CERTIFICATE of ACHIEVEMENT & A.S. DEGREE

LANEY COLLEGE
ENVIRONMENTAL CONTROL TECHNOLOGY

Commercial HVAC Systems - Program Development

National Science Foundation - National Center for Building Technician Education

LANEY COLLEGE

BEST
Building Efficiency for a Sustainable Tomorrow

NSF

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COMMERCIAL HVAC SYSTEMS

Program Documentation

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Catalog description

The Environmental Control Technology (ECT) program prepares students to install, service, and operate heating, air conditioning, ventilation, and refrigeration (HVACR) and building control systems. The program teaches the hands-on, technical knowledge and electronic and computer-based skills needed to increase energy efficiency in buildings. Laney's combined 13,000 sq. ft. ECT & Electrical/Electronic Tech facilities include a comprehensive array of training equipment, including a state-of-the-art commercial HVACR and building electronic controls lab. Careers in HVACR and building controls are a rapidly growing green technology field with excellent employment opportunities. Typical job titles include building operator, HVAC technician, refrigeration technician, controls technician, commissioning technician, energy auditor, energy manager, and HVACR sales. Most of Laney's ECT graduates qualify for immediate employment, with competitive wages.

The program offers two certificate options and two degree options. On completion of a full-time 2-semester program (27.5 units), students earn a Certificate of Achievement in Residential and Light Commercial HVACR. Students can earn an Associate of Science (AS) degree in Residential and Light Commercial HVACR on completion of required General Education units, for a total of 60 units. On completion of all four semesters (52.5 units), students earn an advanced Certificate of Achievement in Commercial HVAC Systems. On completion of required General Education units, students earn an Associate of Science (AS) degree in Commercial HVAC Systems, for a total of up to 71.5 units. Most of the courses in this program are transferable to California state universities.

At the discretion of the department, incumbent professional technicians may qualify to earn the advanced Certificate of Achievement in Commercial HVAC Systems by completing only semester 3 & 4 courses, building on their work experience.

Program design rationale and key elements

Laney College Environmental Control Technology department has expanded its program into Commercial HVACR installation, maintenance, operation, automation and energy management in response to rapidly growing regional and state-wide industry demand for a highly qualified workforce that understands building systems, new technologies, energy efficiency opportunities, and the complex strategies needed to meet the State's energy efficiency and greenhouse gas reduction goals.

Goal

Prepare students to install, service, and maintain commercial heating, ventilation, air conditioning and refrigeration systems (HVACR) and controls, with emphasis on safety, occupancy comfort, and energy efficiency including:

- Meet urgent industry demand for HVACR technicians in the commercial sector
- Support State and California Utility Commission mandates for increased building efficiency, green technology implementation, and carbon emission reductions.
- Develop diverse knowledge and skills needed of HVACR technicians in an industry with rapidly evolving technology.

Program-level learning outcomes (PLO's)

- Explain the theory, function and maintenance of commercial HVACR systems including hydronics and control systems.
- Explain the operation of commercial HVACR systems and controls including psychrometrics, system components and types of systems
- Demonstrate ability to interpret construction documents and diagrams to install and fabricate commercial HVACR systems, components, and controls.
- Demonstrate ability to apply building science principles and financially justify troubleshooting and system optimization to save energy while providing comfort and health.

Exit skills

After successfully completing the Commercial HVACR program, the graduating student shall be able to:

- Read and interpret electrical diagrams from construction documents, wired control system documentation, and other types of diagrams.
- Demonstrate ability to design basic control systems as well as diagnose and repair faults in electrical control systems found in small commercial facilities.
- Read and interpret blueprints and specifications used in the installation of HVACR systems, including air ducts, vents, pumps, water and fuel supply lines, and other components
- Install and customize residential, light commercial and commercial HVAC equipment, including ventilation, filtration, and air distribution systems, hydronic systems including pipes, air and water treatment systems, and heat pumps according to relevant building codes and industry standards.
- Perform routine maintenance and diagnostics on a variety of HVACR equipment, such as checking for leaks, adjusting blowers and burners, and

checking nozzles, thermostats, electrical circuits, controls, and other components

- Demonstrate proficiency in component and system troubleshooting, including sequence of operation, diagrams, service diagnosis procedures, maintenance repair and communication findings to others.
- Demonstrate proficiency in electrical work for HVACR applications; demonstrate ability to test, size, operate, and diagnose problems in electrical equipment, including motors, transformers, circuit breakers and conductors
- Demonstrate proficiency in motors and drives for HVACR systems, including understanding types and components, troubleshooting, maintenance, parameter programming, and safety
- Understand HVAC systems design principles, including all-air systems, all-water systems and air-water systems; explain component and systems functions; properly select and size systems and ducts.
- Demonstrate proficiency in HVACR systems installation and servicing: including low temp defrost methods, evaporative condensers, capacity controls, multiplex and multistage systems
- Demonstrate proficiency in service diagnostics, troubleshooting, maintenance and repair of commercial HVACR equipment, including proper charging, leak testing, evacuating and recovering methods
- Describe the different types of software and hardware used in commercial buildings to control the indoor environment comfort.
- Demonstrate ability to conduct data analysis for performance monitoring using data loggers and information provided by control systems;
- Demonstrate proficiency applying data trending and visualization methods to conduct energy analyses, financially justify the recommendations and present the findings to others.

Embedded course sequence including lecture and lab hours

(AS degree option requires completion of additional general education courses; see current sequence at https://lan.curriqunet.com/catalog/iq/10110/10136/16920)

Course #	Course Title	Hr/week Lec/Lab
First Semester		
E/ET 202	*Fundamentals of Electricity for ECT* Introduction to basic concepts of electricity: Ohm's power, electrical circuits, electrical diagrams, magnetism and electromagnetism, instruments and tools used in the industry, safety procedures, and controls and motors.	1.5 1.5
ECT 11	*Mechanical and Electrical Devices*	1.5 1.5

	Introduction to fundamentals of electricity and electronics as applied to HVAC&R operations: Ohm's law, power and electrical instruments, basic electrical AC and DC circuits, electrical and mechanical devices, and electrical and electronic controls.		
ECT 12	*Blueprint Reading and Interpretation for ECT* Basic techniques for reading and interpreting typical design documents, drawings, and specifications: Emphasis on interpreting HVAC mechanical and electrical drawings, symbols and abbreviations.	1.5	0
ECT 13	*Fundamentals of Refrigeration* Principles and processes of refrigeration systems: Thermodynamics, heat transfer, refrigeration cycle, types of systems and piping, energy efficiency, electrical and mechanical components, tools and instruments, brazing and soldering; methods for charging, recovering, and evacuating refrigerants; EPA laws and regulations, and safe handling of refrigerants.	3.0	3.0
ECT 211	*Mechanical and Electrical Codes* Introduction to national, state and local regulations and standards that govern the design, installation and operation of air conditioning, heating, ventilation, and refrigeration systems: Code development process and its adoption and enforcement by local building authorities.	1.5	0.0
ECT 214	*Technical Mathematics for ECT* Selected topics in mathematics with specific application to the HVAC & R industry: Decimals and fractions, ratios and proportions, unit conversions, areas and volumes, application of algebraic equations in gas laws and load calculations, relevant trigonometric functions, and use of graphs to represent and analyze data.	3.0	0.0
WELD 215	*Welding for ECT* Basic theory and manipulative practices of using various welding and brazing methods related to Environmental Control Technology: Electric welding, brazing and soldering using oxy-acetylene and gas cutting equipment.	1.5	1.5
Second Semester			
E/ET 221	*Motors and Drives* Introduction to the application of motors and drives used in commercial and industrial refrigeration, air conditioning,	1.5	1.5

	heating and ventilation: Different types of motors and drives and their applications, including electric and magnetic (VFD) variable frequency drives for improved efficiency control and energy savings.		
ECT 14	*Advanced Refrigeration* Introduction to more complex and detailed methods of investigating and servicing refrigeration system components: Heat pumps, low-temp defrost methods, evaporative condensers, capacity controls, multiplex and multistage systems.	1.5	1.5
ECT 15	*Refrigeration Equipment Troubleshooting* Introduction to troubleshooting practices on commercial refrigeration equipment: Electrical diagrams, service diagnostic procedures, maintenance, troubleshooting and repair, proper charging, leak testing, evacuating and recovering methods, including safety practices.	1.5	1.5
ECT 16	*Fundamentals of Heating and Air Conditioning* Introduction to residential and light commercial heating and air conditioning components and functions: Natural gas, propane gas, forced air, and hydronic equipment; emphasis on reading electrical diagrams, tracking sequences of operation, mechanical principles of operation, and application and safety procedures.	1.5	1.5
ECT 17	*Heating and Air Conditioning Troubleshooting* Troubleshooting heating and air conditioning equipment: Components and accessories and their relation to the functions of residential and light commercial heating and air conditioning; practical instruction on electrical diagrams, sequence of operation, service diagnosis procedures, and maintenance; special emphasis on safety procedures.	0.5	1.5
ECT 18	*HVAC Installation Practices* Introduction to practical applications of residential and light commercial HVAC systems: Proper procedures for sizing and installing electrical and mechanical devices, HVAC equipment, ventilation, filtration, flue pipes (flex, square and rigid duct pipes).	0.5	1.5
ECT 28	*Energy Management and Efficiency in Building Systems* Introduction to technical and economic operating principles of electrical and mechanical devices for making cost-effective decisions and energy-efficient choices: Use of energy analysis	2.0	0

	software tools such as Energy+, Cal Arch, DOE 2, and others.		
Third Semester			
E/ET 11	*Commercial Electricity for HVAC* Introduction to advanced commercial electricity for heating and air conditioning: High voltage single-phase and three-phase, transformers, capacitors, HVAC system controls, motor controls, HVAC electrical schematic diagrams, instrumentation, national codes and safety.	1.5	1.5
ECT 19	*Psychrometrics and Load Calculations* Analysis of the physical properties of air in refrigeration and air conditioning: Use of proper analytical instruments and manual load calculation, and software for calculating cooling and heating loads.	2.0	0
ECT 21	*Introduction to Direct Digital Controls* Introduction to direct digital control systems and building automation systems: Basic electricity and electronics and overview of the various approaches to system architecture, hardware, software, and system components.	1.5	1.5
ECT 22	*Commercial HVAC Systems* Introduction to the physical properties, interactive components, and methods for operating and controlling commercial HVAC systems: Thermodynamic principles of pressure, specific heat, specific volume, density and enthalpy; hydronic systems including boilers, chillers, cooling towers, water pumps, ventilation, filtration, air distribution, controls and instruments.	1.5	1.5
ECT 24	*Commercial HVAC System Troubleshooting* Introduction to troubleshooting procedures for commercial HVAC systems: Methods used for repairing, servicing and installing electrical and mechanical devices, including ventilation, filtration, air distribution, and air and water treatment systems.	1.5	1.5
ECT 25	*Introduction to Building Commissioning* Introduction to fundamentals of commissioning, re-commissioning, retro-commissioning, and mechanical and electrical building systems: Review of building equipment and building control systems and the commissioning, re-commissioning and retro-commissioning process.	1.5	1.5
ECT 212	*Testing, Adjusting and Balancing HVAC Systems* Introduction to theory and practice necessary to properly test,	1.5	1.5

	adjust and balance HVAC systems: Air and water systems, and instruments used to properly balance the systems.		
Fourth Semester			
ECT 23	*HVAC System Design* Introduction to concepts and principles for the design of commercial HVAC systems and system controls: All-air systems, all-water systems, and air-water systems.	2.0	0
ECT 26	*Advanced Building Commissioning* Advanced processes and applications of building commissioning, re-commissioning and retro-commissioning: Conceptual design through the construction process, acceptance testing, writing final commissioning reports, and training of building maintenance and operations personnel.	2.0	3.0
ECT 27	*Advanced Direct Digital Controls* Introduction to advanced concepts and operation of DDC controls: Input and output devices, programming strategies and translating sequence of operation documents for an HVAC system into an operations program for a DDC system.	1.5	1.5
ECT 29	*Data Analysis for Performance Monitoring* Introduction to the methods of acquiring HVAC equipment performance data to improve operations and reduce energy consumption: Emphasis on data acquisition through the use of portable data loggers and DDC control systems; methods of trending and visualizing data through the use of electronic databases and spreadsheets such as Microsoft Excel.	1.5	1.5
ECT 40	*Introduction to Control Systems Networking* Installation and use of common digital control-system networks: Practices for the installation of some of the standards, such as MS/TP, ARCNET, LONWORKS, Ethernet networks, etc.; benefits of each type of network and diagnosis of common network problems.	1.0	0
ECT 213	*Indoor Air Quality and Building Envelope* Introduction to building indoor air quality standards and maintenance procedures associated with comfort and health problems faced by workers and managers: Building envelope and testing procedures for proper service and maintenance of building heating, cooling and ventilation systems.	1.0	0
Total	**Total Lecture / Lab Hours:**	**42.5**	**31.5**

Rationale for course sequences, pre-requisites, and co-requisites

The Commercial HVAC Systems program has a **2-year** certificate structure. **Year 1** teaches the fundamentals of HVACR system function and equipment while preparing students to enter the residential/light commercial HVACR technician workforce. **Year 2** broadens and deepens the first year fundamental curriculum by teaching commercial building systems and addresses problem solving, critical thinking, hands-on, and computer-based skills so that new graduates can better meet industry's growing demand for a highly qualified workforce that understands building systems, new technologies, energy efficiency opportunities, and the complex strategies needed to meet the State's energy efficiency and greenhouse gas reduction goals. **Year 2** is designed to be attractive to incumbent workers seeking career development. At department discretion incumbent workers may substitute work experience for Year 1.

Sequences of topically related courses:

- Refrigeration system service technician troubleshooting and service. Gives student basic knowledge of refrigeration cycle components, systems, safety, soldering and the industry.
- Residential/small commercial HVAC system service technician troubleshooting, service and install. Gives students basic knowledge of HVAC components, systems, sizing and installation.
- Energy conservation and indoor air quality. Gives students introduction to comfort, safety, and quality installation.
- Commercial HVAC system troubleshooting, service and design. Gives students broadened knowledge of hydronic and water-cooled systems.
- Commercial HVAC system controls monitoring, analysis, and troubleshooting. Gives students an overview of controls equipment and issues.
- Commissioning and data analysis. Gives students broad experience optimizing commercial HVAC systems and controls and financially justifying the investment in energy conservation.

Inputs for program design and development

The US DOE Building Technology program is developing [draft for review] Job Task Analysis (JTA's) for 6 building technology career paths. DOE is using the DACUM (developing a curriculum) process to elicit industry expertise about efficiency job tasks

CTE "Green Occupation Profiles for San Diego/Imperial Counties" p41-43 lists skill/ability requirements for HVACR technician, and gives synopsis of employment data.

NATE certification topics and requirements inform how we develop course content in the Commercial HVACR program.

Student feedback: Laney ECT uses Survey Monkey to administer surveys to track and inform the development of the program and courses. Some sample Likert scale questions (using levels of agreement/disagreement) follow:

- I received safety training that ensured my safety and the safety of others in the lab
- After taking this course, I have a better understanding of the theory on building commissioning
- I was exposed to real-life problems in the industry
- I learned to trouble shoot the kind of problems I will encounter in the field
- I enjoyed the opportunities in the class to work with classmates as part of a team
- I now have a better understanding of career opportunities in the HVAC industry
- It was important to me to practice my technical skills on real equipment and devices
- The renovation activities in the lab this semester interfered with my learning
- While taking this program, new job opportunities in the field opened up for me (promotion, new job, higher salary, etc.)
- The course met my expectations in gaining new knowledge and skills in this field
- I would recommend this program to another student.

A.S. degree option: general education requirements

With additional study students may earn the Associate of Science (AS) degree in Commercial HVACR Systems. The Peralta Community College District requires that at least 19 units be completed in General Education, distributed among the following areas: Natural Science, Social and Behavioral Sciences, Humanities, Language and Rationality (choose one course from each sub-set in English, Mathematics, Computer Literacy, Oral or Written Communication or Literature), and Ethnic Studies. Click here to see the **Laney College General Education Requirements for AA/AS Degrees**.

Transfer institutions, programs, and credits

Pennsylvania College of Technology (PCT): Completion of the Laney ECT Commercial HVAC Systems AS degree qualifies student for 65 credits toward the PCT Building Science and Sustainable Design Major.

Laney ECT hosts "Physics for Building Science (PBS)" a free summer program for high school juniors and seniors, in which they can study physics as an introduction to building science and energy conservation technical careers. Students earn high school physics credit and college physics credit simultaneously in this 5-week intensive. This is a STEM program to build career pathways into technical disciplines.

Alumni follow up is recommended to assess effect of program on technical career choices influenced by the PBS program.

Industry involvement

Industry involvement - best practices

A starting point for program development is creation of an Industry Advisory Group.

The group should collaborate with faculty to develop skill sets and course requirements responsive to modern industry needs.

Laney's advisory group is comprised of large employers, manufacturers, suppliers, contractors, utilities, municipalities, colleges, and state agencies.

Laney ECT's experience with Industry Advisory Group:

Advisory group members continue to confirm that the lack of qualified HVAC technicians is one of the greatest barriers to improving occupancy comfort and energy efficiency in commercial buildings. Anecdotal evidence from advisory group voices has validated the importance of professionalizing the career of the commercial HVAC technician.

Key recommendations included teaching systems thinking and complex problem-solving along with troubleshooting and diagnostic skills and integrating an awareness of energy management and efficiency throughout the program.

In addition, having a multi-stakeholder advisory group has allowed the Laney ECT program to stay connected to regional and national policy issues affecting building technician education and training. Laney's advisory group for its NSF BEST Center is now likewise a multi-disciplinary group, comprised of national stakeholders in the building industry and policy arena. The NSF BEST Center advisory group will have an even stronger advocacy role.

Advisory committee notes are provided in Attachment C

Samples of industry involvement:

- Equipment and software donations with minimum $400,000 value.
- Engineering and design assistance for our HVAC and controls laboratory
- Case study development
- Curriculum review
- Guest speakers
- Placement of Laney graduates
- Discounts for professional training for instructors
- Field trips and opportunities for on-site hands-on learning on-site (such as collecting data at a government facility)
- Use of the advisor company facilities, tools, and labs

Invitation to participate in regional and national conferences

Labor market needs analysis

The ECT department chair regularly receives employment notices and urgent requests from industry and public agencies. Demand for technicians qualified to work on commercial buildings is particularly high. Many ECT students get placed in jobs before even finishing the ECT program.

'The state of California has determined that the best strategy for addressing climate change and energy supply sustainability is efficiency. In commercial buildings this starts with the development of adequate workforce education and training for HVAC contractor/owners, service and installation technicians, sales representatives and building officials. Studies have assessed gaps in industry skill sets and formed an effective action plan to address these gaps. Support should be provided to certify new trainers and courses and provide incentives directly to technicians who complete training.' Excerpted from California Public Utility Commission (CPUC) language in the **California Energy Efficiency Strategic Plan (2008)**.

Appendix A lists several key data sources for LMI analysis indicating the high demand for graduates of the Laney ECT programs:

Typical job titles and pay ranges for program graduates

Since 2003 Laney ECT has tracked many completing students' placement. Students completing the program typically seek employment as refrigeration technicians, heating, ventilation, air conditioning technicians, sales engineers, equipment and system installers, parts supplier personnel, operations and maintenance technicians, building engineers, controls technicians, and energy specialists. Reported income from placed alumni ranges from $11 to $47 per hour, both hourly and salaried. The median pay was $19 per hour. See Appendix B for selection from our list of over 100 placements.

Links to employment data

Current government data on the HVACR industry:

- U.S. Bureau of Labor Statistics: Work Environment for HVAC
- U.S. Bureau of Labor Statistics: What Heating, Air Conditioning, and Refrigeration Mechanics and Installers Do
- U.S. Bureau of Labor Statistics: How to Become a Heating, Air Conditioning, or Refrigeration Mechanic and Installer
- U.S. Bureau of Labor Statistics: Occupational Employment and Wages, May 2011, Heating, Air Conditioning, and Refrigeration Mechanics and Installers
- U.S. Bureau of Labor Statistics: Job Opportunities for Heating, Air Conditioning, and Refrigeration Mechanics and Installers

State (CA) strategic plan for HVAC efficiency:

HVAC job placement info from About.com:

"What is an HVAC Technician" by Aurelio Locsin, Article summarizing employment options, with links to related articles and sources.

Alignment with industry certifications

The Commercial HVACR program content and methods are informed by and coordinated with the outcomes of the following certifications:

North American Technician Excellence(NATE) Technician competency exams cover the topics of: Heating Cooling, Air Distribution, Heat Pumps, Radiant Heating, Light Commercial Refrigeration, and Commercial Refrigeration Certifications. NATE certification topics and requirements inform how we develop course content in the Commercial HVACR program.

HVAC Excellence, ESCO Institute (EPA refrigerant handling certifications). Dedicated to certifying technicians, educators and programs to meet regulatory and industry standards. See "A Guide to the Certified Master HVAC Educator Core Exam" for competencies and resources.

Affiliations with industry organizations

Refrigeration Service Engineers Society (RSES) –Laney ECT collaborates with local chapter. Trade group specializing in training and certification of HVACR professionals and trainers. They publish a comprehensive, timely journal about improving the HVACR industry. Laney staff read and incorporate timely content from journal articles into courses.

American Society of Heating, Refrigerating, & Air-Conditioning Engineers (ASHRAE) Laney ECT is a Golden Gate chapter member. ASHRAE sets design and installation standards, publishes resources, and provides training. See educational resource publications listing.

Additional industry organizations

PAHRA The Partnership for Air-Conditioning, Heating, Refrigeration Accreditation (PAHRA) is an independent, third-party organization that is a partnership between heating, ventilation, air-conditioning and refrigeration (HVACR) educators and the HVACR industry that will award accreditation to programs that have met and/or exceeded industry validated standards.

Air Conditioning Contractors of America (ACCA) Trade organization that promotes professional contracting, energy efficiency, and healthy, comfortable indoor living.

Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Industry organization focused on certifying quality equipment.

Council of Air Conditioning & Refrigeration Educators (CARE) Industry supported organization dedicated to HVACR. Members are HVACR instructors, administrators and other HVACR industry personnel from across the United States

Heating, Air Conditioning & Refrigeration Distributors International (HARDI)

Represents companies that distribute, and support heating, air-conditioning, and refrigeration equipment, parts and supplies to serve installation and service/replacement contractors institutional maintenance staffs

Plumbing-Heating-Cooling Contractors-National Association (PHCC) has contractor members who manage businesses in residential service, new construction, commercial and industrial markets

Recruitment

A recruitment strategy should strive to maximize the diversity of opportunities for students to both enter the program and gain employment upon completion. Also, alternative exit paths before completion should be considered. To meet institutional goals, serving a large entry population, then encouraging incumbent skill-development seeking students to enter advanced courses can even overall enrollment. Wide collaboration with industry and institutions can open doors throughout the program.

Program entry standards:

Laney College ECT department serves a diverse student population and is an entry point to higher education that is open to all. Our approach is to enable students at any level to reach their potential with learning tools we provide. Our experience has been that the following characteristics lead to success:

- previously acquired aptitudes
- academic preparation
- computer skills
- industry experience
- technical skills
- study skills
- focus
- hands-on proficiency
- self-directed researcher
- ability to think critically to solve problems

Sources of potential students:

Every locale is shaped by unique demographics and economic conditions. Laney has found that commercial HVAC students might come from a variety of sources including residential HVAC students and technicians, building maintenance, existing building operators, facilities staff, and other building trades.

Program infrastructure

To operate its program, Laney requires staffing, classroom space, A/V equipment and computer lab space to support 7 simultaneous courses (up to 16 credits) per semester.

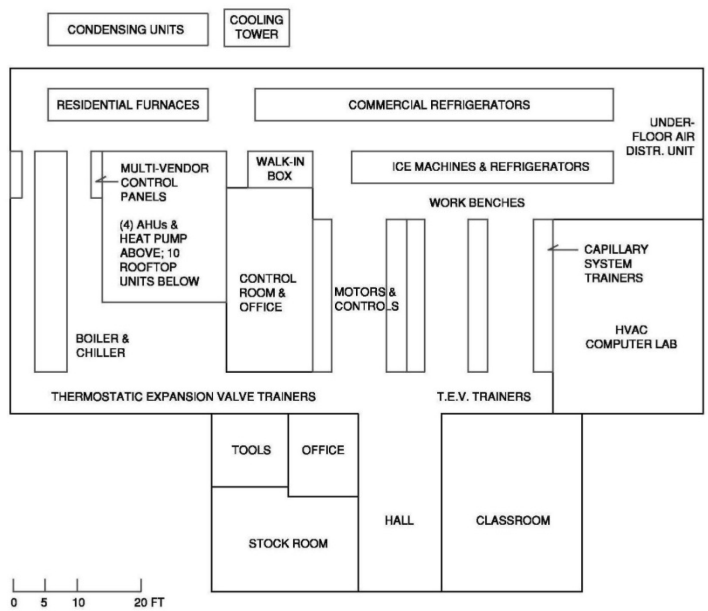
Laney's experience is that nights/weekends make program accessible to working students. Staff could be 4 to 6 part-time instructors anchored by 2 full-time instructors acting as director and co-director. Director/co-director will need to work many hours on development, collaboration, outreach and outfitting and administering the program.

Accessibility of equipment

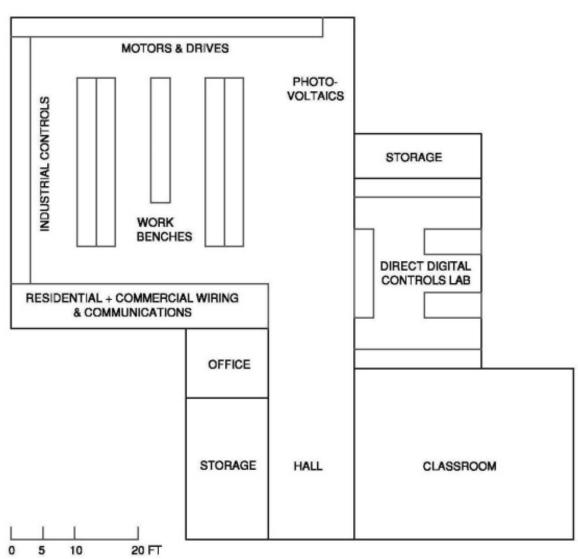
Development of a commercial HVACR systems program requires access to a state-of-the-art building systems lab including equipment, control systems and instrumentation. Student access to equipment is key: safety measures to protect students as well as equipment, space for viewing and working, adjacent classroom area, computer lab area, instrumentation storage area, set-up and maintenance facilities, and accommodation for nighttime classes with year-round simulation of all weather conditions. A high-bay industrial type space with access for installing and operating equipment and accommodating ongoing modifications is key.

Lab layout & elements

See the Building Efficiency for a Sustainable Tomorrow (BEST Center): NSF National Center for Building Technical Education web page for current description and images of the Laney ECT lab facility. Lab plan and sample image below:



LANEY COLLEGE - ENVIRON. CONTROLS TECHNOLOGY
LAB FLOOR PLAN (area = 7500 sf)

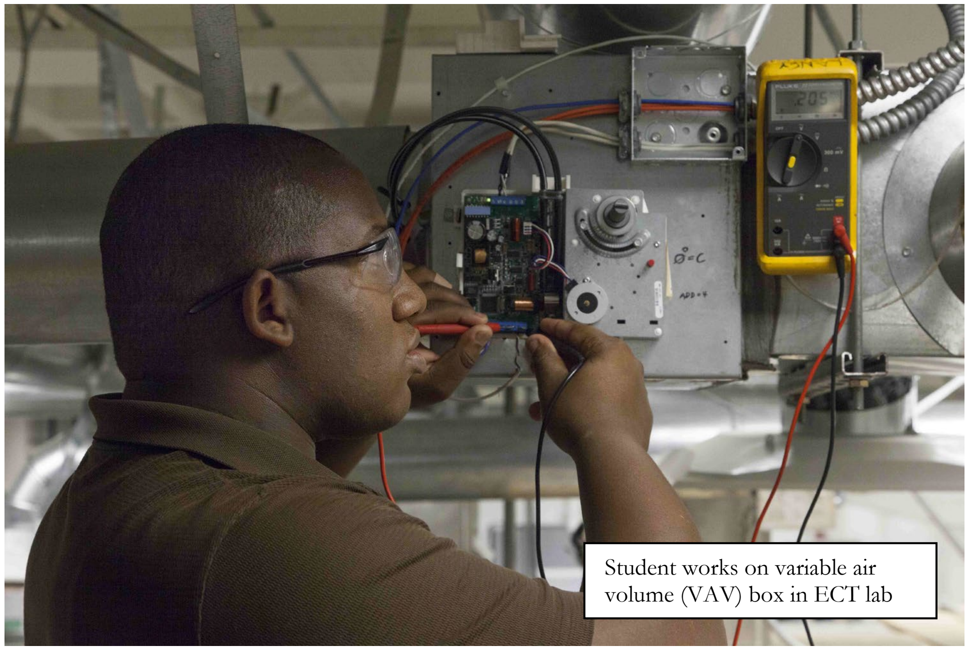


LANEY COLLEGE - ELECT. / ELECTRONICS TECH.
LAB FLOOR PLAN (area = 5500 sf)

Photographs of setup

Boiler, left, and chiller connected to exterior cooling tower

Unistrut structure carries piping safely overhead and allows ready access to equipment.



Student works on variable air volume (VAV) box in ECT lab

Exterior cooling tower adjacent to ECT lab

Essential lab equipment - function and application in classes

- **Water-side equipment:** Chiller, boiler, 4-pipe hydronic system, circulation pumps, heat exchangers, mixing valves, water treatment equipment.
- **Heat rejection:** Cooling tower, condenser water pumps, water treatment.
- **Air-side equipment:** Fan coil units, built up air handling units, ductwork, economizers, VAV boxes, diffusers.
- **Package units:** DX rooftop
- **Control systems:** pneumatic, DDC w/wired and wireless control networks.
- **Residential and Refrigeration Equipment** for the foundational first year: Refrigeration trainers, cases, furnaces, motor stations, worktables, basic metal working facilities.

Commissioning the lab: The commercial building equipment should be commissioned at the component level and the control system level. Laney ECT lab has 3 separate control systems, ALC, Trane Trace, and Cypress. The integration of the 3 systems requires commissioning also, to create an aggregate data display and allow graphic presentation of systems operating states.

See Laney ECT's **HVAC Lab Inventory 2012.xls** spreadsheet for comprehensive equipment function and course applicability.

Tools & instruments - function and application in classes

A critical question for a hands-on program is how many students per piece of equipment to effectively teach and control program costs. Laney requires students to furnish their own hand tools including a multimeter and provides more complex tools and instruments. The ECT lab has one complete commercial central system, with 6 air handling units connecting to many terminal units, and 3 separate networked control systems. For the first-year fundamentals courses Laney provides refrigeration trainers, DX air conditioning systems, residential furnaces, commercial cases.

To increase access to control systems for troubleshooting purposes, trainer boards including actuators are set up parallel to the connected building system.

Typical group size in the fundamentals courses is 2 or 3 students. In courses using more complex instrumentation, students work in larger groups.

List of tools and instruments: brazing torches, vises, compressors for disassembly, refrigerant recovery and recycling machines and cylinders. Commercial tools: infrared thermometers, anemometer, balometer, ultrasonic flow meter, manometer, strobe tachometer.

See individual course documents for application of instruments to courses.

Pedagogy

Problem-based learning

Problem-based learning (PBL) is a learner-centered pedagogy in which students explore a subject in the context of complex, multifaceted, and realistic problems. The goals of PBL are to help the students develop flexible knowledge, effective problem-solving skills, self-directed learning, effective collaboration skills and intrinsic motivation.

Through PBL, students:

- Become immersed in open-ended scenarios simulating real-life work situations
- Work in groups, identify what they already know, what they need to know, and how and where to access new information that may lead to resolution of the problem
- Explore a problem or scenario that is presented with missing information and is open-ended allowing for critical thinking and analysis, thus generating a range of solutions that have not been suggested before
- Determine if the problem suggested is the real problem or whether there is a different problem that needs to be solved

List of PBL scenarios used in Commercial HVACR Systems program courses:

ECT 16: Fundamentals of Heating and Air Conditioning, "Noisy Air Handling Unit #3 in Room B-150″

ECT 18: HVAC System Installation, "Furnace Installation in a Residential House"

ECT 23: HVAC System Design, "Redesign the Air Conditioning Layout"

ECT 24: Troubleshooting for Commercial HVAC Systems, "How to Keep the Chiller Running"

ECT 27: Advanced Direct Digital Controls, "Why is the Light On"

ECT 212: Testing, Adjusting, Balancing (TAB),"Determine the Performance of the Air Conditioning System"

Learning strategies outside of the classroom

Laney ECT encourages but does not require completion of internships or co-ops to fulfill program requirements. Formal internships can be difficult to organize locally in the commercial HVACR industry due to insurance, contract and staffing challenges. However, volunteer opportunities exist, especially in the residential HVAC installation industry. For example: Habitat for Humanity (San Francisco) - ongoing multifamily installation volunteer work and internships; and Habitat for Humanity (East Bay) - ongoing single family installation volunteer work.

Appendix A – Sources of labor market needs analysis

1)The California Public Utility Commission (CPUC) has published a **California Energy Efficiency Strategic Plan (2008)**. During the development of this plan, stakeholders indicated that "**the HVAC industry needs considerable career education and design/installation training,**" and that the labor shortage in the HVAC industry is "beyond critical".

The plan has 2 Workforce Education & Training goals: **First** to "Establish energy efficiency education and training at all levels of California's educational systems" by taking action to: "Support the community college and adult education efforts to support students to develop their education based on visible career paths in energy efficiency and related fields", "Utilize community colleges to provide technical training such as HVAC maintenance and building operator certification", "Develop appropriate linkages with K-12 programs", and "Coordinate with the community colleges and adult education sector to incorporate an energy component into their career laddering concept".

The **second** goal is to: "Ensure that minority, low income and disadvantaged communities fully participate in training and education programs at all levels of the DSM and energy efficiency industry" by taking action to "Collaboratively identify appropriate goals and strategies to build California's energy efficiency workforce through 2020, focusing on training that increases participation from within minority, low-income and disadvantaged communities in achieving California's economic energy efficiency potential", and to "Leverage Marketing Education & Outreach and Workforce Education &Training task forces to partner w/ community-based organizations and provide targeted outreach on employment opportunities with energy efficiency", "Develop Low Income Workforce Education &Training Plan", and "Train qualified diverse business enterprises from minority, low-income and disadvantaged communities to undertake or expand efficiency services". (p. 74-78,CEESP)

Laney College's student population primarily comes from minority and low-income backgrounds.

2) **CA Energy Efficiency Industry Council report** indicates job growth and deficit of communication skills, customer relation skills, and utility industry knowledge.

3) The **Centers of Excellence – "Smart Grid – Industry Profile"** Nov 2012 indicates HVAC maintenance and Building Operations will be key industries needing efficiency training to meet Smart Grid technical goals.

4) The **Current Situations and Trends In Buildings and Facility Operations Report,** (Building Intelligence Group, 2010) outlines technological, economic and

environmental trends indicating training requirements for a higher level competency for HVACR technicians.

5)The Dept. of Labor's "Occupational Information Network (O*Net) Green Employment Summary Report for **Heating & Air Conditioning Mechanics & Installers** (2011) and indicates robust job growth in the occupation.

6)The Bureau of Labor Statistics "Occupational Outlook Handbook" indicates for **Heating, Air conditioning & Refrigeration Mechanics and Installers** 34% national employment growth 2010 to 2020.

7)The **National Center for Construction Education and Research NCCER** publication **Cornerstone (Fall 2011)** lead article indicated HVAC installers are a key trade in implementing green construction, a predicted growth sector. (p. 20)

Appendix B – Placement and wage data

Company Name	Job Title	Starting Pay	Year	Date job started	Job referral
West Contra Costa Unified School District	HVAC & Refrigeration	$24.00			
Episcopal Senior Communities San Francisco Towers	Facilities Director	$7,917.00		Nov-11	Own
A/C Heating Mechanical Inc.	Technician	$42.00			Own
Pacific Gas & Electric	Technician Coordinator	$38.00		Summ-07	Teacher
Episcopal Senior Communities San Francisco Towers	Maintenance Manager Building Engineer	$6,100.00		Nov-11	Own
Complete Building Services	Stationary Building Engineer	$35.00			Own
Highland Hospital		$34.50			
AC Heating & Cooling Service Inc.	Technician	$44.00			
Westin St. Francis Hotel	Stationary Engineer	$33.75		Apr-05	Own
Carrier	Account Sales Manager	$33.50		Sep-07	Own
Copeland Mechanical	Service Technician	$30.00		Oct-12	Own
Bayer Healthcare	Engineer Maintenance	$29.19		Feb-09	Teacher
Alameda County Juvenile Hall	Building Maintenance, Equipment	$29.00		Sep-07	
Siemens	Service Specialty	$58,000.00		Jun-12	Teacher
Siemens	Service Specialty	$58,000.00		Jun-12	Teacher
Bayer Healthcare	HVACR Mechanic	$27.81		Oct-07	
Bay Area Rapid Transit (BART)	HVAC Mechanic	$27.50		Jul-11	Own

Bay Area Rapid Transit (BART)	Maintenance	$27.24	Apr-12	
Key Refrigeration	HVAC Technician	$27.00	Sep-12	Teacher
Cooper Hawkins	HVAC Technician	$26.50		
San Francisco Veterans Medical Center	Air Conditioning Equipment Mechanic	$25.31		
California Pacific Medical Center	Utility	$25.00	Jan-10	Own
Engineered Mechanical Systems	Mechanic	$25.00	Mar-12	Own
Kellogg	Maintenance Mechanic Technician	$25.00	May-04	Own
Livermore Lab Akima Infrastructure Services	Optics Processing	$25.00	Aug-11	Own
Children's Hospital Oakland	Utility Engineer	$24.50	Apr-12	Own
Able Engineering	Utility	$24.00	Nov-12	Own
Legacy Mechanical	Utility Engineer	$24.00	Oct-07	Own
Bently Holdings CA LP	Utility Engineer	$23.68	Jul-12	Own
W. San Francisco	Utility Engineer	$23.50	Mar-12	Own
Con Global	Refrigeration Technician	$23.00	Nov-08	Own
San Leandro Unified School District	HVAC Technician	$46,000.00	Jun-10	Own
USPS	Building Equipment Mechanic	$23.00	Feb-08	
Peralta Community College District	Stationary Engineer	$22.50	2006	Teacher
Yerba Buena Center for the Arts	Building Maintenance	$22.50	Feb-10	Own
Yerba Buena Center for the Arts	Building Maintenance	$22.50	Feb-12	Own

American Chiller Systems	Apprentice Service Technician	$22.00	Mar-04	Teacher
Department of Veteran Affairs	ALC Mechanic	$22.00	Mar-07	Own
Sequoia YMCA	Building Engineer	$21.32	Mar-05	Own
Key Refrigeration	Service Technician	$21.00	Mar-06	Own
American Inc.	Maintenance Technician	$20.22	Feb-04	Own
Bay Point Technologies	VFD Technician	$20.20	Oct-06	Teacher
ACCO Engineering	Service Technician	$20.00	Oct-03	Teacher
MET Labs, Inc.	Maintenance	$20.00	Feb-11	Own
Viox Services	Mobile Mechanic	$20.00	Mar-09	Own
Dependable	HVAC Technician	$19.87	Jun-05	Teacher
Elite Line Services	Technician	$19.27	Apr-08	Own
Eco Duct, Inc.	Materials Exp.	$19.00	Aug-06	Teacher
Legacy Mechanical	Utility Engineer	$19.00	Aug-05	Own
Sears	HVAC Technician	$19.00	Jan-04	Own
Honeywell Corp	Apprentice	$18.60	Sep-07	Teacher
THERMAXX, Inc	HVAC Technician	$18.50		
	Union Apprentice	$18.50		

Appendix C - Industry Advisor Inputs

1) Function of the Industry Advisors

The industry advisory group is critical to the formation and direction of the ECT programs. The program goals of providing job readiness training grounded in a broader education require constant reconciliation with industry needs, trends and goals.

2) Suggested educational content requirements

Ideas informing what should be included in the curriculum:

Sequences of operations have become more complex relative to building technology. Adoption of ASHRAE standard 189 (for high performance buildings) by building codes would lend much needed push. Example: building operator not understanding use of running multiple variable-speed chillers at partial load, then altering to run only one chiller at full load

Communication: driving information upwards to management, how can my building perform better, thus how can my operator perform better? Visit to MD community college highlighted use of dashboards, energy manager in place, making performance visible, people are asking questions.

Communicating with decision makers and financial people, should be important in the curriculum.

Teamwork and Communication: skills are needed among technicians, ability to work and communicate within large teams.

Career pathway for trades to move into decision-making roles. Certifications and training choices can be overwhelming, **mentoring and advising** can help clarify.

Evidence based design: using monitoring performance data to inform design of buildings. Would like to see these curriculums tied together – performance monitoring, HVAC, and design.

Problem-based learning example 1: An instructor at UC Berkeley came into a new lab, and a light over the door would come on. The laser had rolled over to a redundant system. Chuck took photos, gave students all of the info they would need to find the cause. Students go through the sequence of operation, to discover the cause being a differential pressure switch. (from experience, next time would use video instead of photos)

Problem-based learning example 2: Conference room on 7th floor at Laney, mostly glass, NW exposure. IAQ & thermal instability issues. Find out what is wrong & come up with designs to mitigate these problems. Challenging the preconception that there is only *one* best expert design solution. This was a 7-week project. Instructor stressed learning to value the *process*. Assignment includes practicing real-life professional skills, including interviewing a client, mock documents the students could familiarize themselves filling out & using, architectural plans…Will end with a presentation period with every participant required to participate.

P**BL scenarios also should include real-life situations and conditions** – ex. time or funding *constraints*, working in retrofit situations. Under tight constraints & pressure, how can you maximize goal of highest air quality & energy efficiency, vs. what is common to abandon the ideal for quick short-term fix response to the constraints. Industry feedback can help to add these levels of complexity to the teaching exercises.

PBL earlier– need for transforming first 2 years – project based learning from the start – before more advanced engineering.

O&M 101: A "Why" course. How do you interest students in the field of facility O&M? There isn't an O&M 101 for freshmen. How do you introduce students to look at energy mgt& energy efficiency at first year – energy management & environmental sustainability - where students get an introduction to heating & cooling – an awareness of what these systems are & why they are important. Students need to understand how the buildings we live in affect our daily life & the health of our world.

Continuous Commissioning, aggregating data across many automated systems, Six Sigma approach to dispatch operators as operations go out of spec before real problems arise.

Curriculum development around building system equipment and control systems present in the lab. Content will focus on the hardware and programming for each vendor represented, as well as single platform communication to monitor all the control systems. The goal is to reflect real world building operation situations.

Learning how to do an energy balance is an important activity in the lab.

Hands-on experience needed: Internships. Building audits etc.

Building Automation Certificate 2009 approval inputs:

- Laddered sequence of complimentary courses for this certificate. Three industry advisory meetings about the building automation curriculum since 2008.

- We feel pretty confident that we have a good grasp on the certificate, and we are looking for approval and/or feedback.

- Energy efficiency aspect of program emphasized by industry advisors.

- Hardware and software knowledge is *very much* needed.

- Note: in 2013 the program includes ECT1 Physics for Building Science in the first semester. **Agreement:** include a2-unit course in first semester: "How systems work" or "Whole Building Design" with applied physics embedded in it. Question asked was: should we add an applied physics course – heat transfer etc?

  - ❒ **Yes** - applied physics is energy metering and energy balancing – the first law of thermodynamics. That's what you could emphasize more…focus on energy balance. You need to know about sensible and latent heat transfer because we need to deal with moisture issues and if you don't understand psychrometrics, you're not prepared. Because there is not enough k – 12 experiential physics. Our education does not prepare kids to understand heat flows, latent heat, energy exchanges – from a high school course in physics – nothing is transferrable. Should we include **ECT 19 Psychrometrics & Load Calculations** instead? Instrumentation and measurement drive controls. Students need to understand calibration and maintenance. If you cover performance monitoring, you need to teach how to perform an energy balance. Laney is offering the Physics for Building Science summer course for high school students. – it's a CSU transferrable course. We are looking to make it a requirement for ECT students.

  - ❒ **No** - this course is a beginning course for energy technicians and you would hire a more advanced person for that kind of math. It may be more advanced than what this is looking for. Because we are streamlining this curriculum for control tech, they aren't getting all the courses that the deeper program gets. That kind of psychrometrics is imbedded in controls. Instead do a pre-requisite (self study) on-line or equivalent. We need a streamlined program. There also needs to be a **core thread**, even if there isn't a class itself because students need repetition and application to learn physics concepts. Emphasis on measurement has to complement the emphasis on control.

  - ❒ **Create an introductory course covering physics**: The concept of a HVACR basics course is beneficial. Maybe not a WHOLE psychrometrics course, but contextualizing the essence. A hands-on course which investigates the principles and introduces proper equipment sizing. The title should open doors for students. Eliminate the word Physics, maybe title '**How HVAC Systems Work**'. They need to know two principles of thermodynamics, keeping the heat in, the larger the AC, the more energy it takes to keep it going. Focus again on understanding the big picture & whole building design is important. This could be part of an 'Introduction to Energy Issues/Careers' class, an introduction to the big picture, understanding influencing factors and seeing other fields involved. A 2- or 3-unit course the first semester "Controlling the Environment: the Basics". It's a disservice to wait until the 3rd semester to talk about physics. How about a "**whole building design**" course? The whole systems approach (see who is to blame in the building process) would be useful as well.

- **Leave pneumatics course in but focus on applications for control technicians**
  - ❒ The logic involved in pneumatics provides a foundation for understanding how DDC controls systems. Knowing DDC does not inform students about pneumatics.
  - ❒ Are pneumatics for control students or for HVAC systems students?
- **Rename to Introduction to DDC Hardware**
  - ❒ Networking and Troubleshooting Course is weak
  - ❒ It should include IP networking, network configuration etc.
  - ❒ Is there going to be an inside or outside network?
  - ❒ More often than not, computer people come in for database management.
  - ❒ **Noted** that technicians that have these skills often graduate from a 4-year program.
- People should learn a little something about **basic electricity**
- **In Conclusion:**
  - Add "How systems work" or controlling the environment during semester 1 – integrating physics and psychrometrics in the building design
  - Beef up controls systems networking course (Paul will help out on this one).
  - **Note:** in 2013 the DDC and Networking sequence consists of:
    - E/ET 202 Fundamentals of Electricity for ECT,
    - ECT 37 Intro to PC Hardware & Software for Building Technicians,
    - ECT 21 Intro to DDC,
    - ECT 31 Intro to DDC Hardware for BAS,
    - ECT 27 Advanced DDC,
    - ECT 32 Control Systems Design,
    - ECT 33 Control Systems Networking, and
    - ECT 35 Control Systems Integration

3) Program needs

What is needed to run a high value program

Structure

Standards: Need a consistent standard for training, what do students learn in comm. colleges so resources aren't spent in re-training? We might look at a standardized curriculum as a baseline with specialized modules added on. New approaches, technologies and products need to be assessed for inclusion continually.

Technology Gap – it is hard to keep up with new technologies entering the market. Need education on identification & use of technologies, vs. new technology development.

Define the Building Operations field and create diagram which maps paths to it. A visual chart can be very useful. For example, ATEEC focuses on bringing industry to forums to identify career paths

People Gap – "superhero" theory – any technician should be able to learn quickly, be adaptable to ever-changing climate, and fix every problem. Outcomes should present a reasonable, achievable goal for students.

Unions: explore the connection with education & partnerships

Infrastructure

Can we offer training to the private sector which can provide funding in return: facilitate market funding to benefit community college programs?

Multi-Vendor Lab Design presentation by Mark Porter

- The HVAC lab construction, including the control systems, is about 95% complete. Students have gained invaluable lessons while building it, since they have been the installers. Student work on lab facilities is crucial to hands-on learning.
- Laney wanted a program for technicians and engineers to get hands-on experience, so they will have a better concept of how the systems actually operate to meet their design intent, and how to commission and retro commission them.
- Pre-design for the lab involved developing conceptual ideas of how to lay out the equipment that is in the lab right now, generating drawings and consulting with vendors interested in participating
- Facility Dynamics developed this lab like any of their professional projects – specifications, design drawings, commissioning, & project close-out. Students have had experience in each area.
- Curriculum needs to be developed around building system equipment and control systems present in the lab. Content should focus on the hardware and programming for each vendor represented, as well as single platform communication to monitor all the control systems. The goal is to reflect real world building operation situations.

- The lab is used primarily for troubleshooting & maintenance learning. There is not a lot of changing out of components. It addresses whole-system level issues. The control systems represent currently existing systems in the field. Instructors can create faults for troubleshooting problem solving. There are parallel trainer/test-benches for hands-on controls, digital controls, and pneumatics installation, wiring and programming. There is a baseline database.

- Control System interchangeability: students can unplug one vendor's system and plug in another one, so can compare control system function when controlling the same building system.

- Control panels are able to connect to a laptop and server stations, to provide the same interoperability and GUIs as actual control systems in the field.

- The installation of the lab involves having vendors program, commission, and enable their graphical package to have fully operational system that instructors will use to build the modules for their courses.

- Problem solving is the central theme of the lab, providing invaluable analytical thinking task for the students. Air flow ducts can be left undone to make it into an excellent learning tool. Want things to correct along the way for the students to learn. The lab construction process turned into many troubleshooting exercises, allowing students to learn from the "bumps" along the way. There was so much customization in the installation which became excellent teaching tools. For example: the lab required special heat exchangers to make the donated equipment all work together.

- Learning how to do an energy balance is an important activity in the lab.

- The diversity of equipment and flexible scenarios available will help to make students adaptable in the marketplace.

- How can this be documented so that it could help other community colleges to navigate the process?! we are planning to create a sort of retrospective. Will publish a document to help other schools to know how much it will cost. Having worked in the industry, first time costs are often wrong. Costs balloon. To use our costs as a bar for others wouldn't be advantageous.

- Answer: There is finally a critical mass of interest to make this happen. The intention is to teach: Control systems, how they operate, how they interface with mechanical systems. It will cover the range of mechanical systems and focus on controls that are the basis of nearly all problems & are the least understood.

- There are manufacturers who want to fund labs like this, but don't know where to go.

- Problem with lab development: even most sophisticated controls can't control systems that aren't properly sized. Encouraging that we support the next generation of labs that are properly sized and can then simulate what can do if is over/under-sized. Vs. a hodge-podge from different vendors

- Yes, well we didn't pay for most of it, so there wasn't much that we could do. We understand that this is not ideal, but it's a start. Good luck to the other people who are looking to build a system. Parts are expensive, so we made do with what we had.

Many universities can't create separate labs for each area. but community colleges could provide these labs and partner with universities.

4) Resources accessed through Industry Advisors

Curriculum

Financial and economic models, need to speak that language.

DOE's Better Buildings program has done many case studies with lots of building data for benchmarking purposes.

New Buildings Institute – paper on high performance building retrofits.

CBRE tries to get as much info into Portfolio Manager.; there is also the IFMA Benchmarking Exchange service

Databases are difficult to update, evidence the (Buildings Energy Data Book created by Energy Information Agency) for the last 10 yrs.

Adobe – Sets the example of the best operating building for others to aspire to

Cushman & Wakefield - engineering & building management interface on a regular basis.

Skill gaps to address:

- Water efficiency
- Managing energy information systems – installation, interpretation, computer & IT skill-based training
- High tech buildings including labs, healthcare, data centers, cleanrooms, etc. If possible, do this in collaboration with other national networking organizations.
- Installation and maintenance of building performance monitoring database systems/energy information systems

- Performance monitoring of campus buildings and public displays & using schools as a test bed – ex. Effects of changing occupant behavior, etc.
- Use real-life cases as much as possible, on campus, hands-on

Need for new certificates:

- High Tech Facilities. If it flows from broadening of scope to embrace energy performance monitoring: IE. labs/fume hoods
- Economic analysis of energy savings and cost recovery in improving building operations is key

Labs

Publicly available dashboards are available at 3 UC campuses, as well as the Brower Center.

Is there a VAV hood system (fume hood VAV conversion) here or at Berkeley available as a teaching site? Response: There are issues of liability in students learning from real-life. UC Berkeley would like to increase the possibility of students being able to visit these facilities

DOE Labs21 Program: Labs21 has a lot of case studies, data on tools, and educational data to provide that could be useful. A lot of people & factors involved in actual energy efficiency performance of labs/buildings – people actually using it, research agendas, facilities & installation of new equipment, safety risks, operational costs, submetering strategies, archiving materials used in construction & installations, dashboards installed to identify what they need to know, & skills need to know of how to operate, to achieve the goals that they are after. When there are budget costs, facility staff gets cut – reactive vs. proactive, need to bring up a cadre of O&M professionals & establish an operational program. Labs21 would like to work with Laney on developing this idea.

ASHRAE Technology awards – example for dashboard areas where all of the metrics are shown. For labs where students can't enter, for example, because of liability issues, have metrics visible just outside. Ohlone College new N Campus exemplifies this.

Solar thermal laboratory, consider partnership with Santa Clara University: great field trip for solar thermal system that drives an absorber – Solar Decathlon winner

Guest speakers

Paul Ehrlich of Building Intelligence Group, Jay Santos of Facility Dynamics Engineering, and Steve Taylor of Taylor Engineers have been among the many industry experts who have generously donated their time over the years.

Placement

See Appendix B

5) Industry status

Developments

Pacific Energy Center (PEC) in San Francisco has partnership with NW Energy Efficiency Alliance for Building Operator Certification (BOC) training, setting the bar for certifications; Leadership in Energy & Environmental Design (LEED) looks good on paper, but how well do the buildings actually work?

AB 758 bill re: benchmarking requirement for comm. bldgs. before resale of building. See Developing Regulations Implementing California's Commercial Building Energy Use Disclosure Requirements

Prop 39 going to school operations

New directions

The private sector has greater financial rewards for improvements in best energy management practices in building operations. Investment for ex, in LEED Platinum functioning can benefit the private sector – is profitable for them in multiple ways. Look at the building as an asset – what is the bottom line? Image, savings, savings to client… Lots of vendors are now taking LEED training for those reasons

Next Generation of Building Operators New NSF project getting underway. Focused on identifying the issues & needs of next generation of building operators. Look at the background – what are the issues today? Integration, enterprise mgmt, intelligence, certifications, research

Advanced Cooling Technologies: Looking at getting into the curriculum. So that there are technicians that can install it.

Full Detection Diagnostic (FDD) – equipment that is supposed to diagnose itself – technicians who can read these signals

Focus on evaporative technologies – more maintenance sensitive. If we don't maintain them, they aren't sustainable.

Process Gap - Standards, reactive vs. proactive. Want to use data to make decisions but reactive processes are the norm. Lack of feedback loop back to building designers – is their design operating as predicted?

Building Intelligence Group is starting work with **Revit** which has an energy plug-in. It allowed not only the architects and engineers to see the whole building and envelope; in some peoples' views, it will revolutionize industry by reducing change orders.

6) Employment opportunity

Workforce assessment

The status of the building technician/engineer to motivate students, and salary surveys can be helpful to establishing this. Also illustrating the pathways to a higher salary & status.

Status of building operator is changing to a "paraprofessional," skill sets of engineer and technicians are converging.

State License board – C-20 contractor education requirement might get passed & require continuing education for HVAC Contractors - (Aside - State licensing contractor tests are so bad, they really need to be improved!)

Job prospects

President announced goal in State of Union address to improve all building efficiency by 50% in next 20 yrs.

Skills needed are growing exponentially, e.g. internet-based operations, Ethernet-based communication between equipment; separation of mechanical from electrical based equipment is diminishing.

Advanced Technology Environmental and Energy Center (ATEEC) has been mapping career path.

BEST Center Curricula, Resources & Recordings

Academic Programs
Georgia Piedmont Technical College - Building Automation Systems
Milwaukee Area Technical College - Sustainable Facilities Operations
Laney College - Commercial HVAC Systems
City College San Francisco - Commercial Building Energy Analysis & Audits

Professional Development Materials, Presentations & Videos
National Institutes
Building Automation Systems Instructor Workshops
Webinars (e.g., BEST Talks)

Faculty Profile Videos
Reports & Case Studies
Marketing Resources

BEST
Building Efficiency for a Sustainable Tomorrow

National Science Foundation