the case study. These lab sessions featured specific assignments that integrated the case study with the textbook material, with the goal of increasing student retention of telecommunications topics. We developed a course flow that integrated the case study with the textbook, allowing students to progress naturally from one topic to the next as they studied the case along with the textbook.

We chose a case study based on the satellite auto auction vendor AUCNET USA. AUCNET faced a challenge in developing a new network structure that could help it recapture its market. It had lost 400 dealerships in two years, going from 700 subscribers in 1996 to 300 in 1998. The AUCNET case reinforced the textbook material as it gave students a chance to apply immediately the knowledge presented in the text to a real-world problem. We used a pre-test and e-journals throughout the course and a post-test in order to gauge student progress.

This course flow began with the lecture, where the students were tested for their personality types using the DISC instrument, a teambuilding tool developed by Learning Unlimited Corporation. The lectures in class then combined with the textbook to give students the technical basics needed for the labs. The labs built on the lecture, helping to solve assignments related to the case study and required the students to search for outside sources of information to complete the assignment. Each lab built upon the other, requiring a greater sophistication in technical information and production, from simply posting a report on the web to using WebCT and producing a class presentation. The next section details how the MACRA method was combined with the contents of individual modules.

### **Presentation:**

The material was presented in for ways:

- a) Lecture
- b) Lab
- c) Multimedia CD-ROM
- d) Textbook

This mixture allowed the students to reinforce their learning as they were able to apply material from the textbook and outside research to the problem presented in the case study. The combination of methods kept students from simply memorizing a textbook; they had to integrate the knowledge from the textbook, outside research and teamwork in order to solve the AUCNET case.

The students began with data presented in the textbook and lecture which provided the theoretical basis for the course. It then flowed into the lab sessions where the AUCNET case was introduced to the students. In the lab sessions the students were instructed towards a specific objective; from initially diagramming a PBX system individually to later choosing AUCNET's new network topology. They chose this topology from among leased-line, satellite and IP-based solutions.

### **Use of MARCA in the content modules:**

Drysdale wrote that many courses were designed around artifacts instead of principles (Drysdale, 1996). These artifacts arose from problems in the past, but disconnect from being the best way to teach a topic. While artifacts in and of themselves are not the best way to teach, they do have value in that they can help illustrate principles. The MARCA approach seeks to reconnect these "artifacts" with "principles." We do this through the content modules that separate the theory and practice into interrelated blocks. In this course we implemented the MARCA approach in the following way:

	Lecture	Case Study	MARCA Method
<b>Module 1:</b>  <b>Discussion of Technology and Telecommunications</b>	Introduction	Introduction to case study	DISC Instrument
	Chapter 1: What is TC?		Survey of Student Skills
	Chapter 2: Introduction to the Telephone	<i>How AUCNET USA works</i>	Lab 1: Learn about a TC company, post report to Internet, learn WebCT (Individual, 3Hrs)
	Test #1: Analog Networks	Definition of problem	Lab 2: Diagram PBX system to connect USA and Japan, incorporate technology from assignment 1, post report to Internet (Individual, 3Hrs)
	Chapter 3: What media for TC?	<i>Challenges and Top Management Concerns</i>	
	Test #2: Telecommunications Media	Begin building solution space	Lab 3: Investigate TC connections technologies and how AUCNET can use them, post report to WebCT (Group, 3Hrs.), E-Journal

<b>Module 2: Discussion of Data Communications</b>	<p>Chapter 4: Data Communication A</p> <p>Chapter 5: Data Communication B</p> <p>Test #3: Data Communications Fundamentals</p>	<p>Evaluate Technical aspects of company's problem</p> <p><i>Technical Glossary</i></p>	<p>Lab 4: Evaluate wire line and wireless technologies, evaluate technologies, prices and features. Then evaluate these technologies with regards to Aucnet. Discuss technologies, products and features. (Group, 1.5Hrs.)</p>
<b>Module 3: Telecommunications Models, Emerging Technologies and Solving Business Problems with TC</b>	<p>Chapter 6: Telecommunication s Models and Networks</p> <p>Chapter 12: New Technologies</p>	<p>Form solutions for company's problem</p> <p><i>How AUCNET USA works (expanded)</i></p> <p><i>Network Design Options</i></p> <p><i>Future Business Opportunities</i></p> <p><i>Strategic Issues</i></p> <p>Present solutions for company's problem and defend your choice</p>	<p>Lab 5: Draw detailed diagrams showing the current network functions for Aucnet USA, and propose new technologies that Aucnet could use. Work together to think through the problem from the mindset of a telecommunications manager, who must balance new technology with the needs of a business. Write a report that doesn't merely summarize your previous assignments, but rather one that thinks through Aucnet's situation using telecommunications knowledge. Write a report and make a short (&lt;10 minutes) class presentation. In the report show the current network, proposed network and a cost/benefit analysis for the new network (Group, 3Hrs.)</p> <p>E-Journal</p>
<b>Final Module</b>	<p>Review of Course</p>	<p>Presentation of Case Study Outcome</p>	<p>Post-Test to determine skills gained</p>

The table above shows how the MARCA method combined with the textbook to extend the topics of telecommunications and in the course. The labs form the core area where the MARCA approach is used. In the lecture the case study is mentioned to illustrate points from the textbook; in the lab the case study forms the core of “why” the students are conducting their assignments. Every assignment has a bearing on understanding the case study. The students study the case primarily on their own, so the labs provide the core of the MARCA approach.

In the sessions under Module 1, the students are evaluated using the DISC instrument, giving them an idea of how to form into groups later on. The students are then given a brief introduction to the AUCNET case in the lab session. They are then tasked to find out more about a company in the telecommunications industry, learning about its products and finances. They must evaluate it using the competitive advantage section of the textbook, and describe how its products can be used for business advantages. The students then must post this report to their own web space on WebCT. This is required so that students will learn the basics of internet authoring, forcing them to become active users of telecommunications instead of passive browsers. Posting to the web brings a secondary advantage, according to Soloway and Norris: “When students post their reports to the internet for an audience, they write better and write more (Soloway and Norris, 1998).”

In the second lab, session the students used their new knowledge of telephony to show a PBX connecting AUCNET USA and AUCNET Japan. The students had to study the different technologies available for trans-pacific communications. The students learned about currently available products for AUCNET to use for voice communication. They also began to learn about global issues from the case study, in designing a multi-national communications system that must cross oceans and language barriers. This session required that the students search outside the textbook and case study for new systems and examples of how to diagram a PBX. They also became more familiar with the drawing tools of Word as they made their diagrams. Students again posted their findings via the Internet.

In the third laboratory, the students began working in teams to study the media used by AUCNET to conduct its auctions. They studied the various methods the company could use for data communications, from landline Internet to wireless to dedicated satellite channels. Thus began the students’ first attempt at team working. The team working is important to both the MARCA method and the students’ later careers, as employers value students’ ability to work together and form partnerships (Boston Business Journal, 1997).

In the fourth lab session, students evaluated the technologies, prices, and features of wireless and wire line alternatives for AUCNET USA. The students built on their previous work and then expanded the technical knowledge with an evaluation of the business principles behind the adoption of these technologies. The students again posted their report to the Internet. Delegation of responsibility was an important part of this assignment as students were only allotted 1.5Hrs to complete the task.

The fifth lab assignment required the students to draw detailed diagrams of AUCNET’s network and then propose a new design for AUCNET to use. The students use tools from the strategic management section of the case study CD to help them learn how to think like a manager. The students had to look beyond “whiz bang” technology or simply low cost alternatives; the students had to evaluate the value of each technology in solving AUCNET’s problem. The students then wrote a paper and gave a 10-minute presentation where they revealed their networking strategy for AUCNET and how it would benefit the enterprise, looking at information attributes, cost, and compatibility. They then defended their recommendation before the class. This session forced a synthesis of the knowledge gained throughout the course lectures and previous labs as the students were required to use technology, teamwork, and strategy to solve a real business problem.

### **Data Collection:**

In order to evaluate the MARCA method we administered pre and post-tests, e-journals and evaluated student work. These results were collected throughout the term to allow comparison and evaluation while the course was still running, and provided the opportunity to modify the course if needed.

The pre-test and post-test were given on the University standard scantron form, taking advantage of the quick grading and detailed statistics provided by the Information Technology division. E-Journals and student presentations were submitted through the WebCT system. This system allowed students and instructors to communicate quickly and eliminated problems associated with corrupted diskettes, undelivered e-mail, and unreliable websites. It also provided the instructor with a much more convenient method of collecting the student work, as the entire course material (including student submissions) can be compressed and downloaded as a .zip file.

### **Effectiveness and specific benefits:**

The advantages of using the textbook along with a multimedia case study show themselves most clearly when one analyzes the results of the pre and posttests. Students went from an average score 45.46% to 83.95%, an improvement of 45.54%, when tested on identical telecommunications topics before and after the course. This indicates that the students gained technical skills. Furthermore, the students improved their individual problem solving and team working skills as evidenced by the lab assignments completed throughout the course.

The students were able to analyze real-world telecommunications problems and present solutions based on course material and outside research. This reveals that the students gained far more than technical knowledge; they were provided opportunities to hone their business and managerial skills while working in an unfamiliar area. This required them to be adaptable to a changing environment by deploying their skills in a real-world situation; something one does not often find in a standard textbook course. The MARCA method leverages the benefits of traditional instruction with the real-world problem skills developed in the case study methodology combined with a teamwork emphasis and use of information technology to meet business objectives.

Some student comments from their e-journals about the course were:

#### ***E-Journal #1***

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- I learned a lot about how a phone works
- Technology plays an integral part in daily life, but we are ignorant of how it works
- I was impressed with the real-world examples
- Voice is compressed so many times!
- Not all systems have to be technologically advanced, only the best for the business

#### ***E-Journal #2***

- In the future, could we go fully wireless?
- As a MIS professional I have grown substantially
- There is no substitute, either you learn it or you are left behind
- I am impressed to find how fast the technology changes, even though it comes from basic concepts
- I am looking at applying for jobs that I normally wouldn't have considered before
- I learned which equipment and systems perform best for the money
- I learned a great deal from this material

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- I feel better about getting into the real world
- When you are enjoying doing something you don't mind doing it

### **Transferability:**

We believe that the integrated case study methodology can be applied to courses where business and technical topics could benefit from being addressed simultaneously and to courses where real-world problems can lead to expanded perspectives in learning. We have used this approach in a freshman-level engineering course at Auburn University with excellent results. This engineering course was not very successful with either the lecture or case study approach alone, as freshman direct from high school had little skills in outside research and team working. By applying the MARCA methodology, we were able to give the course proper structure and enable students to complete the course successfully. So far this course is progressing satisfactorily. We hope that the increased use of the MARCA method can initiate student interest in difficult engineering and technical materials and will continue to test and improve this methodology.

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### **David Patton**

David Patton is a PhD candidate in MIS at Auburn University. He has completed a Master's in MIS, a MBA with concentrations in Finance and MIS and a BA in Spanish and International Trade. His research interests currently include developing case-study mythology for undergraduate education, ERP integration issues and the legal frameworks developing around IT usage. Please contact him at [pattodw@auburn.edu](mailto:pattodw@auburn.edu) for further information.

### **Chetan S. Sankar, PhD**

Chetan S. Sankar is the Thomas Walter Professor of Management Information Systems at Auburn University's College of Business. He uses research methodology to develop case studies in MIS, engineering management, and global telecommunications management. He has published more than 100 refereed papers in journals, book chapters, and conference proceedings.

He is currently working on a [National Science Foundation grant](#) to create case studies that bring real-world issues into classrooms. This grant makes it possible for undergraduate and graduate students business and engineering students to work together and develop multimedia instructional materials. Research on the use of these case studies and multimedia technologies in classrooms reveal that they could improve the learning process significantly and shape the future of science, mathematics, engineering, technology, and business education. If your teaching, research, or training needs are in these areas, please contact Dr. Sankar at [Sankar@business.auburn.edu](mailto:Sankar@business.auburn.edu) for more information

### **P.K. Raju, Ph.D.**

**Dr. P.K. Raju** is Thomas Walter Professor of Technology Management & Director of Auburn Engineering Technical Assistance Program in the Mechanical Engineering Department at Auburn University. He worked at Purdue, the Catholic University of America in the U.S. and several universities in India before joining Auburn in Fall 1984. Dr. Raju has directed and managed a variety of sponsored research and development projects. These projects have dealt with different aspects of acoustics, vibration, noise control, non-destructive evaluation, and engineering education. These projects have been funded by industries (John Deere, Louisiana Pacific Corporation, Wheelabrator, American Gas Association) and government and international agencies (UNDP, NASA, NSF, DOD, DOE, NIST) and totals over \$4.1 million. Dr. Raju has authored or edited 18 books, published five book chapters and has published a total of 129 papers in journals and conference proceedings. He also is the co-author of eight books on engineering management published by Tavenear Publishers in 2000 and 2001.

Dr. Raju is a member of the ASME, ASEE, INCE, ASA, ASNT, INCE. He served on the executive committee (1992-1996), and as Chairman of the ASME Noise Control and Acoustics Division (1996-1997), and served as Assistant Vice President Region XI (1994-1995). He also served as president of the Alpha Upsilon Chapter of Phi Beta Delta, Honor Society for International Scholars (1996-1997). Please contact him at [pkraju@eng.auburn.edu](mailto:pkraju@eng.auburn.edu) for further information.