1999

Design and Construction of a Mobile Laboratory for Distance Learning in Engineering Technology

Alok K. Verma
Old Dominion University, averma@odu.edu

Original Publication Citation
Verma, A. K. (1999). *Design and construction of a mobile laboratory for distance learning in engineering technology.* Paper presented at the 1999 ASEE Annual Conference and Exposition, Charlotte, North Carolina.

Design and Construction of a Mobile Laboratory for Distance Learning in Engineering Technology

Alok K. Verma
Old Dominion University

Introduction

Last ten years have seen a explosion in the number distance learning programs offered by educational institutions . Distance learning programs of various types are available through more than 1,000 educational institutions in the United States. [1] Estimates are that by the year 2007 almost 50 percent of all learners enrolled in postsecondary education courses will take some of their courses through distance education formats. [2] Offering distance learning programs in Engineering and Engineering Technology pose special challenges for institutions. While it is relatively easy to modify a lecture course for distance education, it is the laboratory courses that offer real challenge. Various solutions have been proposed to address the problem of offering realistic laboratories experience for distance learners. These include virtual Laboratories, computer based simulations, videotaped laboratory experiments and mobile laboratories. This paper discusses the effort that has gone into the design and construction of a mobile laboratory to be used in conjunction with the televised program in Mechanical Engineering Technology Program at Old Dominion University.

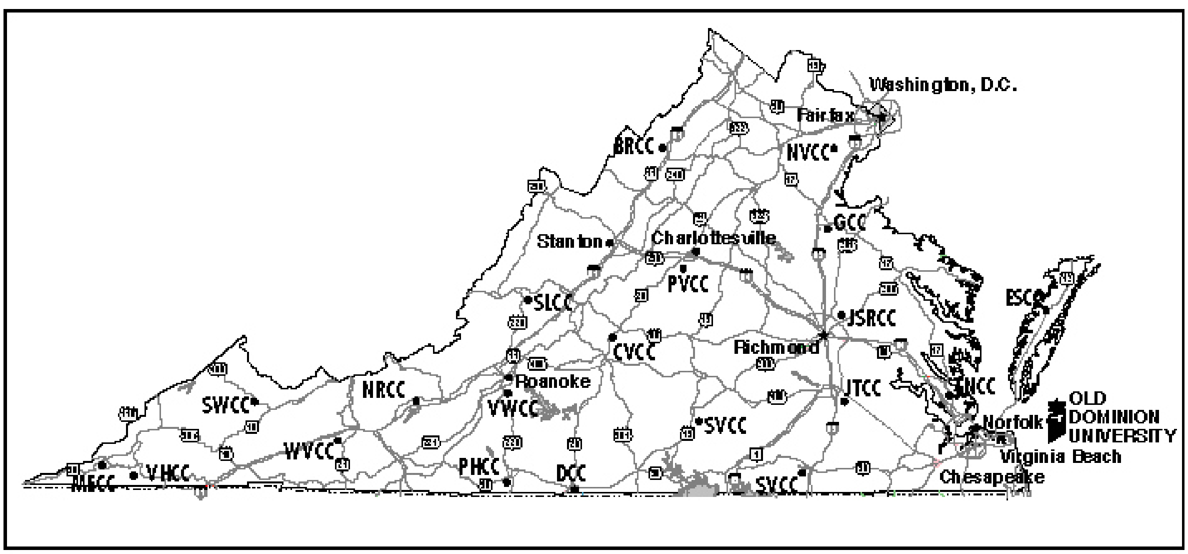


Figure - 1, Location of TELETECHNET Sites

Old Dominion University has one of the largest distance learning programs in the United States, known as TELETECHNET. Classes are offered at more than 30 sites in the state of Virginia and at least ten sites outside the state. Three Engineering Technology programs are offered under TELETECHNET. Locations of these sites at various community colleges in the state are shown in Figure-1.

I. Televised Program in Mechanical Engineering Technology

The televised program in engineering technology at ODU is one of the few programs of its kind in the nation which addresses the need for upper-division instruction for the non-traditional students in remote areas [3][4] . The primary goal of this program is to offer educational opportunities to individuals currently employed with an associate degree. An individual can complete the baccalaureate degree in Mechanical Engineering Technology in approximately four and a half years on a part time basis by taking two courses per semester. Courses are typically offered in the evenings, one day a week via one way video and two way audio connection. Laboratory instruction has proven to be the biggest challenge, since a majority of community colleges lack the equipment necessary to teach the upper division laboratories. Until now the students from remote sites had to come to the Norfolk campus during summer to take laboratory classes. In 1995 the author was awarded a grant by the National Science Foundation to develop a mobile laboratory to support the televised program.

II. Laboratory Requirements in the MET Program

The laboratory courses are a major component of the MET curriculum. The required upper-division laboratory courses include: Fluid Mechanics Lab. (MET 335), Automatic Controls Lab. (MET 386), Strength of Materials (CET-345) and Power & Energy Lab. (MET-387). Curriculum design for the program is discussed in an earlier paper by the author.[5] The laboratory facilities in the above subject areas are almost non-existent at the majority of the community colleges in the state where the program is offered. While the option for creating duplicate laboratory facility was considered for some of the sites, It quickly became clear that the cost for duplicating such facilities would be prohibitive. The obvious solution was to take the laboratory facility to the students. In the early phases of the development of this distance learning program when Roanoke was the only site, the laboratory course in fluid mechanics (MET 335) was taught by transporting equipment in a van.

III. Planning

In 1995 the university received a grant from the NSF (ILI program NSF grant No. DUE-9452281) to build a mobile laboratory to teach Fluid Mechanics Lab. and Automatic Controls Lab. for distance education students. After the grant was awarded, a committee was formed to oversee the design and development effort. The committee included four faculty members from the Engineering Technology Department and a representative from the Research Foundation which oversees such grants. The committee prepared a set of specifications for the mobile laboratory to be sent to possible contractors of the mobile lab. Matching funds were obtained from the University which were used to purchase equipment for the laboratory.

IV. Design Considerations

a. Functional Requirements

During the early stages of conceptual design a set of functional requirements were developed which included:

1. A Large enough area to accommodate a class of 16 students and a faculty member.
2. At least four workstations to perform experiments.
3. Provision for external connections for utilities like water, air and electricity.
4. Climate control system.
5. Storage space for equipment.
6. Security system.
7. A suspension system gentle enough for on-board computers.
8. Leveling system for the trailer.
9. Instructor’s workstation.

b. Size

The mobile laboratory will be housed in a 32' long and 8' wide trailer. The trailer will be fitted with four workstations where a total of twelve experiments can be performed in the Fluid Mechanics area and sixteen experiments in the Automatic Controls area. The trailer will be customized to include storage shelves for additional equipment and connections for utilities. The individual workstations will be modular in nature and can be modified to incorporate experiments in either Fluid Mechanics or Automatic Controls.

c. Equipment Selection

The equipment was chosen for each laboratory primarily to replicate existing equipment at the main campus. The Fluid Mechanics Laboratory at the main campus is the result of over 25 years of planned purchases and acquisitions. Continued accreditation of the MET program at the main campus along with its distant education component would require that we offer same laboratory experience to all our students.

The Automatic Controls Laboratory at the main campus is relatively new. It contains, Pneumatic, Electro-Pneumatic, PLC components and personal computers. Most of the components are portable and can be stored in cabinets when not in use. Electrical (120 V.A.C.) and air connections are provided at each of the work stations including the instructor’s workstation.

d. Environment Control

Once parked at a site, the trailer can be cooled and heated with onboard air conditioners and heaters. The environmental control system must be capable of maintaining comfortable temperature inside while the ambient temperature can vary from zero degrees to 100 degrees F. Two fresh air vents are provided for circulation. In addition to over the roof heating and cooling units, small electric heating strips are provided under the cabinet. In addition to flourescent lightning, battery powered lamps are provided for emergency or for times when shore power is not connected.

e. Layout

Because, space in such facility is limited, information about traffic flow, number of people, types of experiments performed and class format must be used to plan the layout. The 32 feet long and eight feet wide trailer has four workstations for students and an instructor's area which includes a desk, a chair, whiteboard and a bookshelf. The storage area is located in front of the trailer which also includes the air compressor, main power panel and shelves with storage nets.
The layout of the trailer is shown in Appendix I. Appendix-II shows the exterior photos.

IV. Construction of the Facility

a. Request for Proposals

First round of request for proposals resulted in dismal response from the vendors. Only four responses were received and all were unacceptable due to improper format and content. The committee revised the specifications to make them less stringent and offered more time for response. During the second round , the committee received 20 responses.

b. Proposal Evaluation

Out of the 20 proposals submitted, the committee selected three vendors as finalists and they were asked to submit their final proposal. After careful considerations to the quality of work and experience the committee selected Ohio Bus Sales as the top vendor. The vendor was invited to make a presentation to the committee and the contract was awarded on September 29, 1997 .

c. Contract Administration

As the chair of the committee, the author was the main point of contact for the vendor. Any change orders for the laboratory had to be approved by the committee. At mid point during the construction an inspection meeting was scheduled at the vendor's production facility. During this trip, the author delivered the water weighing table to the vendor for installation in the trailer. Exterior graphics for the trailer were also finalized during this trip.

d. Modifications

Several modifications were made during the construction of the laboratory. One of the major modification was the addition of air suspension to the trailer. This was done based upon the strong recommendation from the vendor. This change was necessary to protect the large number of electronic equipment in the trailer.

e. Delivery

The complete laboratory was delivered to the College of Engineering & Technology on July 8, 1998.
A dedication ceremony was held on this day followed by an open house. The Dean accepted the keys for the trailer from the Ohio Bus Sales representative.

V. Summary

The concept of mobile educational facility is not new. However, utilization of such facility for laboratory experiments to supplement distance education is a new concept. The merit of this concept lies in the fact that it offers a cost effective way to provide a laboratory for multiple sites. The concept is being tested for two instructional areas namely, Fluid Mechanics and Automatic Controls. Currently the laboratory is being equipped with the instruments and will be used for instruction during the spring,1999 semester.

Bibliography

1. Lozada, M., "Look out for Distance Learning: It's Out There," *Technique*, 72(7),pp.24-26 (1997).

2. Kascus, Marie, "Converging Vision of Library Service for Off-Campus/ Distance Education," *Journal of Library Services for Distance Education*,1(1), *http://www.westga.edu/library/jlsde/ jlsde1.1.html.*

3. Verma, Alok K. and Richards, Larry, "Televised Instruction: A Technological Boon or Bane". *Proceedings of the ASEE annual conference* at University of Illinois at Urbana-Champaign, June 20-23,1993.

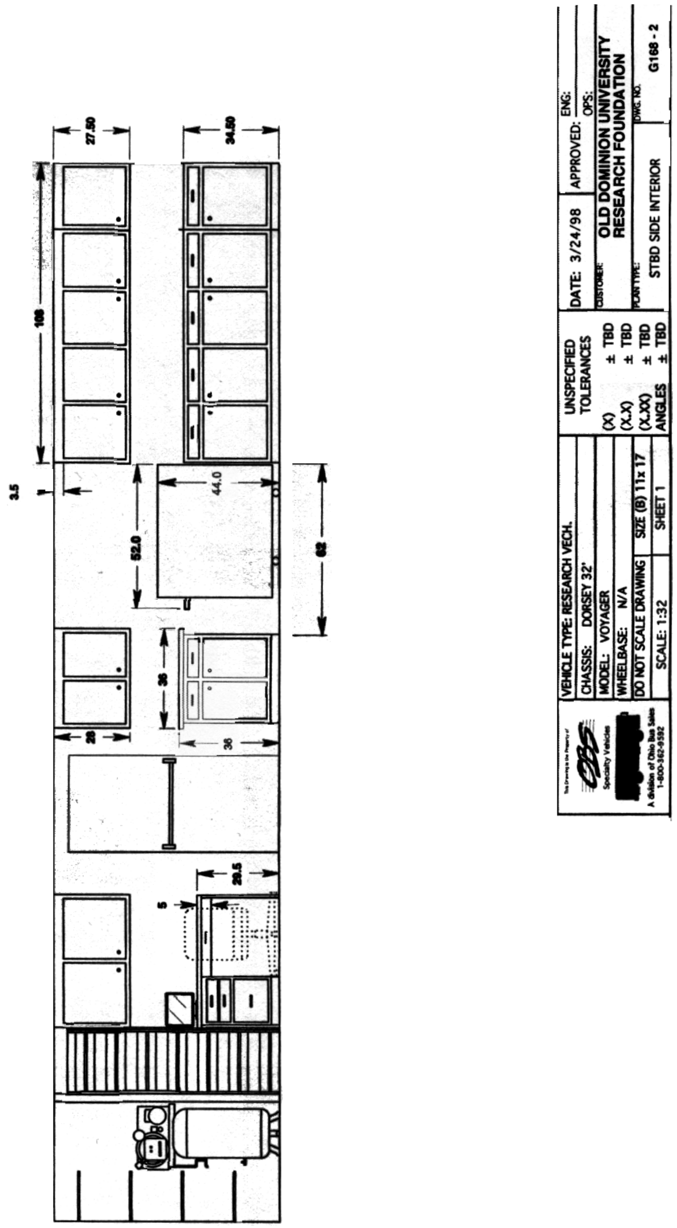
4. Verma, Alok K., Stanley, William D. and Crossman, Gary R., "Televised Instruction in Engineering Technology: The 2+2 Program at Old Dominion University". *Proceedings of the ASEE annual conference* at University of Illinois at Urbana-Champaign, June 20-23,1993.

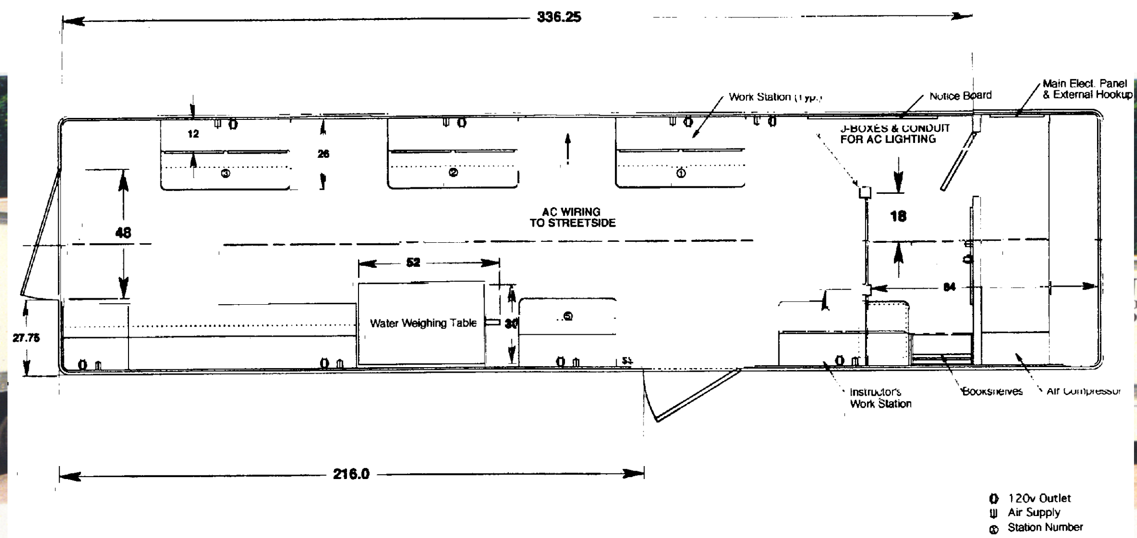
5. Verma, Alok K. , "Curriculum Design for Televised Instruction in Engineering Technology". *Proceedings of the ASEE annual conference* at University of Illinois at Urbana-Champaign, June 20-23,1993.

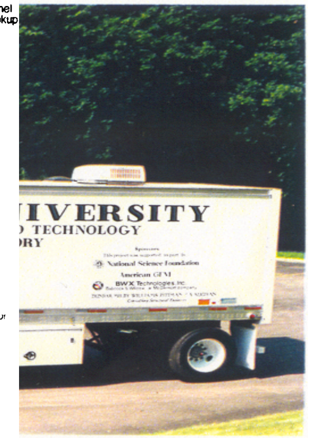
ALOK K. VERMA

Alok K. Verma is Associate Professor and Director of the Automated Manufacturing Laboratory at Old Dominion University. He received his B.S. in Aeronautical Engineering from the Indian Institute of Technology, Kanpur in 1978 and MS in Engineering Mechanics from Old Dominion University in 1981. He joined the Mechanical Engineering Technology Department in 1981. His publications are in the areas of Fluid Dynamics, Advanced Manufacturing Processes, CAD/CAM, and Robotics. His current research interests are in the area of non-traditional manufacturing processes and process optimization. Alok Verma has co-edited the proceedings of the International Conference on CAD/CAM & Robotics for which he was the general chairman. He is active in ASME, ASEE and SME.

APPENDIX - I
Layout of the Mobile Laboratory
Top and Front View







This 32 foot ***Voyager III*** Mobile Lab was delivered to Old Dominion University's College of Engineering and Technology, Norfolk, VA in July, 1998. The unit includes multiple analysis areas, overhead and under-counter storage, water weighing table for determination of flow rates, on-board air compressor for pneumatic air supply to each workstation, and a integrated computer system linking the student and teacher workstations.

SPECIALTY VEHICLES
1-800-362-9592