B.6. Facilities

In this section we review the departmental, College of Engineering and University facilities available for the undergraduate program. The major items discussed include:

- B.6.1. Buildings And Utilization Of Space
- B.6.2. Computer Laboratories
- B.6.3. Library
- B.6.4. Machine Shops
- B.6.5. Undergraduate Teaching Laboratories
- B.6.6. Conclusions On Adequacy Of Facilities
- B.6.7. Future Plans To Improve Facilities

B.6.1. Buildings And Utilization Of Space

The Department of Chemical Engineering currently utilizes space in six buildings: Ross Hall, Wilmore Laboratories, L-Building, Aerospace Engineering Building, and Textile Engineering Building, and Mechanical Shops Building.

Ross Hall is a 27,000 square foot building that is split between the Department of Chemical Engineering and the Department of Mechanical Engineering. The Chemical Engineering main office complex and most faculty offices are housed in approximately 6000 square feet of office space on the first and second floors. The student advising office is also located in Ross Hall. The department also utilizes 2800 square feet of research laboratory space on the second floor and there is more than 4000 square feet of currently unusable research space in the basement of the building. The chemical engineering conference room is also occasionally used as a classroom, especially for student presentations in the unit operations laboratory and process design courses.

Ross Hall is scheduled for a $13.5 million total renovation commencing December of 2004 including a 8000 square foot addition to allow incorporation of state-of-the-art instructional facilities in the building as well as student work and lounge areas. $10 million of the project is being funded from Auburn University deferred maintenance funds and $3.5 million (the addition) was raised by the Ginn College of Engineering through private giving. Of significance is a generous $1 million gift from Joe and Billie Carole McMillian to completely renovate the auditorium in the basement of Ross Hall to provide a 70 seat, full multimedia equipped, state of the art lecture hall. The McMillan Lecture Hall will be equipped with an LCD projection system, document cameras, high-end audio equipment, a smart podium control system and a complete video conferencing system. This lecture hall is located adjacent to the new student work and lounge area, graduate student offices and faculty offices. Also incorporated within the renovated building is a 50 seat computer laboratory, two large conference rooms with video conferencing equipment, and several new research laboratories. The central location of these facilities within the Ross Hall complex will certainly create a feeling of a home department that is particularly important for students in chemical engineering’s challenging curriculum, where their education will be further enhanced by more frequent encounters with their faculty, fellow students, and graduate teaching assistants within a more technologically modern instructional facility.

L-Building houses three faculty offices, the chemical engineering shops, several graduate student offices, and 1650 square feet of research space. The undergraduate Pulp and Paper Laboratories (2000 square feet) are housed here as well. New since the last ABET visit is a 500 square foot undergraduate student lounge. The lounge provides students with space for group meetings, homework, and study.

The Mechanical Shop Buildings 1 & 3 includes 11,500 square feet of research space for Chemical Engineering.

Wilmore Laboratories underwent a $14,000,000 renovation in 1999-2001. A National Science Foundation grant, the State of Alabama, Auburn University student laboratory fees, and alumni and supporter contributors funded the project. The new facility includes 65,000 square feet of teaching/research laboratory space and office space primarily for Chemical Engineering, Mechanical Engineering and Materials Science. The department has12,500 square feet of state-of-the-art laboratory space, offices for graduate researchers and teaching assistants as well as laboratory space for undergraduate research projects (approximately 20 students per term). Details of the undergraduate teaching laboratories are provided in Section B.6.5.

Currently, lecture facilities utilized by the department are located in Aerospace Engineering Classroom Building, Lowder Business Building, Broun Hall and Ramsay Hall. Aerospace Engineering Building houses the majority of the classrooms (nine rooms) used for our undergraduate teaching. The classrooms used in Lowder and Broun are large (100+) capacity, full multimedia-capable classrooms.

Textile Engineering building currently houses our primary undergraduate computing facility (described separately below).

B.6.2. Computer Laboratories

Our students have access to the chemical engineering computer labs currently housed in Textile Engineering Building. The two labs occupy approximately 1500 square feet (TXTLE 228 and TXTLE 230) and contain a total of 36 Dell Optiplex Pentium PCs running Windows XP. The PCs are new since the last ABET visit and have also been upgraded once during this time. All computers are connected to the Internet through a local area network and have MS Office Professional and state of the art engineering software installed.

The ability to access the Internet at any time is imperative to encourage students to make proficient use of the abundance of information available. This is in line with the departmental desire to instill a desire for life-long learning in our students. Furthermore, the Internet is an excellent resource for keeping up to date with issues related to the professional practice of chemical engineering. Proficiency in the use of common software tools, such as word processing, spreadsheets and presentation programs are inline with several departmental outcomes.

Expertise in the use of process simulation software is of great importance to chemical engineers. From basic simulation of single units (in order to increase the understanding of fundamental underlying phenomena) to simulation of complex chemical plants and systems, a process simulator provides efficient calculation methods. Any simulation software is only as good as the input provided by the user. Therefore, the correct formulation of the problem and critical thinking are required to ensure feasible results.

Use of generic numerical solver routines is preferred over process simulation packages when solving explicit equations rather than modular problems. A wide variety of solver packages for algebraic and differential equation problems are available. Furthermore, special tools are available for advanced mathematical analysis (e.g., signal processing and model identification). Again, the importance of critical thinking in formulation of the problem and analysis of the solution must be emphasized.

Table 6-1 describes the major software products employed by students for engineering analysis.

Table 6-1 Software Availability in Chemical Engineering Computer Labs

Type of Computation	Software Available
Process Simulation and Design	Aspen Engineering Suite v 11.1- (Pinch, Plus, Properties) WinGEMS v 4.5- Paper process design and simulation software.
Mathematical Analysis	Maple v7.0 Matlab v6.5 Polymath v5.0 TK Solver v3.2 EES (McGraw Hill Engineering Equation Solver) Microsoft Excel 2002
Curve Fitting and Data Analysis	TableCurve 2D v4.0 Microsoft Excel 2002
Process Control and Simulation	Rockwell Software: (RS Linx, RS Linx Tools, RS Logix, RS View)
Computer-Aided Design (Mechanical)	Solid Edge v14.0
Written and Oral Communications	Microsoft Word 2002 Microsoft PowerPoint 2002

The department's computer lab is integrated with the college of engineering computer network. Students also have free access to three other college of engineering computer labs. One of these labs houses 48 Sun Ultra 5 workstations running Solaris 2.8 and two are Windows XP labs with 81 Dell Optiplex GX260s. All these labs are open 24 hours, 7 days a week while classes are in session. Students and faculty alike have access to a terabyte of online disk storage for applications and home directories.

B.6.3. Library

The Ralph Brown Draughon Library houses 2.5 million volumes and has a seating capacity of 2,500 designed to serve the study, teaching, and research needs of Auburn students, faculty, and staff. Students have access to an Engineering Specialist in the reference department to help guide them in literature and resource searches for laboratory and design projects.

Computer workstations for accessing the Internet and the libraries' collections, individual study carrels, and group study rooms accommodating four to six persons are also available for student use.

In addition, students and faculty have ready access to the online catalog and holding information as well as electronic journals and scientific search engines (SciFinder) to conduct online research via the campus web system.

B.6.4. Machine Shops

In addition to the College of Engineering machine shop facilities, the Department of Chemical Engineering has 850 square feet of shop space (L-Building 210A and 203) housing a dedicated technical specialist in machining and equipment fabrication. The shops serve to support undergraduate education through fabrication and maintenance of unit operations and pulp and paper equipment, as well as equipment for undergraduate research. The shop is also available for special student projects such as the AICHE Chemical Engineering Car Competition. The department shops were moved from inadequate space in Ross Hall to their current location in 2003. The current space is efficiently utilized and houses numerous hand and power tools including a Monarch toolmakers lathe as well as two smaller Northern Lathes that were purchased in 2003.

B.6.5. Undergraduate Teaching Laboratories

Overview

Extensive improvements have been made to the student laboratories since the last ABET visit. The Unit Operations and Process Control Laboratories now occupy 3000 square feet of space in the new Wilmore facility. These labs include the Reactions Engineering Lab (WILMR 169), the Unit Operations I/ Process Control Lab (WILMR 181), and the Unit Operations "High bay" (WILMR 199). The labs are well equipped with utilities such as steam, air, water, and single phase 110/220 V and 3-phase 120 V power.

<u>Unit Operations Equipment Added or Significantly Improved Since Last ABET Visit</u>

Frictional Losses in Pipes and Fittings

The current apparatus was built in 2004 to replace an older unit. The new unit has more fittings, corrosion resistant piping, and higher pump head in a modular design that allows for easy modification. The feed tank and pump can be wheeled away and used as a mixing tank/pumping system for running salt solutions in the evaporator unit. Students use the pipes/fittings equipment to compare friction factors in pipes of varying diameter and material of construction, and pressure drop due to various pipefittings. Students also calibrate a rotometer and pressure drop flow meter (orifice plate).

Double Effect Evaporator

This is a QVF Process Systems model QT5 double effect evaporator purchased in 2001 with funds from an internal Auburn University "semester transition" grant. The all glass unit consists of two 25 L evaporator vessels with external boilers, condenser as well as ancillary vessels and instrumentation. The unit is used to demonstrate the efficiency of multi-effect evaporators, and for students to study the effect of steam pressure and operating pressure on the economy and capacity of the unit. It also provides students with experience in performing enthalpy balances. The glass construction allows visualization of boiling and recirculation in the external boiler.

Gas Absorption Column

This unit is a 4-inch diameter, 8 foot packed bed absorption column and a smaller boiler/stripping column. The unit was built with funds obtained through an internal Auburn University "semester transition" grant in 2001-2002. It is designed to absorb CO_2 into a diethanolamine solution that is then regenerated. Students study how gas and liquid flow rates affect pressure drop in the column and determine where flooding begins. They may also see how flow rates affect absorption of CO_2. The unit has CO_2 sensors at the inlet and outlet to the column as well as a pH probe to sense carbon dioxide absorbed in solution. Differential pressure meters are used to find pressure drop across the column, as well as gas flow rate by means of an orifice plate meter. A variable speed blower and two variable speed gear pumps provide gas and liquid flow. All flow controls and sensors have 4-20 ma input/output. These will eventually be set up for control and data acquisition for both the unit operations and process control laboratory classes.

Draining Tank Experiment

This apparatus was designed and built in 2003 using department funds. The unit consists of a 6 inch diameter by 12 inch high acrylic tank to which may be attached, draining tubes of varying length and diameter. Students record changes in tank height over time as liquid flows through a given tube. Both water and a 60% sucrose solution are used so that both laminar and turbulent flows are observed. The experiment allows students to compare draining times, friction factors, entrance length effects, and variation from "ideal model" behavior for the various tubes. The apparatus is currently used for the Unit Operations Laboratory I course but is designed to be easily portable so that we may use it for future classroom demonstrations and in-class laboratory exercises.

Centrifugal Pump Test Bench

This apparatus was designed and built in 2002 using department funds. The unit replaces an old pump bench and has improved data acquisition abilities. The unit has an inline torque meter/ speed sensor, paddle wheel flow meter, and a differential cell to measure pump head. All readings are displayed on a PC monitor along with motor efficiency, and pump efficiency so that students may get immediate feedback as to how pump performance parameters vary with changes in motor speed and valve settings. The unit is designed so that pump heads can easily be swapped out so that students can compare similar pumps with different impeller diameters.

Ion-Exchange Columns

This unit consists of 12 inch by ½ inch diameter ion-exchange columns of glass construction. The columns are packed with a Dowex sulfonic acid resin onto which a solution of copper chloride is pumped using a peristaltic pump. Resins of various sizes and degrees of cross-linking are available so that students can compare the effects of different resins (as well as flow rate through the columns) on the absorption curve and breakthrough time. Copper concentration in the effluent is measured by a visible light spectrophotometer and a pH probe is used to track the exchanged (hydronium) species. Data is logged and plotted directly into an MS Excel spreadsheet. Pumps and valves are also controlled from Excel. In addition to ion exchange, students are also exposed to VBA programming and data acquisition/control possibilities.

Reactions Engineering - Batch Kinetics, CSTRs in Series and PFR

These units were built in the new Wilmore Reactions Engineering Lab in 2000, using department funds.

Students use stirred batch reactors to measure initial reaction rates for a fading reaction of the common indicator dye, phenolphthalein. Jacketed glass reactors and bettor stirrers are improvements over previously used equipment, as is the use of a fiber optic "dip probe" spectrophotometer setup to track reaction progress. Students perform the pseudo first order reaction at different temperatures in order to calculate activation energy and the Arrhenius constant for the reaction. Students use linear and non-linear regression techniques to calculate forward and reverse reaction constants respectively.

Students use kinetic data from the batch experiments to model the CSTR and PFR systems and predict reactant conversion. Tracer studies are also performed to measure actual mean residence times for the reactors at varying stir rates. The CSTRs are one and two liter jacketed glass vessels outfitted with have variable speed stirrers. A fiber optic "dip probe" spectrophotometer is used to measure concentration in the reactors. The reactants (phenolphthalein and sodium hydroxide) are fed from 30-gallon tanks through rotometers using centrifugal pumps. Reactor effluent is automatically discharged to the drain. The effluent tank is set up for a future pH control experiment.

The PFR is a 12-foot long, 1-inch diameter pipe, packed with 2 mm glass beads. Students compare predicted conversion with that expected from batch experiments and can observe approximate "plug" flow with dispersion using tracer tests.

Small Scale Sieve Tray Distillation Column

This unit was constructed using a combination of existing components and new parts purchased with department funds. It consists of an 18-tray ¾ inch diameter column with an electrically heated boiler. A "swinging bucket" system is used to control reflux rate. Feed can be introduced and samples taken at 3 different locations in the column. This column is useful when time does not allow us to run our larger bubble cap column. It also has the advantage that because of its glass construction students can view hydrodynamic conditions in the column while operating at steady state, as well as changes in response to process changes. Composition analysis of samples is by refractive index.

Crystallizer

The crystallizer was purchased as built as part of an NSF grant. It consists of a jacketed glass vessel attached to a chiller and fitted with a variable speed stirrer. Solutions of Magnesium Sulfate are precipitated in one of 3 hydrated forms depending on concentration, temperature and agitation rate.

Boiling Heat Transfer

This apparatus is a PA Hilton Two Phase Heat Transfer unit originally purchased circa 1980. In 2002, the unit was retrofitted with a new heating element and seals to convert it from R113 to R141B. Also at this time, pneumatic control valves were added to the cooling water feed lines and the temperature and pressure sensors were interfaced to an Allen Bradley PLC. The PLC is, in turn, connected by Ethernet to a PC running Allen Bradley's RS View and RS Links control software. The DAQ/Control software allows students to easily view process conditions and keeps the system pressure more constant than previously possible. The glass construction unit is excellent for viewing the three boiling regimes. Students study the dependence of the heat transfer coefficient and critical heat flux on system pressure and perform energy balances on the unit. Process Control Laboratory students gain valuable experience using the most modern control software for a difficult control problem.

Tunnel Dryer

An existing tunnel dryer (Armfield Co. Ltd.) was converted from steam to electric power to make portable during remodeling of the Wilmore Laboratories Building. Several major improvements were also made to the unit at this time. An insulated tray outfitted with thermocouples that measure bed temperature at different points was constructed and mounted on a rack atop an electronic balance. Data from the balance and thermocouples are taken directly into an MS Excel spreadsheet. Students get excellent representations of drying curves for porous media (glass beads) of different sizes. Temperature data allows students to see how changes in mass transfer mechanisms relate to temperatures in the bed and to test the assumption of "perfect" insulation. Students determine heat transfer coefficients during the constant rate period by combined mass and energy balances and determine values for effective diffusivity in the second falling rate period.

<u>Additional Unit Operations Equipment</u>

Large Bubble-Cap Distillation Column

This is an 18-tray 1-foot diameter stainless steel bubble cap column built by Brighton Metal smiths and Engineers in 1974. The unit was originally designed for petroleum research so configuration is very flexible allowing for batch or continuous operation with feed introduced on any tray. We typically use the column to distill an ethanol/water solution.

Oxygen Mass Transfer in a Bioreactor

This is a 16-liter New Brunswick model SF116 fermenter formerly used for research. It is fitted with an Ingold polarigraphic dissolved oxygen probe. Students do a step change experiment to determine probe response, and then use an oxygen/nitrogen gassing in/gassing out system to track oxygen absorption rates at various agitation rates and sparge rates. Data is taken directly into MS Excel spreadsheet for analysis; students use the "solver" optimization feature to perform a least squares fit to the model equation and determine K_la following each run. Data is correlated and compared to literature models.

Refrigeration Cycle Demonstration

This apparatus is PA Hilton unit purchased circa 1980**.** The unit demonstrates the Carnot refrigeration cycle and consists of transparent evaporator and condenser sections, and a compressor. Flow rates and temperatures to the evaporator and condenser can be manipulated and the compressor work and coefficient of performance calculated.

Reynolds Apparatus

This Armfield apparatus mimics equipment used by Osbourne Reynolds in his historical flow characterization experiments. A constant head tank drains into a tube with a bell-shaped inlet. A dye injector is positioned above the inlet. Students are able to observe laminar, transition, and turbulent flow depending on the velocity through the tube.

Stefan Diffusion Tube

Students track the change in diffusion path length of a volatile liquid and calculate diffusivity. Tubes are connected to a header over which dry air is slowly passed. The tubes are immersed in a constant temperature bath and liquid levels are monitored using a cathetometer. Students can compare results to literature values. Several experiment variations are used including varying the starting levels of liquid (students use regression techniques to determine how much convective mixing may be occurring at the mouth of the tubes) and employing different temperatures to determine the dependence of diffusivity on temperature.

Catalytic Dehydration of t-Butanol

This apparatus consists of typical chemistry glassware arranged in a fume hood. A heated round-bottomed flask is fitted with a stirrer and reflux condenser. Isobutylene gas produced in the acid catalyzed dehydration reaction of t-butyl alcohol flows to a wet test meter and is used to track the rate of reaction. Students use a catalyst-grade sulfonic acid resin to initiate the reaction and vary the concentration of t-butanol by using either water or methylcyclohexane as diluents. Water inhibits the reaction and the kinetics follow the Langmuir-Hinshelwood form. Students use non-linear regression to find multiple kinetic parameters.

Cooling Fin

This unit was built in-house about 1998. It consists of three rods, three feet in length that protrude horizontally from a steam chest that serves as a constant temperature source. Two of the rods are stainless steel (1" and ½" in diameter) and one is aluminum (½" diameter). Ten thermocouples are positioned along the length of each rod and are interfaced to a data acquisition system. On start up, the transient temperature response is recorded and plotted in real time on an Excel spreadsheet. Students can observe how the different diameters and thermal diffusivities of the rods affect the development of the temperature profile. From the steady-state data, average and local heat transfer coefficients are calculated and compared to what is expected from natural convection correlations in the literature. Students may also model the transient response in Polymath using the Method of Lines.

Transient Centerline Temperature Response

This apparatus was constructed in-house in 2000. The unit consists of a constant temperature water bath and a cylindrical test tank, through which heated water is pumped. Cylinders and slabs composed of various metals are placed in the test tank and transient centerline temperatures are recorded by means of a thermocouple located in the test objects. Students can use Heissler charts and/or computer models to determine the heat transfer coefficient for a given geometry using an object of known composition. Given incomplete physical properties of a second object of the same geometry, students try to identify the material using the transient temperature response.

Fluidized Bed

PA Hilton Unit H692 consisting of a section of 2-inch glass pipe through which compressed air is introduced to a bed of 100-micron glass beads. Flow rate is measured by rotometer and differential column pressure is measured by water manometer. The experiment is used to demonstrate the various fluidization regimes. Pressure drop data is compared to that predicted by the Ergun equation.

Pulp and Paper Laboratories

The pulp and paper engineering laboratory has equipment sufficient for students to manufacture various paper materials starting with wood chips and post consumer recycle materials. Every step of the production process can be done in the lab, and the products fully tested and analyzed. A single-vessel and a two-vessel laboratory digester are used in paper lab courses. The two vessel digesters are automated and are used both for undergraduate teaching and general pulping research.

The laboratory has a complete wet test laboratory for the chemical and physical property evaluation of pulp and paper. Equipment includes Valley beaters, pulpers, laboratory screens, twin M/K digesters, TAPPI standard sheet making, pressing and testing machines. Other pulp evaluation capability includes Canadian Standard Freeness (CSF) testers, kappa evaluation and CED viscosity. A constant humidity, constant temperature room (TAPPI standard) equipped with physical and optical property evaluation of paper and paperboard is available. This capability includes testing of paper for tensile, tear, bust, caliper, air porosity, sizing, opacity and brightness.

The paper-recycling laboratory includes a flotation cell, screw press, tabletop membrane filtration system and a modular large-scale membrane filtration system for wash water clarification.

Process Control Laboratories

Single Tank PID Controlled System

This process is comprised of a holding tank, an air actuated control valve, a current to pressure transducer, a differential pressure sensor, and an Allen-Bradley SLC500 controller with the necessary process cards. The control objective is to maintain a set point height of water in the tank. This laboratory experiment system was designed to illustrate the behavioral patterns of different control regimes while familiarizing the student with control and sensor equipment. By utilizing the latest technology advancements available in the Allen-Bradley Rockwell Software packages, the student is introduced to PID control systems in feedback as well as model predictive configurations in a simple control scheme. This also allows the importance of sampling time and dynamic lag to be illustrated using a real process control system with "hands on" teaching techniques.

Two Tank PID Controlled System

This process is comprised of two holding tanks of different volumes in series, air actuated control valves, current to pressure transducers, differential pressure sensors and an Allen-Bradley SLC500 controller with the necessary process cards. The control objective is to maintain a set point height of water in the second tank. This laboratory control system is used to continue education of control behaviors learned from the single tank experiment, but applied to a slightly more complicated system with increased instability. Because the system is inherently more difficult to control, more complicated control configurations can be illustrated. This system is tested using feedback, cascade, feed-forward and model predictive control techniques. This laboratory experiment also teaches the methods of de-coupling multiple processes to insure overall process control stability.

Two Phase Heat Transfer PID Controlled System

This process is comprised of cooling coils, heating element, air actuated control valves, current-to-pressure transducers, pressure sensors and an Allen-Bradley SLC500 controller with the necessary process cards. The control objective is to maintain a set point pressure over the condensation coils. This laboratory system is used to express possible behaviors of extremely non-linear processes and how they can be controlled effectively. It also illustrates to the student how to engineer complicated specialty control systems by using simple control concepts as building blocks. This system also implements non-linear differential equations into the model predictive control scheme to express the modern control possibilities as computer processing speed capabilities increase.

B.6.6. Conclusions On Adequacy Of Facilities

Overall, the quantity of space available to the department is adequate but will need to be increased and better organized to meet faculty and student needs in the future. Our department is expanding and more research and office space will be needed to house faculty, graduate students and undergraduate researchers. Of particular necessity to the undergraduate program is to have more suitable space for informal student meetings with each other, students from other disciplines, and chemical engineering faculty.

Our current unit operations laboratories are in very good condition and are more than adequate for instruction. The department has made a strong commitment to improving the lab facilities over the last 7 years. We have added many modern experiments since the last ABET visit. However, improvements are needed in several experiments to provide a more meaningful and satisfactory experience focused at specific learning outcomes. For instance, our large-scale distillation column needs a better control system to allow students to obtain data to compare with theory. A significant effort continues to be required to maintenance and improve the teaching lab facilities.

The application of modern control software and control algorithms in the process control lab is a strong point of our program. Additional experiments need to be developed to further enhance student learning.

A traditional strength and unique element of our program is the undergraduate pulp and paper laboratory. The pulp and paper specialization prepares our students for successful employment in this important industry in the southeastern region. These hands-on laboratories play an important role in the success of this program.

We rate our current computer teaching laboratory as fair. The variety and quality of software available to students in the lab is excellent, but the computer hardware will require updating. The physical space that the lab occupies is inadequate as a teaching facility and is inconveniently located. The other College of Engineering computer labs are satisfactory as additional resources for our students. The overall computing and communications infrastructure is satisfactory. Additional multimedia equipped classrooms, videoconference rooms, and wireless computing abilities are needed in the near future. Many of these needs will be met with the upcoming Ross Hall renovation.

Library and machine shop facilities are adequate for our needs.

B.6.7. Future Plans To Improve Facilities

Ross Hall Renovation and Addition

The imminent renovation of Ross Hall will improve our facilities and address a number of our shortcomings. The makeover will add another 8000 square feet of space. Faculty office space will be improved, and modern laboratory space added. A good portion of added space will be in an atrium to be added to the rear of the building. This area will have tables for students to work and is designed to be an inviting space that promotes student-student and student-faculty interaction. Both chemical and mechanical engineering students and faculty will utilize this space. Moreover, a modern 1000 square foot student lounge is also planned into the addition. Wireless networking will be available throughout the building.

The "old auditorium" in the basement of Ross currently serves as storage space and is unfit for other use. The auditorium will have new life in the renovated facility and serve as modern 1800 square foot auditorium to be used for instruction, seminars and meetings. The auditorium will be fully equipped with state of the art multimedia presentation and video conferencing equipment.

A state-of-the-art computer facility will be added to Ross Hall. The old computer laboratory in the Textile Engineering Building will be converted to other use. The new facility will have 2400 square feet of space and contain 50 workstations. The instructor lectern will be equipped with modern presentation equipment. Both Chemical and Mechanical Engineering will share this space. A divider may be used to separate the space for instruction, or the room may be opened up for student use depending on need. Two tables with four seats each are provided for group work. Each table will have ports for linking laptops to the network (or students may use wireless). We believe the proximity of the computer labs to faculty offices will benefit both formal instruction and out-of-class contact between faculty and students.

Undergraduate Laboratory Equipment

On the drawing board are plans to expand the offering of bioengineering experiments. We plan to soon begin phasing in experiments in enzyme kinetics and fermentation. Also, we currently do not have a shell and tube heat exchanger in lab and plan to acquire that equipment. Other unit operations equipment will be added as funds available.

The equipment we have in the Process Control Laboratory is excellent for teaching modern hands-on process control, however as stated previously, we would like to expand the number of experiments. We plan to utilize the gas absorption column (previously described). This column has 4-20 ma sensors and control inputs already in place. All that remains to be done is to interface the unit to a computer-based control system. We plan to add this control system as soon as possible.

The large distillation column (previously described) was once outfitted with instrumentation and controls. When Wilmore Laboratories was remodeled, the controls were removed to give students a more hands-on experience. In retrospect, students probably had a better experience with process controls in place. We plan to again add modern controls to the unit in the near future.

Overall we have very good facilities for undergraduate instruction. We anticipate the level to be "excellent" once these additions are made and the Ross Hall remodel is completed. The fashion in which funding for these improvements to our laboratory facilities is planned and administered is discussed in Section B.7.4.