

California Commissioning Collaborative

Making Connections: Analysis and Development of Educational Opportunities



Submitted to:
California Commissioning Collaborative

Submitted by:
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Contents

Section	Page
Section 1 Summary.....	1-1
Section 2 Objectives and Approach.....	2-1
2.1 Project Overview / Objectives	2-1
2.2 Interviews.....	2-1
2.3 Supplemental Research.....	2-2
Section 3 Results	3-1
3.1 What Skills Do Hiring Firms Want?.....	3-1
3.1.1 Beginner vs. Expert.....	3-1
3.1.2 Cx vs. RCx	3-2
3.1.3 Certification	3-3
3.2 What Education and Training Resources Do Hiring Firms Want?.....	3-3
3.3 What Educational and Training Opportunities Are Available Now?	3-5
3.3.1 Formal Education.....	3-5
3.3.2 Internships.....	3-5
3.3.3 On-the-Job Opportunities.....	3-6
3.3.4 Professional Advancement.....	3-6
3.3.5 The Web.....	3-7
3.3.6 Unions.....	3-7
3.3.7 Model Programs.....	3-8
3.4 What Are the Current Supply Needs?.....	3-9
3.4.1 Critical Lacks	3-9
3.4.2 Public Awareness of Need.....	3-10
3.4.3 Scale.....	3-11
3.5 Options for Expanding the Commissioning Workforce	3-12
Section 4 Recommendations for the CCC.....	4-1
4.1 Education	4-1
4.2 Marketing and Public Relations.....	4-3
4.3 Website Utilization	4-3
4.4 Intervention Via Public Sector Agencies: Influence on Policy	4-4
4.5 Standards.....	4-4
4.6 Timing.....	4-5
Appendices	

With the goal of making building commissioning common practice in California, the California Commissioning Collaborative (CCC or Collaborative) has encouraged the strengthening of a service delivery infrastructure by working to increase educational and training opportunities. Reports by and for the CCC published in 2004 and 2005 helped to identify training needs and strategies, as well as available workshops, courses, and seminars. At the request of the CCC, Nexant, Inc. undertook a qualitative study in late 2007 to identify both perceived needs for education and training in the State and opportunities for the CCC to address those needs. The study was carried out through telephone interviews with industry participants and attendance at workshops on workforce development, supplemented by some Internet research on existing education and training for commissioning.¹

This report is entitled “Making Connections” because it became clear from the scheduled interviews, workshops, and informal conversations that one of the most powerful ways the California Commissioning Collaborative (CCC) can affect the development of an expanded commissioning workforce is to utilize its central position in the industry in California to *connect* people, businesses, and institutions that have expertise and resources with the students, career changers, and educators who need them in order to meet the State’s need for qualified commissioning providers. Some independent activities for the CCC are recommended as well.

Marketing and public relations will provide critical support for the outreach needed to make connections and increase collaboration. The CCC’s proposed initiative to link commissioning with the sustainability movement² can have enormous value not only in heightening the awareness of building owners about how commissioning can help maintain the value of their assets but also in heightening the awareness of students, re-entry workers, engineers, construction managers, controls experts, and others about opportunities to integrate their skills, capabilities, and values within a growing industry. While many elements of the green or sustainability movement focus on renewable energy, and even in the built environment may emphasize sustainable materials, the CCC has an immediate opportunity to demonstrate the role that building commissioning and retrocommissioning can play in a bringing about a sustainable future.

The report that follows further describes the objectives of the study and our approach (Section 2), the results (Section 3), and recommendations (Section 4) for the short, medium, and longer term, as well as some actions recommended for a “quick start.” The names of the organizations interviewed and selected reference documents are attached (see Appendix A). References to organizations and other documents that may prove useful, depending upon the recommendations adopted, are cited in notes, with website links when available.

¹ For simplicity and convenience, “commissioning” as used here encompasses commissioning, retrocommissioning, and recommissioning unless there is a particular need to distinguish among them.

² “It’s Not Green If It Doesn’t Work: Marketing Commissioning as a Sustainability Strategy,” Oct 15, 2007

2.1 PROJECT OVERVIEW / OBJECTIVES

Commissioning activities can involve people with a range of abilities and skills, from a project engineer who takes measurements, and who might have an AA degree or be a student intern, to a senior engineer who has the knowledge and the experience to synthesize information and identify non-obvious problems in building performance, and who very likely has an advanced degree and other professional credentials.

The objectives of this qualitative study were to characterize the educational needs of commissioning providers in California and to make recommendations for influencing the development of educational opportunities for active professionals and persons entering the field—in particular to recommend ways in which the CCC could help close any gaps between what is available and what is needed. The CCC also expressed a strong interest in learning both how persons in related fields might be encouraged to move into the commissioning field and how students (whether traditional undergraduates or re-entry, career-changing adults) might be made aware during their community college or college experience of career opportunities in building commissioning.

2.2 INTERVIEWS

We began the study by planning interviews with commissioning industry participants. We formed a project advisory committee comprising Jim Parks (SMUD), Keith Forsman (PG&E), David Claridge (Energy Systems Lab, Texas A&M), and Lia Webster (Nexant, Inc.) to provide guidance on interview questions, suggest potential interviewees, and review draft recommendations.

After a kickoff conference call with the advisory committee, a list of potential interviewees was compiled based on recommendations from the CCC, the advisory committee, Nexant contacts, and referrals from other interviewees. Commissioning providers, not all based in California, were selected for their known experience and interest in the industry. Building owners or managers were all based in California. Educators, primarily in California, represented degree-granting institutions, utility energy training centers, and the Building Operator Certification (BOC) program. Professional associations were national in scope; all provided commissioning classes at least annually, and some offered certification as commissioning agents. “Others” were people with an interest in the industry who did not fall clearly into the other groups but who, in informal discussions, provided useful insights. The distribution of interviewees is shown below, and a list of organizations contacted is attached (see Appendix A).

Interviewees

Commissioning providers	7
Building owners or managers	5
Utility program managers	3
Educators	8
Professional associations/ conference producers	5
Others	2

Four interview guides were developed for the study, one for each of the following groups: professional Cx/RCx service providers and building owners/managers; utility retrocommissioning program managers; educators, including instructors at the utility energy training centers; and professional associations and conference producers.

Interviewers solicited information and opinions on the following topics:

- Essential skills of a Cx or RCx service provider, both beginning level and expert
- Skills, experience, or qualities that are hardest to find
- Most important non-technical skills
- Backgrounds of students (any level, any setting)
- Kinds of education or training provided or desired
- Desirability and value of certification programs
- Internships/mentoring availability
- Preferred modes of instruction
- Recent or expected changes in course offerings
- Ways of drawing people to the field (in/from school, or in related fields)
- Issues or suggestions not addressed otherwise in the interview

The interview guides are attached in Appendix B. All questions were open ended to elicit opinions and allow for as much discussion of experience, perceptions, and suggestions as the interviewee wished. Interviews were expected to take 25 to 30 minutes, and ranged from 25 to 90 minutes. We looked for differences among the different groups of interviewees, and point out some of them under Results, but many responses were similar across groups.

2.3 SUPPLEMENTAL RESEARCH

In addition to indicating a range of perspectives about the topics of interest, the interviews, along with some web research, were helpful in networking with others in the state who were actively

engaged in exploring education and training issues related to workforce development and jobs in energy efficiency and/or renewable energy. These sources led us to three unanticipated events that gave us additional perspectives both on training needs and on resources—specifically the range of organizations whose interests and activities overlap or align with those of the CCC.

Two of those events were all-day sessions of the CPUC Workforce Education and Training workgroup, in December 2007, which focused on discussing needs and providing input to the California IOUs' Strategic Plan in response to CPUC Decision 07-10-032. The participants, all of whom were in some way involved with education and training for careers in energy efficiency, represented electrical and sheet metal workers' unions, community organizations, adult education, community colleges, the California State University system, the California Department of Education, the Building Owners and Managers Association (BOMA), BOC, Lawrence Berkeley National Lab (LBNL), and state commissions. Their comments helped inform the recommendations presented in Section 4 of this report. The third event was the January 2008 summit on Advancing the New Energy Economy in California, which yielded additional contacts and new perspectives.

As our primary sources were open-ended phone interviews, in this section we provide as many of the interviewees words as possible. Statements in quotation marks are either direct quotes or near paraphrases.

3.1 WHAT SKILLS DO HIRING FIRMS WANT?

3.1.1 Beginner vs. Expert

We asked all of the interviewees to tell us what education and skills they regarded as ideal for junior and senior level commissioning providers.

3.1.1.1 *Technical Education and Skills*

Interviewees who provided commissioning services tended to expect a higher level of education than other interviewees; they were the only ones who mentioned master's degrees, and they expected new hires to have an engineering degree, even though some said that they did not necessarily regard a four-year degree as essential. For example: "A four-year engineering degree in itself is not very valuable in being effective at gaining knowledge on site." "More than 99% of engineering students never get any hands-on experience with air handling units and other HVAC equipment. This leaves them less prepared for the real world than someone who went straight into the field during those four years." "A [four-year] college degree should not be a prerequisite."

Although one interviewee commented that "a P.E. license [which requires a degree] helps establish credibility for the team lead and is usually required in California," he also felt that a degree for other members of the team was arguable—"the more they know the stronger they'll be, but the specific skills don't require a degree." At least one interviewee reported hiring part-time students to help with workload in the current tight job market. In casual conversation, another indicated that his firm had not looked at modifying its typical recruiting approach, which brings in degreed engineers, but that it might do so.

Overall relatively few differences in technical skills emerged from the interviews. Capabilities expected of more senior consultants or staff, but not of beginners, were: life-cycle cost analysis, trend analysis, knowing how to identify the best prospects for retrocommissioning, having a sophisticated understanding building control systems, and knowing how to evaluate systems in the real world (diagnostics). Interviewees were more explicit when asked "What skills, capabilities, or experience are hardest to find?" (See Section 3.4)

Desirable for all, but critical for anyone doing more than taking measurements was said to be understanding the interaction among building systems—"not just a mechanical engineering

focus.” Terms that came up repeatedly were “interaction,” “integration,” “relationship,” “big picture,” and “whole building perspective.”³

3.1.1.2 *Non-technical Capabilities*

The critical non-technical skills described by interviewees clustered around two primary topics: (1) communication and customer/client relationships (“be able to talk to owners, building operators, architects, IT managers, contractors, electrical and mechanical engineers, controls vendors, construction supervisors, and others”) and (2) documentation (“the paper work takes a professional perspective”; “reports require good written work as opposed to engineering drawings”). These were followed by marketing, management, analytical skills (“be able to recognize the critical pieces of information”), and having a business perspective (“see the relationship between energy savings and economic or productivity benefits”).

3.1.1.3 *Expertise*

The greatest difference between a beginner and an expert commissioning agent was felt to be years of experience, with the accumulation of detail and familiarity with a range of building types and of technologies operating under different conditions. Comments on experience were: “Five or six years of experience is still junior level.” “With less than 10 years of experience, you’re a team member but not the lead / you’re still an assistant.” It takes 20 years of experience to be a senior commissioning agent.” And, from a different perspective, “You need some experience living in the construction world.”

One interviewee described the ideal path to becoming a commissioning agent as “an Associate degree for practical knowledge, followed by a Bachelor’s degree, followed by four to 10 years’ experience in design, operations, contracts, and other areas.”

3.1.2 Cx vs. RCx

The building owners we interviewed did not distinguish between commissioning and retrocommissioning skills/capabilities/ or background, but consultants did—in fact some thought there are great differences at least in approach if not in specific skills. One noted, however, that at present “There’s good consensus about how to do commissioning, but a lack of consistency about retrocommissioning.”⁴ The tabulation below lists the differences that were highlighted:

Commissioning	Retrocommissioning
Process oriented Requires coordination with more different parties Should have background in construction management and understanding of the design process	Forensic, diagnostic, more investigative (“more about the art of engineering”) Involves problem-solving, troubleshooting Requires familiarity with old as well as new technologies

³ As expressed on the blog <http://buildingcommissioning.wordpress.com>, commissioning requires “the ability to think in both macro and micro terms.”

⁴ Consistency is an issue for the utilities too. One utility program manager complained that they “get a different service from every retrocommissioning provider.”

3.1.3 Certification

Views on the value and nature of certification for commissioning and retrocommissioning, and who might best manage it, were mixed. Some regarded it as valuable, others as perhaps valuable but not crucial. From a facility managers' perspective, "in hiring, experience matters more than certification" and "certification isn't as important as having completed actual projects successfully." Most interviewees who were familiar with the certification programs, felt that they were generally doing a good job but pointed to lack of uniformity that could both provide consistent training and let building owners know what certification means. Some felt that lack of a degree should not in itself be a barrier to certification.

Other comments on certification-related topics follow:

Teaching

- The instructor should be a practicing professional
- Certification programs should be run by those whose job it is to teach (i.e., colleges)
- Any certification program should involve a required 3-month internship followed by evaluation

Testing

- They need to test the skills that are required to execute the plans
- Certification should require a two-day test at least partly in a field setting
- Any certification process should actually test the ability of someone to work in the field

Emphasis

- There is too much focus on process and not enough technical detail

Standardization

- Commissioning and retrocommissioning should be certified separately
- There should be a central trade organization to certify rather than organizations with narrower interests (e.g. Air Balance)
- There are too many programs ("five now with another to come from ASHRAE"); it's hard to assess the quality; "co-branding" is a good idea
- ASHRAE's certification (under development) is likely to prevail/dominate
- If there's to be certification, there should be "some sort of accreditation board."

3.2 WHAT EDUCATION AND TRAINING RESOURCES DO HIRING FIRMS WANT?

The following are representative opinions of commissioning providers and building owners. Interviewees generally like the content and delivery of the training currently available through

Portland Energy Conservation, Inc. (PECI), the CCC, the Pacific Energy Center, ASHRAE, and a few others. Their wishes include:

- A two-year commissioning program at community colleges; (“build up the technical level for two-year programs *and* for continuing education for people currently in the field”)
- A two-year commissioning program at community colleges that includes an internship
- A two-year community college program (roughly one year on coursework for retrocommissioning, one year as an intern, and an additional semester covering the design component for commissioning)
- Creation of an HVAC systems lab, “where one could go through a structured testing program and perform the data collection and analysis”; in this regard, community college programs need to be “structured more like a trade school”
- Team teaching: community college + industry
- Web-based retrocommissioning orientation
- More retrocommissioning-specific classes
- More classes like those at the Pacific Energy Center (PEC)
- More on-line workshops on single aspects of commissioning
- “On-demand tutorials” with Q&A; opportunity to submit questions and get answers not immediately, but within some reasonable period
- Webinars: One or two-hour webinars with Q&A (The drawback to webinars is that “they’re not sufficiently interactive” and sometimes are of “insufficient depth.”)
- Labs or opportunities to get field experience (“You really can’t do the work without field experience.”)
- More attention to documentation of retrocommissioning projects (“Documentation is a challenge in the industry; it’s not just a checklist, though some people think so.”)
- More lighting and building envelope classes
- Include demand response

Web-based training is widely accepted as means for upgrading knowledge and is even accepted by some as means of delivering fundamental knowledge, but its value is seen to vary with the participant’s experience: “Webinars are good for people with some field experience; they’re not as valuable for junior staff, unless coupled with hands-on work.”

From the perspective of consulting firms, a training center like PG&E’s PEC provides the ideal delivery of Cx/RCx training for existing staff, but the practical mode for many people is web-based.

3.3 WHAT EDUCATIONAL AND TRAINING OPPORTUNITIES ARE AVAILABLE NOW?

Different modes of education address the needs of people at different points in their careers and education.

3.3.1 Formal Education

Most respondents believed that the universities focus on the fundamentals of traditional engineering programs, to the neglect of the hands-on experience that employers will require. Thus unless the graduate has had an internship somewhere along the way, additional training of a new hire will be needed, whether provided in-house, at a utility training center, or through a community college or a university extension program.

Community college programs are more oriented to combining fundamentals with experience, and would benefit from support and expansion. Existing programs draw a mix of students. For example:

- The full-time two-year Commercial Energy Analysis / Energy Management Technician program at Lane Community College in Oregon primarily serves adult career changers with educational backgrounds that may be entirely unrelated to energy or building design and operation. Intended outcomes include the ability to “understand the interaction between energy consuming building systems and make recommendations based on that understanding.”
- The Environmental Control Technology program at Laney College in Oakland, California, a program offered only at night, draws a mix of adults and recent, often relatively poorly prepared, high school graduates. Commissioning courses come in the third and fourth semesters.

While these programs may come closest to preparing graduates to participate in commissioning assignments, other community college programs are also training students in related areas from which they might, with interest and some additional training, make a transition to commissioning. This point is worth noting in light of some of the identified options for the CCC later in this section.

3.3.2 Internships

Enthusiasm for the internship experience was high among interviewees; but the availability of internships seems low, if one to none offered annually per commissioning firm is the norm. Among our interviewees’ consulting firms, one offers internships, one reported having an intern this past summer, and another described having previously employed interns (through a Building Commissioning Association program of a few years ago). Among the four private sector facility owner/managers we interviewed, only one reported providing regular internships.

In the public sector, the California State University system provides a maximum of 24 internships per year with current funding (two to four interns per campus) in its building

operations area (not involving commissioning); these paid jobs are not part of the students' academic programs.⁵

3.3.3 On-the-Job Opportunities

Commissioning providers generally did not report providing systematic on-the-job training to their staff, presumably because the firms are relatively small, but some instruction or preparation for the field is provided: e.g. inspection procedures, functional performance testing, energy savings calculations, use of company-specific analysis tools and protocols, and documentation. One firm provides an in-house lunch time seminar series and another allows employees 40 hours a year to participate in on-site web-based seminars or attend off-site courses and seminars. Most of the commissioning providers interviewed had staff attend some combination of professional association, college-level (University of Wisconsin commissioning courses or UC Berkeley extension's HVAC-R series), utility-organized (the Pacific Energy Center's year-long retrocommissioning program), and/or manufacturer-developed courses (e.g., a five-day course presented by a manufacturer of control systems). One mentioned that employees have used CCC resources.

Some on-the-job training is provided to building operators at the end of contractor-implemented retrocommissioning projects. That training covers what to monitor, how to analyze the data, and how to respond to various situations that might arise, and in at least one case includes a "persistence matrix."

Among the facility owner/managers we interviewed, three said that they provide on-the-job training to their staff (e.g. job shadowing, protocols, safety courses, basic systems and principles, and energy efficiency calculations), and one said that their staff has taken classes offered through the utilities and the U.S. Green Building Council.

In the public sector, the California State University system offers two kinds of commissioning training to its staff: one is a two-day training through the MBCx partnership and the other a five-day course through the University of Wisconsin-Madison extension. Assuming that two or three people are trained on each of approximately 60 campus buildings retrocommissioned, roughly 100 to 200 staff have had some retrocommissioning training through CSU (most of these, however, are expected to retire within the next five years).

3.3.4 Professional Advancement

Workshops, webinars, and conference sessions sponsored by commissioning associations, non-profits, and commissioning certification programs typically target building owners and commissioning providers, but also attract engineers with varying specialties, building operators, and others. Classes were thought to be generally good, but apart from the CCC's offerings, these events for professionals do not occur in California every year. One interviewee discouraged walk-throughs as part of such events; although genuine hands-on work experience is vital, walk-

⁵ Although it was beyond our scope to attempt to determine the number of classes/programs offered or the number of students or program participants, we have reported approximate numbers of trainees if they were provided by interviewees.

throughs by large groups were described as hard to manage and no more valuable than classroom instruction.

The Pacific Energy Center's year-long commissioning program, which requires a significant commitment by participants, serves working mechanical engineers (the largest number), building operators, building technicians, architects, facility managers, municipal employees, building owners seeking new skills and professional advancement. About 12 people per year complete the course. Another 200 or so per year get at least one full-day of training on commissioning, and approximately 50 more get a half-day of training on commissioning.

The Building Operator Certification program has included limited commissioning training in its mix of courses to date and is currently considering strengthening the commissioning segment. Since 2002 BOC has certified more than a thousand building operators, who are responsible for 500 million square feet of commercial and institutional space. Participants are reported to want to learn how to do commissioning, not just learn about the benefits and the general process.

3.3.5 The Web

Commissioning providers generally reported that members of their staff have taken web-delivered training and that it has met their expectations. Two interviewees noted that this medium was the best or ideal way for staff to access educational resources, although another mentioned that more experienced staff will benefit more from this training because of their additional hands-on experience. One interviewee suggested that the fundamentals of commissioning can be taught through this format. The cost-effectiveness and convenience of web-delivered training was emphasized as a benefit by two interviewees (they involve no travel, and some can be taken at any time). One interviewee expressed interest in having more specific topics available, as much of the web-delivered training is believed to be too general.

Facility owner/managers all said that their staff members have taken web-delivered training. Three of the interviewees found the web-delivered seminars to meet expectations though one found that the medium allowed for staff too become distracted, and felt that there was a lack of staff accountability associated with web-based courses.

Most of the interviewees mentioned that the most valuable web-delivered seminars were one to two hours in length and provided an opportunity for questions and answers.

3.3.6 Unions

Unions train electricians and HVAC technicians in large numbers and, at least in one case,⁶ in multiple languages. There is overlap and potential competition for students between these organizations and the community colleges. However representatives of SMACNA and the International Brotherhood of Electrical Workers (IBEW) have both expressed the conviction that broad-based training is important and that no one should be trained for a narrow skill for which

⁶ The San Jose training facility of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

the demand can abruptly rise and fall.⁷ It seems desirable to address relationships with the union training as part of the development of any community college program.

3.3.7 Model Programs

Interviewees and other identified several educational programs, from various fields, that provide solid education supplemented with laboratory or field experience, thus preparing those who complete the programs with the knowledge and skills they need to enter on a career. Those programs are briefly characterized below.

Lane College (Oregon) Commercial Energy Analysis Program: A well-established two-year Associate degree program that includes an internship. The full-time daytime program began in 1992. The program utilizes old and new campus buildings as its lab.

Lane College Summer Session Professional Advancement: A two-week summer “boot camp,” during which each participant develops a project to implement during the coming year. The following year, participants return to present their projects to the current year’s class.

Pacific Energy Center: A comprehensive retrocommissioning workshop series to train building professionals interested in developing their commissioning skills. This year-long, one-day-a-month program gives students actual practice in applying basic engineering principles to building systems. An introductory course on identifying retrocommissioning opportunities is a prerequisite.

City College of San Francisco Biotechnology Program: Created to meet the need for entry-level workers in the biotech industry, the program began with a single certificate program and grew into four components: the Biotechnology Certificate, the Biomanufacturing Certificate, the On-Ramp to Biotech program, and the Bridge to Biotech program, the latter two for persons with no math or science background. Paid internships were offered, and all four programs emphasized a hands-on approach. The number of students served increased from 28 to 454 in two years. Some students have returned for more course work when they recognize the need for more education. The development history of this program, which includes meeting funding challenges and involving local industry, could provide a roadmap for developing a community college energy program with different interrelated levels. (See Attachment C of this report.)

DOE-sponsored Industrial Assessment Centers (IACs): The IACs’ goal is to produce “industry ready engineers.” Through the IAC at San Francisco State University, students complement their classroom learning with applied projects for Bay Area manufacturing industries conducted under the supervision of engineering faculty.

Utility-Sponsored Community College Education: PG&E’s PowerPathway is an example of a utility-sponsored community college training program with apprenticeships. This program, intended to help fill technical positions at the utility, is designed to bridge existing

⁷ Presentations at the CPUC Workgroup on Workforce Training and Education, 12/7/07

skill and knowledge levels. There are three categories: Full Bridge, for those with limited or no related work experience; Intensive Bridge, for those with some related work experience; and Capstone Course, for those with who have completed a prerequisite AA degree or certificate.⁸

Innovative Community College Degree Delivery Program: To maximize the use of a single curriculum across multiple colleges, Lane College will launch delivery of its Commercial Energy Analysis degree program via the Internet in the fall of 2008 (pending a grant award). Three other community colleges have committed to participate. Core courses will be delivered by Lane via the Internet, and the partner colleges will provide lab facilities and lab instructors.

3.4 WHAT ARE THE CURRENT SUPPLY NEEDS?

Some utilities and at least one large institution reported that a shortage of retrocommissioning firms was a greater constraint on the number of buildings that could be retrocommissioned than current funding. In addition, energy consulting firms are competing with each other for employees, and facility managers in both the public and private sectors are concerned about losing, over time, their current skilled technicians and engineers. Interviewees identified the levels of skilled workers currently in shortest supply as “technicians” and the “mid-range” (not entry-level and not experts).

3.4.1 Critical Lacks

When asked “What skills, capabilities, or experience are hardest to find?,” interviewees responded:

- Controls experience, especially with programming (“As controls programming becomes part of IT [information technology/programming], the two areas [HVAC and building controls] are moving farther and farther apart.” “The typical engineer doesn’t have adequate training in controls systems, control logic.”)
- Combination of controls and HVAC or building system knowledge/controls and (“Not nearly enough people have both controls and HVAC experience.” “More often people come from the building operations side, and controls is their deficit; it’s easier for controls people to learn building systems than the other way around.”)
- Engineering economics; benchmarking from a cost perspective (“Having some training on how to match the job [project] requirements with costs would be helpful.”)
- Energy engineering
- Life cycle analysis

⁸ <http://www.pge.com/careers/powerpathway/jobseekers/index.html#typesofcourses>. Owing to the support of state, federal and foundation grants, most course tuition is covered for participants. PG&E may invest between \$250,000 and \$1,000,000 to take an employee from apprentice to journey level in expertise.

- Knowledge of mechanical systems (“In college there seem to be no courses in mechanical systems”)
- Data analysis skills, among technicians
- Balance of hands-on experience and fundamental knowledge; a rounded set of skills; multidimensional experience
- Combination of analytical and fix-it skills (“We tend to get one or the other.”)
- Depth and thoroughness (“Providers do resets but don't find bad sensors...miss the less obvious...don't go deeper.”⁹)
- Whole building perspective; understanding system approach/interaction effect
- Field experience
- Diagnostic skills (“Getting from the fundamentals to evaluating an existing system”)

A very specific lack described was retrocommissioning experience with grocery stores.

Recommendations in Section 4 address many of these needs.

3.4.2 Public Awareness of Need

Despite the industry’s recognition that it faces a labor shortage, until very recently state policy makers seemed unaware of the growing need to educate people to fill energy-related jobs. The Governor’s Career Technical Education Summit early in 2007 highlighted the need for technical education to fill jobs in the construction, manufacturing, health care, and automotive industries, but did not mention any aspect of energy. Likewise the state’s Employment Development Department’s (EDD) Labor Market forecasts from 2004 show that the state was not attuned to what was beginning to happen in this industry when EDD defined its categories and made its 10-year projections.

Although the Collaborative may still wish to share with EDD the industry’s picture of job growth in commissioning and retrocommissioning, some state entities are beginning to highlight the need for greater numbers to serve the energy efficiency market. The CPUC’s October 2007 decision (D. 07-10-032)¹⁰ brought the matter to the fore, declaring that “Because the state appears to have a shortage of well-trained energy efficiency technicians and professionals, expanded training programs are needed....” The utilities, with input from a wide range of interested parties, are responding.

In December 2007 the Governor proposed to “bring approximately 20,000 new engineers into California’s workforce over the next decade by expanding existing educational programs” in order to address physical infrastructure needs.¹¹ To date there appears to be no similar formal level of effort to expand education for addressing the state’s energy needs; however, the January 2008 summit on “Advancing the New Energy Economy in California” gave a big boost in

⁹ This comment, from a utility program manager, was admitted to be based on a small sample.

¹⁰ Interim Opinion on Issues Relating to Future Savings Goals and Program Planning for 2009-2011 Energy Efficiency and Beyond, Oct 18, 2007

¹¹ “Gov. Schwarzenegger Announces 2008 Proposal to Bring 20,000 New Engineers to California’s Workforce,” press release, Dec 26, 2007

attention to the importance of energy jobs in the State. And already scheduled energy-related summits and conferences in California will provide forums for addressing training needs.

On the national level, President Bush signed the Green Jobs Act of 2007 on December 19, authorizing \$125 million for green job training programs across the country.¹² (Although many “green”-focused activities and websites, including www.greenjobs.com¹³ are entirely or predominately focused on renewable energy, rather than on the built environment, the Green Jobs Act is intended to include energy efficiency.)

This context creates an opportunity for the CCC to exert influence on state policy. Again, Section 4 provides recommendations.

3.4.3 Scale

In parallel with this study, the CCC is developing a best estimate of the number of commissioning professionals and technicians needed by the state.¹⁴ To indicate here some sense of scale as a context for those numbers, we looked at the square footage of existing buildings, as reported by the California Energy Commission’s March 2006 Commercial End Use Survey (CEUS), and the square footage being retrocommissioned through the IOUs’ 2006-2008 retrocommissioning programs.

According to the 2006 CEUS, the total existing floor stock of commercial buildings in “the statewide service area” was 4.9 billion square feet.¹⁵ Against that number the floor stock in developing or committed status for retrocommissioning through the two largest IOUs’ 2006-2008 RCx programs totals roughly 50.2 million square feet (or about 1% of existing floor space), based on informal estimates by program managers; a total of more 100 million square feet is projected by the end of 2008.

¹² The Green Jobs Act of 2007 (H.R. 2847), introduced by Reps. Hilda Solis (D-CA) and John Tierney (D-MA), authorizes up to \$125 million in funding to establish national and state job training programs, administered by the U.S. Department of Labor, to help address job shortages that are impairing growth in green industries, *such as energy efficient buildings and construction* [italics added], renewable electric power, energy efficient vehicles, and biofuels development. http://solis.house.gov/list/press/ca32_solis/wida6/greenjobscomm.shtml According to the Congressional Research Service Summary 7/27/07, the Green Jobs Act of 2007: Amends the Workforce Investment Act of 1998 to direct the Secretary of Labor (Secretary) to: (1) establish an energy efficiency and renewable energy worker training program that targets certain persons (including individuals in need of updated training related to the energy efficiency and renewable energy industries, veterans, unemployed workers, and at-risk youth) and sectors of the energy efficiency and renewable energy industries; and (2) establish a national research program to collect and analyze labor market data to track workforce trends resulting from energy-related initiatives under this Act.

Directs the Secretary to award: (1) National Energy Training Partnerships Grants on a competitive basis to nonprofit partnerships to carry out training programs that lead to economic self-sufficiency and develop an energy efficiency and renewable energy industries workforce; (2) grants to states to administer, in coordination with a one-stop delivery system, labor market and labor exchange programs that include funding to state agencies to identify job openings, administer skill and aptitude testing, and provide counseling and case management services; (3) *energy training partnership program grants to states to administer renewable energy and energy efficiency workforce development programs* [italics added]; and (4) at least 10 Pathways Out of Poverty Demonstration Program competitive grants to community based nonprofit organizations to carry out training that leads to impoverished families gaining economic self-sufficiency.

¹³ “Greenjobs exists to make it easy for talented individuals and renewable energy [RE] companies to find one another and to provide RE employers with the people and information they need to remain competitive.”

¹⁴ Personal communication from Kirstin Pinit

¹⁵ In this survey, “commercial” encompassed small and large offices, restaurants, retail, food stores, refrigerated and unrefrigerated warehouses, schools and colleges, health care, lodging, and miscellaneous.

On a national basis, it has been said that every year we add 3% to the floor space of building stock (including residential buildings).¹⁶ If that were a replacement figure, it would leave 97% of buildings anywhere from one to more than a hundred years old. The industry is now at the very thin front edge of beginning to retrocommission those buildings.

3.5 OPTIONS FOR EXPANDING THE COMMISSIONING WORKFORCE

While comfort, productivity, and cost savings are all important motivations for building, operating, and maintaining energy efficient, high performance buildings, at this historical moment Californians' zeal for sustainability, reduced energy use, reduced greenhouse gas emissions, and all things "green" is a strong force that the commissioning industry can use to its advantage to grow the business, to reduce energy use in the State, and to strengthen the service delivery infrastructure by increasing educational and training opportunities.

Spurred in part by the green movement, new green organizations are being created, new state energy efficiency initiatives are being launched, more community colleges are looking to offer new programs, private businesses are developing and providing commissioning training for staff, collaborations among organizations for education and training are being explored. Although many of these initiatives do not explicitly address commissioning, most do have a least a component focused on the built environment and involve the training of people in some of the fundamental background capabilities and skills required of commissioning providers. Among those activities most closely related to commissioning there can be economies of effort and maximization of payoff through the sharing of information, contacts, experience, model programs, and curriculum development. The CCC is well positioned to play a key coordinating role.

Figure 1 schematically shows the important connections that need to be made.

¹⁶ As reported at the January 2008 summit on Advancing the New Energy Economy in California

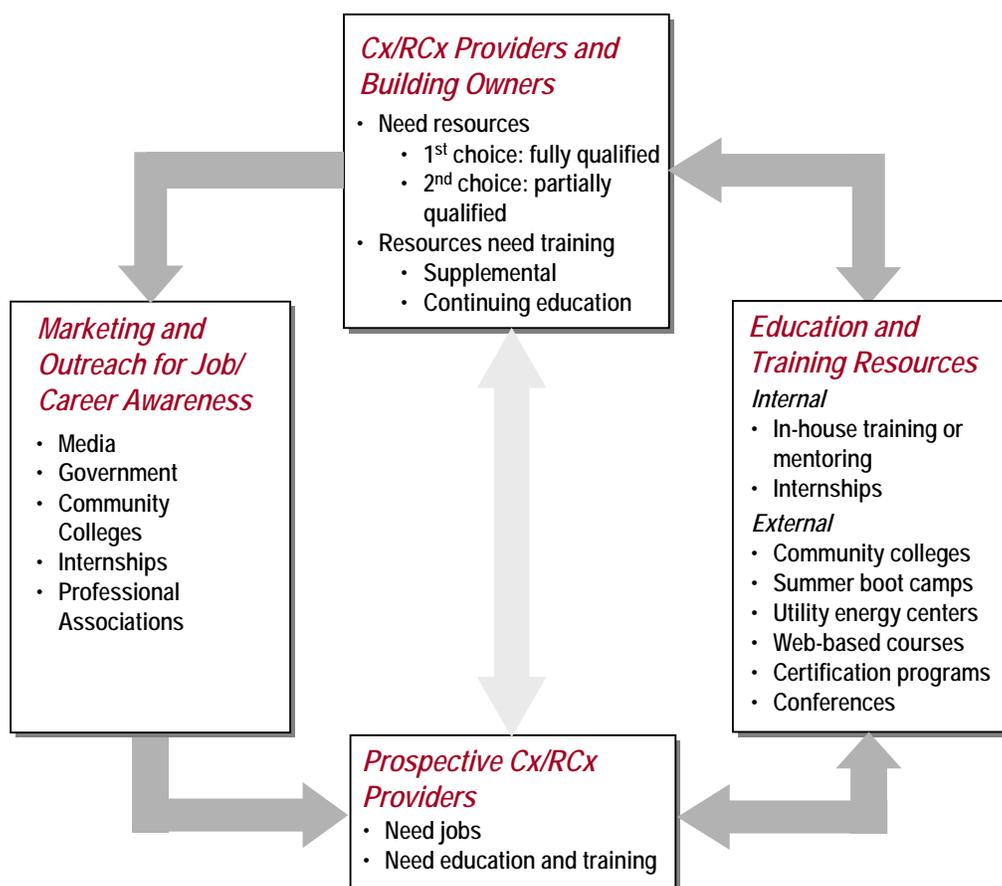


Figure 1: Critical Connections for Commissioning Workforce Expansion

The full list of nearly fifty options for CCC interventions derived from this study, many of them directly suggested by interviewees, is presented in Appendix C. The options fall generally into five categories:

- Education
- Marketing, public relations, and outreach
- Increased website utilization
- Intervention via public sector agencies
- Influence on standards

From the extensive list, Nexant, with the help of the Project Advisory Committee, has developed a set of recommendations, in Section 4.

The interview results and the public and political drive for energy efficiency suggest that there are numerous opportunities to help move commissioning into the mainstream of building design, construction, and operation in California.

The recommendations here, selected from among the more than forty identified options that are listed in Appendix C, are priority actions that the CCC might take to enhance educational opportunities in the state and thereby build a workforce of commissioning and retrocommissioning agents that will be needed to help the state meet its energy goals. The options recommended—the majority focused on direct or indirect educational interventions—are within what we believe to be the CCC’s sphere of influence and likely to have a significant effect.

4.1 EDUCATION

The CCC has played and continues to play an important role in the dissemination of information, guidelines, and tools, as well as providing training. Potential interventions to enhance educational opportunities—particularly in community colleges, as most interviewees urged—are numerous. The time is ripe for CCC to build alliances with more and different organizations that have an interest in green jobs and green buildings in order to help increase not only awareness of commissioning but actual numbers of persons prepared to work in the industry.

- Fund a full-time position to do the following:
 - Convene a workshop of interested community college department heads, faculty, and commissioning experts to brainstorm curriculum development. Right now, individuals and organizations in various locations are working with community colleges separately. A forum for sharing ideas, approaches, steps accomplished, and the like could advance curriculum development, spark ideas for funding, possibly allocate planning tasks, and evaluate potential internal resources (e.g., the Association of Community Colleges or the California Community Colleges Chancellor’s Office) and external resources (utilities, industry, government).
 - Help create a central information source for faculty who are beginning to add commissioning-related courses or develop programs (e.g., a website with password protected access). Identify new courses and programs that are under development¹⁷ and share model programs from this and other fields.
 - Work with the colleges, DOE, and organizations such as BOC, BOMA, NAESCO, and the California Lighting Technology Center and Western Cooling Efficiency Center at UC Davis to maximize information gathering and

¹⁷ For example, the City College of San Francisco energy certificate program—which is just in the planning stage and tentatively intended to involve conservation, energy efficiency, and renewable energy. Discussions began late October and early November 2007. The planners are looking into working with the Pacific Energy Center. This start-up would benefit greatly from information about commissioning, industry contacts, curriculum templates, and help linking industry with the program.

- dissemination, avoid overlapping efforts, and provide or identify funding opportunities.
- Work with Laney College (and others that may be subsequently identified) to expand their program(s) to other community colleges in the state.
 - Help develop regional training centers that provide a controlled environment for gaining hands-on experience through identified community colleges.
 - Work with the utilities, community colleges, and public and private companies to offer internships for students—both on campus and with outside agencies. Help design a replicable internship program and identify funds for internships.
 - Promote professional development opportunities that could include co-branding the University of Wisconsin extension program, Building Operator Certification, train-the trainer programs, and summer energy boot camps for professional development. A good example is Lane’s two-week course for engineers and senior facility managers, which includes a “take-home” project with a one-year follow up, during which those who completed their projects present the process and results to the current year’s participants. If sufficient instructors can be found, they could be offered in multiple locations. Boot camps might be a compressed form of the PEC classes, which “fill the gaps left by standard engineering education,” by providing the “missing skills needed to perform commissioning.”
- Develop or sponsor development of an M&V course or courses for current commissioning providers.
 - Provide cross-training between HVAC and building controls to address the concerns described in Section 3.4.1 above.
 - Continue to develop tools: in particular “wizards” that drive a user’s experience with a series of customized questions or choices based on the user’s previous response, and that help narrow the application’s focus to the content the user is looking for.
 - Provide a forum (e.g., a colloquium or WebEx conference) for utility program managers to discuss issues and expectations regarding consistency of third-party retrocommissioning implementation in advance of the 2009-2011 cycle, sharing and building on and lessons learned over the past two years.
 - Explore opportunities to collaborate with owner groups and trainers of building operators. For example, the Building Operator Certification (BOC) program is discussing shared initiatives with the Building Owners and Managers Association (BOMA) and the International Facility Managers Association (IFMA). There is an opportunity here for CCC to help develop curriculum for the commissioning element and make it—particularly retrocommissioning—a stronger component of the BOC; is currently considering building a new module to give operators experience with diagnostic monitoring (collecting data, reviewing settings of systems, observing whether operating as programmed/designed, etc.).

4.2 MARKETING AND PUBLIC RELATIONS

Interviewees regard increased marketing and publicity about commissioning as important for a variety of reasons: creating awareness of career opportunities; connecting undergraduates and career changers with education; alerting commissioning consultants, facility owners and managers, and building engineers to available webinars and courses outside the well-publicized annual professional and trade conferences; informing and attracting people with related skills; and especially increasing business opportunities that grow the field generally.

- Implement the proposal to market commissioning as a sustainability strategy. “Green” and “sustainable” are motivating terms at present. Attach “green” and “carbon management” and “sustainability” to everything the CCC does.
- Strengthen the CCC’s connection with the U.S. Green Building Council by bringing someone from the USGBC onto the CCC Board of Directors. (“LEED is a big hook for the whole industry.” A closer relationship with the USGBC might also lead to more consistency in standards.)
- Place an article in professional and trade journals to broaden recognition of the field.
- Market to students and community college districts: promote commissioning careers with information for campus career counselors.
- Encourage the industry to offer additional training specifically on retrocommissioning. (See the proportional energy usage of existing buildings under two scenarios in Appendix E.)

4.3 WEBSITE UTILIZATION

The CCC’s website is a useful vehicle for marketing. Further, some of the things interviewees wished were available are already provided by the CCC, such as case studies and tools; thus there is an awareness gap, even among people who are interested and involved in the industry. Making the CCC’s website more visible will help to address this gap.

- Draw more people to the website through reciprocal webpage links with related organizations and search engine optimization that will increase traffic through search results on Google and other search engines. Although it is not necessarily a goal of the CCC to be known outside California, some commissioning providers elsewhere are looking for resources like those that the CCC has already created: some, for example, cited a need for case studies, when the CCC has a substantial on-line trove of readily available stories. Another interviewee already familiar with the site reported planning to use the case studies and tools in her classes. She also found the website helpful in her grant writing.
- Utilize the website as one vehicle for implementing the CCC’s proposed marketing strategy.
- Enrich and enliven the website while incorporating the “commissioning is green” theme. For example, the CCC’s collection of case studies is comprehensively illustrates effective commissioning in different types of buildings, but there is an

opportunity to emphasize environmental impact by highlighting especially significant case studies more boldly. The site is an excellent resource for professionals *who already know about it* but may not hold people who could be interested in the activity of commissioning but are not yet familiar or entirely comfortable with the term. (See <http://buildingcommissioning.wordpress.com/> for contrast. While this blog does not have the depth of the CCC site, it is dynamic, colorful, interactive, well illustrated, and attention-getting, and it cuts across the fields of architecture, commissioning, construction, LEED, relevant politics, tools, costs, events, articles, and reports.)

- Maintain a comprehensive list of ongoing degree and energy-related certificate programs in California focused on or closely related to commissioning. In short, be a clearinghouse of information on courses for students in California.

4.4 INTERVENTION VIA PUBLIC SECTOR AGENCIES: INFLUENCE ON POLICY

In light of current enthusiasm for greening the state, the CCC has an opportunity to have an influence on state policy regarding education and training that will prepare people to commission, operate, and maintain high-performance buildings.

- Coordinate with the Engineering Education Council proposed as part of Governor Schwarzenegger's "20,000 New Engineers" commitment (cited in Section 3.4.1 above) to incorporate commissioning into state-funded educational programs; use the Governor's plan as leverage.
- The CCC is already developing an estimate of the numbers of commissioning and retrocommissioning agents needed. Use this information to prepare a white paper for policy makers that defines the problem that the industry is imperiled because of the need for expertise.

4.5 STANDARDS

Commissioning providers expressed the most interest in and concern about standards for retrocommissioning, followed by utility program managers who were concerned from a consistency perspective. As in other recommended activities, there is an opportunity for the CCC to bring interested parties together for the benefit of the whole industry.

- Create an industry standard for retrocommissioning providers. Collect and compile all guidelines, and then form an industry-based working group to combine them into one standard process with explicit procedures. "Programs focused on energy savings, for example, leave out a lot of scope (such as the point-to-point testing that is found in LEED-EB) that is fundamental to retrocommissioning."
- In particular, collaborate with two current national and state initiatives:
 - Collaborate with ASHRAE in the development of its commissioning certificate program, which is currently under way.
 - Collaborate with the California utilities and SMACNA to ensure that commissioning concepts are included in the training and testing associated with the IOUs' Big Bold initiative for reshaping the HVAC industry. This initiative is

likely to encourage and ultimately require certification of HVAC installers. Under consideration in mid December 2007 was a goal of 15% (approx 2,000 per year) certified by 2011 and 100% certified by 2020.

4.6 TIMING

Changes to increase use of the website can be implemented in the short term; ideally that would happen in concert with the potential new marketing strategy.

“Quick-start” opportunities will take time to develop and implement, but nevertheless call for making connections with other organizations in the very near term: for example, collaboration with the BOC in providing training through BOMA and with ASHRAE on the development of its certification program. Likewise as interest in training for green jobs is burgeoning, timeliness in organizing the recommended workshop for community colleges will be important in helping to promote coordination and avoid duplicative efforts.

Actions to influence policy will most likely require some time to develop and take effect, and might be thought of as medium-term efforts.

Long term and/or ongoing opportunities include retaining the priority to collaborate with the USGBC, to infuse commissioning concepts into all discussions of green buildings, and to maintain awareness with periodic publicity about the benefits of commissioning and career opportunities.

Appendices

Appendix A Organizations Interviewed

Appendix B Interview Guides

Appendix C Options Identified

Appendix D Example of Community College Program Development

Appendix E Potential Energy Savings in New and Existing Buildings

Appendix F Additional Resources

ORGANIZATIONS INTERVIEWED

(does not include informal contacts)

Arden Realty

ASHRAE

Association of Energy Engineers

Building Commissioning Association

Building Operator Certification

Cogent Energy

CSU Chancellor's Office

EMC Engineers

Energy Systems Lab, Texas A&M

Genentech

Glumac

International Conference for Enhanced Building Operations (ICEBO)

Keithly Baber Associates

Lane Community College (Oregon)

Laney College

National Conference on Building Commissioning

Network General

Nexant, Inc.

Portland Energy Conservation, Inc.

Pacific Gas and Electric Company

PG&E Pacific Energy Center

San Francisco City College

Southern California Edison

Sacramento Municipal Utility District

SMUD Energy and Technology Center

Target

Interview Guide — Consulting Firms & Facility Managers

[Record name affiliation, phone #, date & time of contact, and rescheduled date/ time if needed.]

Hello. I'm calling from Nexant, in San Francisco, on behalf of the California Commissioning Collaborative. We are conducting a study of Cx and RCx education and training needs and opportunities in California. We are seeking expert opinions about whether current offerings are adequate to meet the increasing demand for Cx and RCx services in the state.

Could you take a few minutes to answer some questions about how well the need for Cx and RCx training is being met? (if not a good time, reschedule) (if not available, ask for a referral) (if asked How much time? All questions are open ended; we anticipate 30 minutes)

Thank you.

Content / Skills Needed

First I'd like to ask you about the ideal skills and experience of a Cx or RCx service provider.

1. Let's start with entry level—a new 2-yr or 4-yr graduate. What are the fundamental skills that you want a new hire to have?

(If necessary, probe: “What about data acquisition and monitoring?, trend analysis?, building control systems?” “Which are beginning or advanced?”)

2. What are the *additional* critical skills and experience required of a senior Cx or RCx agent (or an on-site staff person with similar responsibilities)?

RCx:

Cx:

3. What skills, experience, or qualities are the most difficult to find?
4. What non-technical skills are most important? (e.g. documentation, skills transfer, marketing)

Do you expect them to be learned on the job, or outside it?

5. (If a consulting firm) How is a team for a Cx or RCx project typically structured? (relative number and levels of personnel)

Delivery / Access

Now I'd like to turn to the ways in which engineers and building operators receive education and training in Cx and RCx.

1. What kind of on-the-job training do you provide?
2. Have your entry-level or mid-level staff taken off-site or computer-based training courses through universities, community colleges, or professional associations?
If so, have these courses met your expectations?
3. What kind of educational resources do you wish were available?
What would be the ideal way for your staff to have access to them?
(If no response, prompt with examples)
4. Would you like to see a Cx/RCx certification program, perhaps similar to the two-level Building Operator Certification?
How would you describe it?

(If little response, probe) Are the existing certification programs producing good results?
(If No or unsure) What changes would you like to see?
OR (If unfamiliar with the programs) How would the ideal certification program be structured?
(Follow-up, if not covered) Would there be a benefit to having RCx certification? Or more than one level of certification?
5. Have you considered offering apprenticeships or internships to college students?
6. How might we attract experienced people with related expertise (e.g. controls experts) into the field? [*added when the issue kept coming up*]
7. Is there anything else you would like to say about how to meet future needs for qualified Cx/RCx agents?

Is there any help in particular that you would like to see the CA Commissioning Collaborative provide?

I appreciate your responses. Thank you for taking the time to assist the Collaborative.

Interview Guide — Utility Program Managers

[Record name, affiliation, phone #, date & time of contact, and rescheduled date/time if needed.]

Hello. I'm calling from Nexant, in San Francisco, on behalf of the California Commissioning Collaborative. We are conducting a study of Cx and RCx education and training needs in California. We are seeking expert opinions about whether current offerings are adequate to meet the increasing demand for Cx and RCx services in the state.

Could you take a few minutes to answer some questions about how well the need for Cx and RCx training is being met? (If not a good time, reschedule) (If not available, ask for a referral) All questions are open ended; we expect the interview to take about 25 minutes.

Thank you.

Content / Skills Needed

First I'd like to ask you about the ideal skills and experience of a Cx or RCx team.

1. What are the fundamental skills and experience required of a Cx or RCx team for your program?

If EB-RCx program:

If NC-Cx program:

(If necessary probe: "What about data acquisition and monitoring?, trend analysis?, building control systems?" "Which are beginning, advanced?")

"How would you differentiate the skills needed for Cx and RCx from, say, the skills needed for energy audits, or skills in mechanical engineering?")

2. Do you differentiate between requirements of the lead engineer and other team members?
3. What skills, experience, or qualities are the most difficult to find?
4. What non-technical skills are most important? (e.g., documentation, skills transfer, marketing)

Delivery / Access

Now I'd like to turn to the ways in which engineers and others receive education and training in Cx and RCx.

1. What kind and level of training does your program provide?
2. What kind of educational resources do you wish were available?
What new training models might help more people increase their skills? (If no response, prompt with examples)
3. Would you like to see a Cx/RCx certification program, perhaps similar to the two-level Building Operator Certification?

How would you describe it?

(If little response, probe: Are the existing certification programs producing good results?
(If No or unsure) What changes would you like to see?

OR (If unfamiliar with the programs) How would the ideal certification program be structured?

(follow-up, if not covered) Would there be a benefit to having RCx certification? Or more than one level of certification?
4. Is there anything else you would like to say about how to meet future needs for qualified Cx/RCx agents?

Is there any help in particular that you would like to see the CA Commissioning Collaborative provide?

I appreciate your responses. Thank you for taking the time to assist the Collaborative.

Interview Guide — Colleges & Training Centers

[Record name, title, affiliation, phone #, date & time of contact, and rescheduled date/time if needed.]

Hello. I'm calling from Nexant, in San Francisco, on behalf of the California Commissioning Collaborative. We are conducting a study of Cx and RCx education and training needs and opportunities in California. We are seeking expert opinions about whether current offerings are adequate to meet the increasing demand for Cx and RCx services in the state.

Could you take a few minutes to answer some questions about how well the need for Cx and RCx training is being met? (If not a good time, reschedule) (If not available, ask for a referral) All questions are open ended; we expect the interview to take about 25 minutes.

Thank you.

Content / Skills Needed

First I'd like to ask you about the ideal skills and experience of a Cx or RCx service provider.

1. Let's start with entry level—a new 2-yr or 4-yr graduate: What are the fundamental skills a new graduate going into the field should have?

(If necessary probe: "What about data acquisition and monitoring?, trend analysis?, building control systems?" "Which are beginning, advanced?")

"How would you differentiate the skills needed for Cx and RCx from, say, the skills needed for energy audits, or skills in mechanical engineering?")

2. At the other end of the continuum of skill and expertise: What are the *additional* critical skills required of a senior Cx or RCx agent (or an on-site staff person with similar responsibilities)?

Are they the same or different for Cx and RCx?

3. Which of the skills we've discussed do your courses teach?
4. Do you address related non-technical skills? (e.g. documentation, skills transfer to building operators, marketing, communications)
5. What backgrounds do your students typically have?

Delivery / Access

Now I'd like to turn to the modes through which education and training are made available.

1. What is the best way to make undergraduate students aware of Cx/RCx as a career path?
2. How might we attract experienced people with related expertise (e.g., controls experts) into the field?
3. How do you attract people to your courses?
(skip for community college) What kind of outreach do you do for undergraduate students?
4. Do your students have opportunities for internships or mentoring programs?
5. (skip for training center) Are the campus facilities a potential laboratory for coursework?
6. (skip for training center) Do you offer extension classes or web-based courses to help people advance in their careers?
Will you describe them briefly?
7. Would you like to see a certification program, perhaps similar to the two-level Building Operator Certification?
What might that look like?

(If little response, probe: “Are the existing certification programs for Cx/RCx producing good results? “
(if no or unsure) What changes would you like to see?
OR (if unfamiliar with the programs) How would the ideal certification program be structured?
(follow-up, if not covered) Would there be a benefit to having RCx certification? Or more than one level of certification?
8. (skip for colleges & universities.) What do community colleges need in order to offer (or increase) training? (e.g., curriculum support? industry participants? other?)
9. (skip for training center) Does your institution have any student organizations focused on environmental issues in the built environment?

Is there anything else you would like to say about how to meet future needs for qualified Cx/RCx agents?

Is there any help in particular that you would like to see the California Commissioning Collaborative provide?

I appreciate your responses. Thank you for your time.

Interview Guide — Professional Associations

[Record name, affiliation, phone #, date & time of contact, and rescheduled date/time if needed.]

Hello, I'm calling from Nexant, in San Francisco, on behalf of the California Commissioning Collaborative. We're following up on a study of Commissioning training conducted a few years ago to find out what changes may have occurred since then, and what changes may be needed to meet future demand.

Could you take a few minutes to answer some questions about education and training for Cx and RCx? (If no, get referral within the organization) Is this a good time? (If yes, "Thank you"; if no, ask to schedule the call at a more convenient time) All questions are open ended; we expect the interview to last about 25 minutes. [*Draft expanded to incorporate questions asked of other interviewees*]

Courses

First, I'd like to ask you about your Association's courses.

1. Are your offerings for Cx/RCx training essentially the same now as in 2004-2005—or different?

If different, in what way? E.g.

Different topics?

Different technical levels?

Using a different format / venue / delivery method? (e.g., Webex)

More courses?

Fewer courses?

If different, what led to the change?

2. Are you making any major changes in your Cx/RCx courses for 2008-2009?

If yes, What?

3. What background and level of experience do most participants in your courses have?
4. Does any of your training involve hands-on work?
5. Do you address related non-technical skills? (e.g. documentation, skills transfer to building operators, marketing)

Skills (Supplemental: If outside area of expertise, skip to Delivery / Access)

Now I'd like to turn to more industry-wide issues.

1. What are the fundamental skills a new college graduate going into the Cx field should have?

(probe: "What about data acquisition and monitoring?, trend analysis?, building control systems?"... which are beginning or advanced?)

(ask: "How would you differentiate the skills needed for Cx and RCx from, say, the skills needed for energy audits, or skills in mechanical engineering?")
2. At the other end of the spectrum: What are the critical skills required of a senior Cx or RCx agent (or an on-site facilities staff person with similar responsibilities)?

Are they the same or different for Cx & RCx?
3. (If not already mentioned) Which of the skills we've discussed do your courses teach?

Delivery / Access

The last set of questions has to do with the ways in which people get access to education and training.

1. What are the venues through which you provide training? (e.g., conferences, separate workshops, self-paced web-based courses, Webex)
2. How do people in the field learn about your Cx/RCx training events?
3. How do you attract college students (undergrad or grad) to your courses?
4. How might we attract experienced people with related expertise (e.g., controls experts) into the field?

Is there anything else you would like to say about how to meet the need for increased numbers of qualified Cx/RCx agents?

Is there any help in particular that you would like to see the CA Commissioning Collaborative provide?

I appreciate your responses. Thank you for your time.

Following is the larger list of options generated by the study from which the recommendations made in Section 4 were drawn. They are grouped by general category, but not prioritized within the categories.

EDUCATION

Specific opportunities for further CCC interventions to enhance education options—focused on community colleges, as most interviewees urged—include:

1. Convene a workshop for interested community college department heads, faculty, and commissioning experts to brainstorm curriculum development. Right now, individuals and some organizations in various locations are working with community colleges separately. A forum for sharing ideas, approaches, steps accomplished, and the like could advance curriculum development, spark ideas for funding, possibly allocate planning tasks, and evaluate potential internal resources (e.g., the Association of Community Colleges or the California Community Colleges Chancellor’s Office¹) and external resources (utilities, industry, government).
2. Identify and share model programs from other fields and support new curricula based on needs identified at the workshop (see option 1, above).
3. Help create a central source of information for colleges beginning to add commissioning-related courses or develop programs (e.g., a website with password protected access).
4. Help City College of San Francisco develop an energy certificate program—which is just in the planning stage and is tentatively intended to encompass conservation, energy efficiency, and renewable energy—and which could later be shared with other community colleges. Discussions began in late October and early November 2007.² The planners are exploring working with the Pacific Energy Center. This start-up would benefit greatly from information about commissioning, industry contacts, curriculum templates, and help linking industry with the program.
5. Work with Laney College (Peralta District) to expand its program to other community colleges in the state.
6. Develop/sponsor/or otherwise promote development of a summer energy boot camp to upgrade or update the skills of commissioning providers. A good model is Lane (Oregon) College’s two-week summer course for engineers and senior facility managers, which includes a take-home project with a one-year follow up, during which those who completed

¹ www.cccco.edu/

² CCSF is also looking to develop a Green/Sustainable Energy Efficiency Center (depending on grant funds); tentatively, it would teach science and math, an introduction to energy efficiency and “building surveys,” how to calculate payback, and how to get SBA funds.

their projects present the process and results to the current year's participants. A certificate of completion is awarded.

7. Coordinate institutional and industry resources to develop regional training centers that provide a controlled environment for gaining hands-on experience through identified community colleges. Include a laboratory for getting hands-on HVAC experience, which most interviewees complained was lacking; explore the possibilities for portable labs where more standard labs are not available.³
8. If DOE is working to expand its Industrial Assessment Center to include commercial buildings, support to the extent possible and promote if and when completed. Several interviewees and others regarded the Industrial Assessment Centers as an excellent model that could be adapted for energy management, efficiency, and high performance in commercial and institutional buildings.
9. Co-brand the University of Wisconsin extension program and offer in California locations annually or partner with California's community colleges to establish a similar program.
10. Propose and help develop an IOU-sponsored train-the-trainers program for community college instructors.
11. Multiply RCx classes and programs like those at the Pacific Energy Center by urging increased utility funding for the energy centers (perhaps for bringing the shorter classes to other locations). "PEC classes fill the gaps left by standard engineering education"; they provide the "missing skills needed to perform commissioning." Classes like those at the PEC benefit consulting firms, utilities, individuals, and the industry as a whole.
12. Provide a forum (e.g., a colloquium or WebEx conference) for utility program managers to discuss issues and expectations regarding third-party RCx implementation in advance of the 2009-2011 cycle, building on lessons learned over the past two years. Include program managers from outside California for additional lessons learned. The objective would be to clarify communications between program managers and third parties and generate solutions to inconsistency in approach and performance.
13. The Building Operator Certification (BOC) program is discussing shared initiatives with the Building Owners and Managers Association (BOMA) and the International Facility Managers Association (IFMA). There is an opportunity here for CCC to help develop curriculum for the commissioning element and make it—particularly retrocommissioning—a stronger component of the BOC. The BOC has a strong presence with large property management companies, a delivery system, good connections in the

³ See, for example, the mobile building automation systems laboratory and the building commissioning cart developed at the University of Nebraska (www.engineering.uinl.edu/ENonline/Spring04/wheels.html) and the Center for the Built Environment (www.cbe.berkeley.edu/researchcommissioning.htm), UC Berkeley, respectively.

commercial office market in particular, involves testing, and requires follow-up. Its training results are also independently evaluated.

14. Help guide the training being developed/implemented by other national or international organizations, such as that of the Natural Resources Defense Council's (NRDC) for the CB Richard Ellis Group,⁴ perhaps by developing a prototype training program in California. Other large property management firms may start their own programs—and there may be an opportunity to collaborate and encourage consistency in methodology. The Marriott, for example, has developed a retrocommissioning plan for its hotels and is spreading it through the chain.
15. Work with the utilities, community colleges, and the state universities to recruit companies and campuses to offer internships for students. Help design a replicable internship program.
16. Identify public funds for internships.
17. Help engage funding sources for community colleges. For instance, the Los Angeles Community College District received a grant from the Los Angeles Department of Water and Power (DWP) for training, an arrangement that came about when DWP recognized that it was going to need more than 800 technicians in all sorts of disciplines in the near future, given that 50% of its workforce was within five years of retirement.⁵ The CCC might be an intermediary in linking utilities' staffing needs, utility funding, and new or strengthened community college energy efficiency programs. Note that the California IOUs already have relationships with some California educational institutions.⁶

Direct Educational Activity

18. Develop or sponsor development of an M&V course for current commissioning providers. As discussed at the CCC Advisory Council meeting on November 15, 2007, "Providers lack fundamental understanding of M&V."
19. Provide cross-training between HVAC and building controls. Address an identified gap in the IT (controls programming) area: "controls companies have taken it over but don't integrate." (See also marketing options.)
20. Offer or promote a course directly through the CCC for facility managers and engineers on how to identify economical projects to undertake. "If cost analysis were focused on more [better understood], more projects in relatively simpler buildings would be undertaken."

⁴ CB Richard Ellis Group press release May 31, 2007

⁵ Stated at the summit on Advancing the New Energy Economy in California, Jan 14, 2008

⁶ For example, PG&E has an initiative for employment development connected with Laney College and San Francisco Community College for engineers and technicians. This program, called PowerPathway, trains and prepares individuals for energy sector positions specific to PG&E's hiring needs.

21. Offer/sponsor additional training specifically for retrocommissioning, given that older buildings far outnumber newer ones. (“There’s a lot of need arising in existing buildings to help them hold their tune.”)
22. Develop or encourage development of on-line self-help learning technology: more tools like the CCC’s Functional Testing and Design Guides and beyond: for example, a “wizard” or wizards—active Internet applications that drive a user’s experience with a series of customized questions or choices based on the user’s previous response, and that helps narrow the application’s focus to the content the user is looking for.
23. Develop economic baselines and benchmarking data for particular types of buildings that could be used as commissioning guides throughout a chain.

MARKETING, PUBLIC RELATIONS, AND OUTREACH

Specific opportunities for CCC interventions include:

24. Implement the proposal to market commissioning as a sustainability strategy. “Green” and “sustainable” are motivating terms at present. Attach “green” and “carbon management” and “sustainability” to everything the CCC does.
25. Market the CCC’s resources to related professions. In planning annual event schedule, perhaps reduce the CCC’s presence (if necessary) where already well known and create or increase its presence in related fields—especially among contractors, construction managers, building designers, controls experts, refrigeration engineers, facility mgmt engineers, and HVAC and controls vendors. Make presentations at conferences that such people attend: what it is, how their experience fits, what makes it interesting.

There is a hope among some in the industry that “mechanical and electrical contractors may want to grow into this area,” but opinions are mixed. According to one interviewee, controls contractors have shown reluctance to expand into commissioning, preferring to sell new equipment, and others regarded recruiting controls experts as not likely to be successful, for reasons of salary,⁷ or lack of building experience, or preference for a more specific, rather than big picture, focus. A focused effort to educate and engage contractors in their own forums could make a difference.

26. Market to the community college districts: promote commissioning careers by providing information for campus job counselors.

⁷ Although we did not ask about wages and salaries, at least one interviewee volunteered that salaries were a barrier to controls experts who might otherwise be interested in commissioning; another said that salaries “need to go up at the top end” to keep professionals in the field; and another stated that an increase in salary along with broader recognition of the field would help attract and retain good people. More than one interviewee suggested that a job retention problem for technicians is that they are not sufficiently valued, resulting in low wages and high turn over.

27. Market to students: highlight career opportunities in a field that can connect a student's multiple interests in field work, technical/engineering work, solving environmental problems, and being in a growing, future-oriented field. Be where the students are: e.g., on the web, posters and fliers in schools; a video that the schools can show and that can run on the web, linked to specific college department websites.
28. Develop relationships with the press, or work with those who have them, to get press coverage of the industry the increasing number of jobs.
29. Place an article in professional and trade journals to broaden recognition of the field.

INCREASED WEBSITE UTILIZATION

Specific opportunities for CCC interventions include:

30. Promote the CCC's website in connection with the CCC's proposed marketing strategy. Although it is not necessarily a goal of the CCC to be known outside California, some Cx providers elsewhere are looking for resources like those that the CCC has already created: some, for example, cited a need for case studies, when the CCC has a substantial on-line trove of readily available stories. One interviewee reported finding the website very helpful in her grant writing and plans to use the case studies and tools in classes.
31. Draw more people to the CCC web site and its resources through (1) reciprocal webpage links with related organizations, (2) search engine optimization that will increase traffic through search results on Google and other search engines, and (3) possible payment for high placement on related search results and for sponsored links.
32. In concert with driving people to the site, enrich and enliven it, and incorporate the commissioning is green theme. The site is an excellent resource *for professionals who already know about it*. But it may not hold people who could be interested in the activity of commissioning but are not yet familiar or entirely comfortable with the term. By contrast, see the blog <http://buildingcommissioning.wordpress.com/>. While it does not have the depth and resources of the CCC site, it is dynamic, colorful, interactive, well illustrated, and attention-getting, and it cuts across the fields of architecture, construction, LEED, relevant politics, tools, costs, events, articles, and reports.
33. Add a "Resources for Students" section to the CCC site with graphical interest, illustrations of Cx/RCx agents working in the field; illustrations of equipment that can often be malfunctioning or out of synch with other equipment with a caption about the cost and energy savings that can occur as a result of commissioning; ways and places to learn more about commissioning, references/links to new developments in the field, new technologies, etc. Highlight both visually and in text an especially significant case study. (The CCC's

collection of case studies is excellent for comprehensiveness and showing different types of buildings, but here is an opportunity to emphasize environmental impact.)

34. Maintain a comprehensive list of ongoing educational and training programs in California focused on or closely related to commissioning.⁸ In short, be a clearinghouse of information on courses for students in California.
35. Add a “Resources for Contractors and Architects” page and arrange links between their organizations and the CCC, especially any California or Western regional organizations or chapters.

INTERVENTION VIA PUBLIC SECTOR AGENCIES

Specific opportunities for CCC interventions include:

36. Coordinate with the Engineering Education Council proposed as part of Governor Schwarzenegger’s “20,000 New Engineers” commitment⁹) to incorporate Cx into state-funded educational programs; use the governor’s recent plan to create more engineers as leverage.
37. The CCC is already developing an estimate of the numbers of Cx and RCx agents needed. Use this information to prepare a white paper for policy makers that defines the problem that the industry is imperiled because of the need for expertise.
38. Communicate with the California Employment Development Department regarding industry workforce needs.
39. Establish and maintain communication with community bridge organizations that help match people seeking to enter or re-enter the workforce with education, training, and jobs. The CCC is in a position to make connections with those organizations (e.g., the Ella Baker Center in Oakland¹⁰) to provide information about both educational resources and the Cx-related jobs they can lead to.

⁸ E.g., the PEC’s year-long RCx program; Sonoma State’s Energy Management and Design; Laney Community College’s Environmental Control Technology; pending Los Rios program with SMUD Energy and Technology Center input; UC Davis Energy Management Certificate Program

⁹ Press release 12/26/07

¹⁰ <http://ellabakercenter.org>

40. Involve County employment and job development agencies (Workforce Investment Boards¹¹), which are a potential bridge between community colleges and jobs. Community colleges create special programs when there is a perceived demand, which comes in part from the Employment Development Department and in part directly from industry. County organizations can help mobilize because of the synergy with their economic development goals: community colleges educate the workforce, counties recruit and retain businesses.

INFLUENCE ON STANDARDS

Specific opportunities for CCC interventions include:

41. Retain the priority to collaborate with the USGBC and to infuse commissioning concepts into all discussions of green buildings.
42. Collaborate with ASHRAE in the development of its commissioning certificate program, which is currently under way. Given ASHRAE's size and clout, whatever ASHRAE does is likely to become standard.
43. Collaborate with the utilities and SMACNA to ensure that commissioning concepts are included in the training and testing associated with the IOUs' Big Bold initiative for reshaping the HVAC industry. That initiative is likely to encourage and ultimately require certification of HVAC installers. Under consideration in mid December 2007 was a goal of 15% (approx 2,000 per year) certified by 2011 and 100% certified by 2020.

¹¹ E.g., The Napa County WIB. "Born out of the Workforce Investment Act of 1998, the Napa County Workforce Investment Board is responsible for strategic workforce planning leading to the alignment of economic, educational and workforce resources in the community. In addition, the Board makes policy for and oversees the publicly funded job training dollars that flow to Napa County through both formula allocation and competitive grant sources. In order to promote a strong economy, the Workforce Investment Board assures the integration of employment, training, education, and business services for job seekers, workers and employers." From <http://www.napaworkforce.org/Site/2/0/2/Home.aspx>. The EDD may also provide grants directly to organizations providing employment and training services in specific areas.

44. Create an industry standard guideline for retrocommissioning. Collect and compile all guidelines, and then form an industry-based working group to combine them into one standard process with explicit procedures. “Programs focused on energy savings, for example, leave out a lot of scope (such as the point –to-pint testing that is found in LEED-EB) that is fundamental to retrocommissioning.”¹²
45. Sponsor an independent evaluation of commissioning training.

¹² Useful tools include Practical Guide to Commissioning Existing Buildings for building operators (see <http://eber.ed.ornl.gov/commercialproducts/retrocx.htm>) and Including Retro-Commissioning in Federal ESPCs and Example Retro-Commissioning Scope of Work to Include Services as Part of a Super ESPC Detailed Energy Survey for use with energy performance contracts (see http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html).

Development Of San Francisco City College Biotechnology Program

(Excerpt from a draft document headed “Theme V Organization,” 5/26/05)

B. Case Study: Biotechnology Program

Biotechnology is one of the fastest-growing industries in the nation, with a high demand for entry-level workers. The San Francisco Bay Area continues to be a leading biotechnology center. The Biotechnology Program is under the Biological Sciences Department and was created to meet the need for entry-level workers in the industry in the Bay Area. The first component of the program to be developed, the Biotechnology Certificate program, started in 1993. Currently the program has four components: The Biotechnology Certificate program, the Biomanufacturing Certificate program and two recent additions, the On-Ramp to Biotech program, and the Bridge to Biotech program. The number of students served has increased significantly in the past few years from 28 students in 2001 to 454 students in 2003.

The Biomanufacturing Certificate Program is currently a sixteen unit program that will soon increase to more than 18 units. It includes one year of chemistry (CHEM 32-33), and one semester of Biology (Bio 11), Elementary Algebra (Math 840 or higher) and Industrial Biotechnology (BTEC 101.)

The Biotechnology Certificate program is a two-course, 10-unit program that includes Bio 65, Recombinant DNA Technology and Bio 60, Molecular and Cell Biology. It is a more advanced certificate and is designed to prepare students to work at a biotech company as a technician in quality control, research and development, or biomanufacturing.

In spring 02 the college, in partnership with SF Works, determined that we needed to reach out to the southeast sector of the city, given the development of the UCSF Mission Bay Campus there, to develop multiple entry points into our biotechnology programs. The On-Ramp to Biotech program and the Bridge to Biotech programs were developed to meet this community need. The On-Ramp to Biotech program, offered in partnership with SF Works, a community-based organization, is designed to target low-income, under-skilled students with no prior science or math background. It offers an integrated 10 week course for 15 hours a week that includes instruction in math, the language of biotech, and resume writing to adults who are at the 6-9th grade level to give them the basic skills they need to enter the Bridge and Certificate programs. Paid internships at UCSF and USDA are offered to the students. The Bridge to Biotech Program is a learning community composed of three classes, a credit course, Biology 72B, a noncredit VESL course, and a noncredit Transitional Studies Math course. It is designed for students who have no Biology background and are at the 7-9th grade level of math and English skills. CCSF ESL and Transitional Studies students are targeted in recruitment efforts for this program.

In addition, a number of short courses are offered as electives on such topics as FDA regulations, Mammalian Cell Culture, ELISA, PCR, HPLC, GCMS and capillary electrophoresis.

All four Biotechnology programs emphasize a hands-on approach to prepare students to work in lab and manufacturing jobs in the biotechnology field throughout the Bay Area. More and more students are now getting both certificates. Many students who have completed the programs are now employed in a variety of industry, academic and government research and manufacturing settings, including for example at Genentech, Bayer, UCSF, JSCA, Chiron, Epitomics and the U.S. Department of Agriculture. Some return to take more courses as they realize the need for more education.

A fifth program will begin in fall 06. In spring 05, we learned that CCSF has been awarded a grant from the Governor's Discretionary Funds to create a Stem Cell Research Certificate Program to provide participants with the advanced skills needed to find jobs in the lucrative and rapidly growing field of stem cell research.

ORGANIZATIONAL MEANS TO IDENTIFY AND MAKE PUBLIC STUDENT LEARNING OUTCOMES

The support of the Office of Research, Planning and Grants has played a key role in identifying student learning outcomes for the Biotechnology program. The Director of Research, Planning and Grants was a moving force in creating the Biotech program at CCSF. Seeing Tech Prep as a funding source for programs for high skill occupations, the Director made initial contacts with people involved in the biotech industry and worked with the Biological Sciences and Chemistry Departments to get the program started using Tech Prep funding. Industry needs are the basis for the program. Student learning outcomes were initially established based on formal meetings that included industry representatives, high school personnel, university personnel and CCSF Biological Sciences and Chemistry faculty. As the program has evolved, it has received continued support through a variety of grants that facilitate keeping in close touch with industry to refine student learning outcome goals. Such grants include a Center for Applied Technology (CACT) Workforce and Economic Development grant, which supports the Northern California Biotech Center and a National Science Foundation grant which supports Bio-Link, a National Advanced Technological Education (ATE) Center for Biotechnology, described later.

The intended student learning outcomes for courses offered in the Biotech programs are spelled out in the course outlines. For example, one of the major student learning outcomes for Bio 65, one of the two courses required for the Biotechnician Certificate, is: "Employ proper methods of laboratory report documentation and presentation including use of a computer for data analysis and report generation." The Biotechnology faculty reported appreciation for the support they have received from the Office of Instruction for developing course outlines and the certificate programs. The Biotechnology Certificate catalog description states that "The biotechnology certificate program is designed to prepare students to work at a biotech company as a technician in quality control, research and development, or Biomanufacturing." The catalog description for the Biomanufacturing certificate states that "The requirements for the certificate in Biomanufacturing described here will prepare students for entry into the field as a bio-process technician, media prep technician, pharmaceutical materials specialist, or pharmaceutical manufacturing technician." A Biotech Hotline number is also listed in the catalog that prospective students can call for more information.

The program coordinators and the Dean have developed a brochure advertising the Biotechnology and Biomanufacturing Certificate programs. The Biotech Career Chart that is in this brochure is one of the most clearly defined career ladders the college currently has. The coordinator of the Bridge program produces flyers, brochures and other information materials to advertise the program to prospective students. He has made concerted efforts to contact faculty in the ESL and Transitional Studies Departments to provide materials for them to use to introduce students in their classes to the program. Although receiving information in class from the instructor in theory is an effective way of reaching students, the Bridge to Biotech Coordinator has found that instructors often find it difficult to take time away from coursework to advertise the Bridge program and wishes there were other ways to advertise the program to CCSF students. The On-Ramp to Biotech program is advertised through community outreach efforts. A new website is being planned for the Biotech Program and is intended to be operational in spring 05 but college support is needed to help revamp the website.

ORGANIZATIONAL SUPPORT FOR PROVIDING PROGRAMS TO SUPPORT STUDENT LEARNING

One of the operational objectives in the 2003/2004 Annual Plan for the School of Science and Mathematics, which houses the Biotechnology program, is “To provide high quality educational programs and courses for associate degrees, transfer to baccalaureate institutions, career education and workforce training...” and the Operational objectives include “Continue to develop the college initiative in workforce education and economic development....” The Biotechnology program is cited in the Annual Plan as one of the school’s strong workforce training programs. Several needs of the Biotechnology program are noted in the “assessment of problems and needs” section of the Annual Plan. One is the need for more sections of classes: “With strong demands for Bio 11 and CHEM 32, many of the beginning biotech students could not find spaces in these classes.” As a result they were able to add more sections of these courses in spring 05. Also this report notes that “In terms of equipment, ASTR, BIO, BIOTEC and ENGN have long lists of equipment to keep their courses up-to-date. And “Space for labs and offices are major problems in BIO, BIOTECH, CNIT, and PHYC.”

The need for constant updating of curriculum, faculty retraining, equipment, supplies and facilities to keep up with a rapidly changing industry make the Biotech program expensive to maintain. Fortunately, the Office of Research, Planning and Grants has been instrumental in seeking and receiving major grant funding to sustain the program. Half of the salaries of the two coordinators of the biotechnology program are grant funded. VTEA funded the original Bridge to Biotech program and has provided crucial support in launching a number of vocational programs at the college. The Bridge to Biotech program currently has a \$500,000 grant from NSF-CCLI, and the On-Ramp to Biotech program has a \$600,000 grant from NSF-Partnership for Innovation and also receives VTEA funding. These grants fund curriculum development and expansion of these programs. A NSF-ATE grant for \$815,000 has funded a project entitled Fix-a-Gene that trains students to work in gene therapy. A Genentech grant is supporting the development of an equipment registry center. The college also has a Center for Applied Competitive Technology (CACT) grant, which, along with some funding from other grants, supports the new equipment registry center, BioLink and the Northern California Biotechnology Center, NCBC. The NCBC, hosted by CCSF, coordinates biotech instructional and outreach activities in 10 Bay Area

community colleges. BioLink, a National Advanced Technological Education (ATE) Center biotech training center, whose home is at CCSF, (although it is currently located at UCSF due to lack of space at CCSF) is also partially funded by the National Science Foundation. Both of these resources provide a means for CCSF to network with other community colleges and industry to identify skills students need to successfully enter the workforce.

Through block grant funding, the Biotech program has received some funds to develop a lab at the Southeast Campus. But the Biotechnology program has mainly relied on other grant funding to meet its needs and in fact has been able to provide the Biology Department with some supplies. Since the program is mainly sustained by outside funding, it has not needed to make a lot of requests for the limited college funds through the college's budgeting process up to now. If grant funding diminishes, finding alternate ways to fund the program will become a serious concern. The Buildings and Grounds Department has provided support to the department in getting equipment donations from industry. Equipment worth about \$250,000 has been received from companies such as Amersham Bioscience, Bayer, Chiron, and Genetech. The program has been challenged to find ways to collect the large equipment and sort, store, catalog and establish processes for checking out equipment. Fortunately, a grant has funded a position to coordinate the development of this equipment registry center.

Several years ago, the Dean of the School of Science and Mathematics recognized the need for a new full-time instructor for the Biotechnology program and he helped win support for hiring one of the current coordinators of the program. The Biotechnology program invites representatives from industry to teach short-term courses or give lectures in courses and fortunately is able to fund them as consultants through grant money. Biotechnology is one of the academic programs requiring a Master's degree in the field or an equivalency as a minimum qualification. This state requirement will make it difficult to hire some industry representatives, who have up-to-date knowledge of the field but do not have a Master's degree, if the program loses grant funding to hire these instructors on a consultant basis. The program needs to explore how the equivalency process will help them hire these experts if grant funding diminishes.

Constant re-training of faculty is essential to enable them to stay current in the biotechnology field. BioLink funding supported sending one of the program coordinators for training in summer 04 but more professional development funding is needed.

The Biotechnology program is an inter-disciplinary program. In addition to courses in the Biology Department, the program also includes courses offered by the ESL Department, the Transitional Studies Department, the Math Department, and the Chemistry Department. The Biomanufacturing certificate program began with collaboration between Chemistry and Biology and will eventually include collaboration with Engineering and Computer Technology. Collaboration among these departments has been very good so far. But the college's main organizational structure for offering instructional programs is through departments that are grouped into schools. For example, departments make budget requests via their school, and departments make requests for hiring faculty. Inter-disciplinary programs such as Biotechnology may need extra support to learn ways to request supplies/equipment, faculty, and reassigned time for coordination and so forth.

A lot of coordination is needed to manage the grants that the program receives and to keep the program going. Departments have chairs and also have the opportunity to ask for release time for faculty from teaching duties to coordinate programs. Fortunately, so far grant funding is supporting the Biotech program coordinators so the Biology Department has not yet needed to request coordinating units for Biotechnology. Grant funding has also supported the coordinator of the Bridge to Biotech program who is responsible for recruiting, assessing, advising and providing orientation for students and for general administrative duties.

The coordinator for the Bridge to Biotech program has invited financial aid and DSPS representatives to speak to students in the program. Other than this, those we interviewed were not aware of how much biotechnology students use Counseling, Learning Resources and other support services at the college.

Need for equipment, labs and offices for Biotech have been reported in the Annual Plan report. Currently most biotechnology courses are offered at the Ocean Avenue Campus. The Bridge to Biotech program courses are offered at the Southeast and Mission campuses, and the On-Ramp to Biotech program is offered at the Southeast Campus. Block grant funding was used to develop the lab at the Southeast Campus. Space has been allocated for the Bridge to Biotechnology program in the planned new Chinatown Campus and Mission Campus buildings. The program has support from the Vice Chancellor of Academic Affairs for developing a Biotech Center in the Science Building.

Administrative support for the Biotech program has been strong. The program has received major support from the Director of Research, Grants and Planning, who was instrumental in getting it started and continues to support it through supervising preparation of grant funding proposals and serving as administrator for BioLink. The Associate Vice Chancellor of Work Force Education serves as principal investigator of the National Science Foundation Partnership for Innovation grant. A former Vice Chancellor of Instruction was instrumental in starting the Bridge to Biotech program by recognizing that the Biotechnology certificate program was an opportunity that should be made available to ESL and Transitional Studies students but that many would need a support program to gain the language and math skills needed to enter the certificate program. The Dean of the School of Science and Mathematics has provided support through such activities as finding space for the equipment registry center at the Airport Campus, supplying a display case in the Science Building to advertise the program, and seeking a Biotech Center in the Science Building and describes himself as the “glue that keeps everything together.” The campus deans at Southeast and Evans provide support for the programs offered at those campuses. Administrators were also willing to support low enrolled classes in the first years of the program, recognizing that time was needed to build the program. The Chancellor and a Board member have been strongly supportive of the program. The Chancellor’s Office nominated the program for two awards which it received from the Association for Community Colleges.

CCSF collaborates with SF Works, a community-based organization, to offer the On-Ramp to Biotech program. CCSF provides the space for the classes and the instructors and SF Works recruits the students and coordinates the program. The links between the CCSF Biotechnology

program and BioLink and the Northern California Biotechnology Center are outstanding examples of successful collaborations. CCSF can take pride in the regional, state and national leadership it provides through its participation in the BioLink Center and The Northern California Biotechnology Center.

Organizational means to evaluate the effectiveness of programs in producing student learning outcomes, and to make improvements

Since the Biotechnology program is interdisciplinary the department-based program review process has not yet easily served as an effective means to evaluate the effectiveness of the program. However, the reports required by the various grants the program enjoys, provide the program with opportunity to evaluate its effectiveness.

The college's faculty evaluation process works well for most departments but is somewhat challenging for biotechnology not only because of the interdisciplinary nature of the program but also because biotechnology is a relatively new and rapidly changing field. One of the coordinators of the program reported that one instructor assigned to her evaluation team did not think he had the knowledge and skills to evaluate her properly.

The Biotechnology program recognizes a huge need for authentic assessment techniques to measure student attainment of identified student learning outcomes. Measuring how well students can apply techniques and perform lab procedures in a consistent manner is time-consuming and difficult without instructor-reassigned time to design and conduct the assessments. Data from such assessment would provide the program with valuable information that could be used to adapt instruction and curriculum to improve student attainment of learning outcomes. The coordinator of the Bridge to Biotech program plans to work with the Office of Research to develop an effective mid-semester assessment tool. Although information on student success by course and department is easily available through the Decision Support System, this system is not currently set up to show data for programs that are within departments or are developed through collaborations with several departments, like the Biotechnology program.

Former students who have gotten jobs have been invited to return to speak to students in the program. Through these speakers, students and teachers learn more about the essential skills students need in the workplace. The Northern California Biotechnology Center advertises student employment rates. There is currently no college-supported systematic method used to collect information on success of graduates of the program. Fortunately, two of the grants the program receives provide some support to track students after they finish the programs to record job placements and job success.

Faculty report great satisfaction in seeing many disadvantaged students move from being under-skilled and often under-motivated, to successful, enthusiastic employees in the biotech field. They see the program as a successful vehicle for getting more students interested in science and math and report that many return to CCSF to take additional coursework. BioLink and the Northern California Biotechnology Center facilitate sharing among colleges on effective

curriculum and instruction and foster a culture that promotes continuous efforts to improve at all of the participating community colleges.

Conclusion

In order to write this conclusion, the Theme V committee discussed how well these two case studies reflect areas where the college as a whole has made strides in the past six years and areas where improvements need to be made. The Theme V Committee was a representative committee that included the Dean of the Educational Technology Office, the Dean of Curriculum, Tenure Review and Faculty Evaluation, the President of the Academic Senate, the Articulation Officer, the Chair of the ESL Department, instructors from the English Department and the Transitional Studies Department and a representative from Library and Learning Resources. In addition, the Department Chairperson Advisory Council (DCC), which includes seasoned department chairs from Social Sciences, Math, ESL, Engineering and Consumer Education was consulted and provided valuable perspective.

Significant advancements in the past six years

We have identified several areas in which the college has made significant strides in the past six years in improving organizational structure to support student learning.

1. The college has made notable advancements in the past few years, through the Office of Research, Planning and Grants, in the pursuit of grant funding to support programs and has had a high rate of success in receiving grants. The support that the Biotechnology program enjoys from grants, as described in this essay, is an outstanding example. Without grant funding, the college would not be able to provide this vocational program that meets identified community needs. Other notable examples include the 2002-2007 Title III grant which has two major goals: 1) to increase persistence and retention of students, particularly during their first year in college, and 2) to improve academic quality by integrating developmental instruction and academic support, and the Koret grant, which provides funding for supplemental instruction and support services for basic skills courses in Math and English.

2. A second notable area of achievement is the support that the college administration has provided for developing new programs, particularly interdepartmental collaborative programs. Without this kind of support, some innovative programs would probably not have been developed. In the essay, we've described the support the Biotechnology program has received from Vice Chancellors, Dean of Science and Math, and the Director of the Office of Research. Another example is the Design Collaborative, which was begun several years ago as a collaborative effort to develop courses that could be taught in any of five participating departments (Architecture, Art, Graphic Communications, Multimedia Studies and Photography). The Research Office and the Office of Instruction were instrumental in facilitating development of this collaborative effort.

3. A third area in which the college has made significant strides is the increased capacity to provide more easily accessible data to administrators, faculty and staff via the Decision Support System (DSS), and the reports and research studies that are now available on the college website. The Biological Sciences Department and other departments find the DSS useful for

finding data for program review and other purposes (See Standard 1A.) The DCC and the Theme V committee agree that the construction of a data-rich environment that is easily accessible has been a notable achievement but note that the Office of Research needs to remain responsible to the informational needs of faculty and staff and be rigorous in checking the accuracy of the data that is reported.

4. In the past few years Office of Instruction has significantly increased the support it provides to departments with its technical review process. Both the Biotechnology and Biological Sciences instructors interviewed spoke of their appreciation of this support. This optional technical review of course outlines and certificate and degree proposal drafts prior to submission for College Curriculum Committee action eliminates many common problems that cause delays in obtaining final proposal approval.

Directions for the future

The Theme V committee proposes the following recommendations for areas where the college needs to make steps to improve the organization support provided to programs to support student learning.

1. Improve Publicity. We've noted here that both the Biotechnology Program and the Biological Sciences Department would like more support in advertising their programs and it's likely that many departments have this need. College support for advertising and recruiting students into the great variety of programs at CCSF is limited. The college website is generally a good source of information for many programs but can be over-whelming; especially for the many non-native English speakers that CCSF serves. The Communications Committee is reviewing and suggestion improvements to the website. Other means of publicity need to be improved as well. CCSF has hundreds of programs spread out all over the city at different campuses and outside locations. Informing students at one campus about other program opportunities at other campuses, or even their own campus is a challenge. The College recognizes need for improvement and has made outreach and recruitment a priority in the current Strategic Plan. We need to do a better job of reaching out not only to those who are not yet CCSF students but also to those who are students already enrolled and don't know of all the opportunities available to them at CCSF. New students in particular need more support for learning how to successfully negotiate the complexities of enrolling, registering, and getting financial aid, counseling and other student support services.

2. Improve Hiring Processes. The concern that the Biological Sciences faculty expressed over the lengthy hiring process is not unique to this department. Typically it can take a semester to complete the hiring process for a full-time instructor from development of the job announcement to recommendation of a candidate to the board. Especially in competitive fields, we may lose highly qualified candidates to colleges that have a speedier process. Administrative hiring can be quite lengthy also. At least two deans hired within the past few years report that they heard nothing from the college for months after submitting their applications and had begun searches elsewhere. Although required procedures need to be followed, we should investigate where we might be able to speed up the hiring processes. Other departments also share the feeling of Biological Sciences faculty that the interview process is fairly rigid and wish it allowed for more spontaneity and dialogue with candidates. We should investigate how we

might be able to do this without compromising the integrity of the interview process. We note that the college is committed to hiring a diverse faculty and has made a notable improvement to the faculty hiring process recently by asking all candidates to include a statement in their job application discussing how their course content and teaching methods meet the needs of culturally and academically diverse learners.

3. Develop better ties between Program Review, Curriculum Development, and Institutional Planning Procedures. Some progress is being made in this area. The program review process now gives programs the option to address departmental plans and activities for discussion and assessment of student learning outcomes for their courses and/or programs. Prior to spring 05, review of course outlines was not tied to the program review cycle. In fall 04, the college agreed that departments would complete a review of all course outlines within each six-year program review cycle. The college should continue to consider how the program review process could help us improve organizational structures that would support evaluation of student learning. The Biological Sciences Department faculty spoke of direct means of assessing student learning outcomes (grades, transfer rates) and of surveying student satisfaction for their program review and the Biotechnology program spoke of the success reported by their graduates. The college needs to have a fuller discussion of how the program review process could help us institutionalize ways to evaluate our efforts to assess student learning outcomes and make improvements.

4. Improve tracking of graduates and program completers after they leave CCSF. The need to know how students are performing after graduating and completing our programs is not unique to Biological Sciences and Biotechnology. All agree that more knowledge about how well we are preparing our students for the next step in their lives would help us to evaluate our programs and make needed changes for improvement. Tracking student success should become a priority for the college.

5. Find ways to provide more professional development opportunities for faculty. Most departments would agree with the concerns that Biological Sciences and Biotechnology expressed here about the lack of funding to support sending faculty to conferences and training opportunities. We suffer, as do other colleges, from the loss of statewide AB1725 funding for staff development and need to find other sources. The Theme V committee also recognizes lost opportunities for professional development related to faculty evaluation. Currently, there is no continuity to the faculty evaluation process. The strengths and weaknesses that an evaluation committee's reports on the strengths and weaknesses of an instructor are not reported to any subsequent evaluation committees. No mentoring or other support is provided to instructors who receive evaluations indicating a need for improvement. Providing evaluation committees information from previous evaluations could help committees identify areas where an instructor seems to not be improving and could benefit from mentoring or other professional development activities. This process could provide us with an organizational structure that would help us strengthen our instructors' abilities to foster student learning.

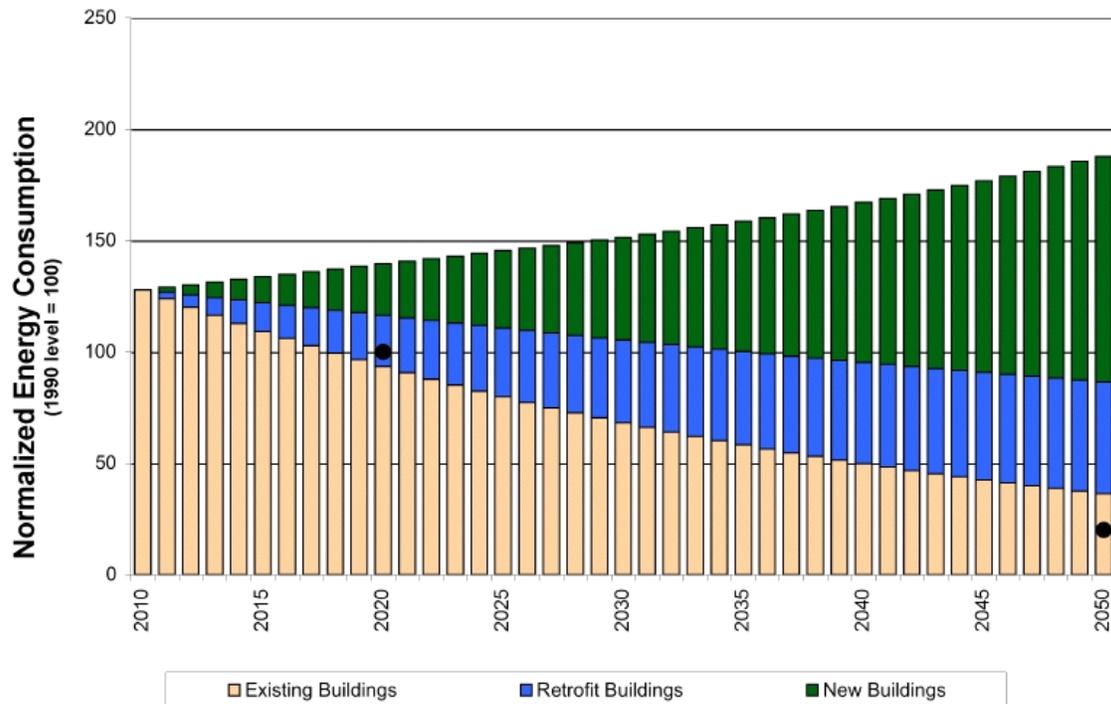
6. Improve communication between instructional and counseling faculty. The Biological Sciences chair's concern, noted in Case Study 1, that counselors sometimes lack accurate or up-to-date information about programs is shared by others. The challenges counselors face in being knowledgeable about the hundreds of programs at CCSF and advising students accurately are not

small. We need to develop better ways for counseling and instructional programs to communicate and collaborate to insure students are given the most accurate information available. We need to explore the organizational means we could put in place that would foster this communication.

7. Increase funding for resources/facilities/staff. Every department at CCSF can testify, as did Biotechnology and Biological Sciences, that they could do a better job of meeting student needs with more funding. The needs are great and varied, be it for funding for more publicity, more lab aides, more labs, better facilities, or support to assess student learning outcomes. Financial resources are very limited. Our success in securing grants has helped. The Standard IIID report commends the college for making informed and intelligent decisions relating to the distribution of the relatively scarce resources we have. The college needs to continue to explore all possible avenues to improve financial resources so that we can continue to provide strong programs that support student learning and more effectively evaluate how well learning is occurring.

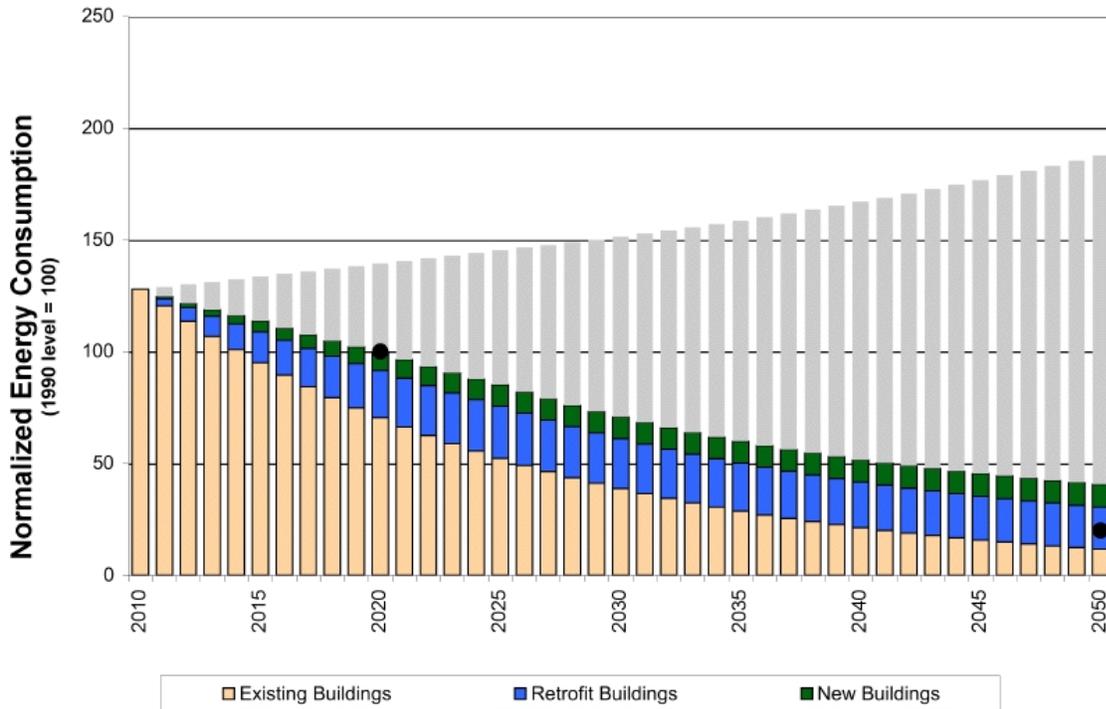
Appendix E Potential Energy Savings in New and Existing Buildings

The following two graphs, from the “CPUC Strategic Energy Efficiency Plan: Commercial Sector Chapter Summary,” January 5, 2008 (Based on the Final Working Draft) dramatically illustrate the scope of potential improvements in commercial building operation (and construction) in the context of AB-32 goals, as well as indirectly indicating the latent demand for retrocommissioning of existing buildings.



Business As Usual

New Construction and Retrofit Rates grow at 2.3% per year, there is a 20% improvement in energy use in new buildings, and a 12.5% improvement in existing efficiency by 2025. The black dots are the AB-32 goals for 2020 and 2050. *Source: Borgeson and Coffey, 2007.*



Aggressive Improvements to Both New and Existing Buildings

New buildings start at 60% energy savings and get to 99% by 2030, retrofit rate is 5% of the stock floor area per year, and retrofits starting at 50% energy savings and getting to 80% by 2030. *Source: Borgeson and Coffey, 2007.*

The following is not a comprehensive listing, but includes events, training programs, and organizations that came to our attention during interviews, informal conversations, and web research for this project.

EVENTS

- National Conference on Building Commissioning, Newport Beach, April 22-24, 2008
- Green California Summit, Sacramento, April 7-9, 2008
- Economic & Workforce Development (EWD) through the California Community Colleges, Annual Conference, Newport Beach, April 23-25, 2008.
- California State University (CSU) Facilities Management Conference, June 2008
- Green Community College summit (in the planning stage, led by Green Technology)
- L.A. Community College District (LACCD) Annual Sustainability Conference¹³
- UC/CSU/Community Colleges Sustainability Conference 2008 at Cal Poly San Luis Obispo (best practices on campuses)

TRAINING PROGRAMS & INITIATIVES

- Alliance to Save Energy Green Campus program
- Architecture 2030 Initiative
- BACCC (Bay Area Community college Consortium): has funded a project to identify job skills and education required for positions in ten “clean technology” industry sectors, with a focus on Silicon Valley, by interviewing one person in each sector; one of the sectors is “green building”
- BEEP (BOMA Energy Efficiency Program): BOMASF is the California host for BEEP; has PG&E funding
- BOC: targets existing workforce, specifically bldg engineers as opposed to building managers; BOC-certified operators are responsible for .5 billion sq ft; BOC is exploring shared initiatives with BOMA & IFMA
- California Community Colleges, 1.8 million students; 6300 career and technical education degrees and certifications; many faculty focused on CTE; half of the recipients of engineering degrees in public institutions in California started as community college students
- California Dept of Education, Adult Ed Program, 1.4 million students

¹³ LACCD in 2001 kicked off one of the largest public-sector green-building projects in the nation. LACCD expects that, at the close of the project, 40 new or renovated buildings will meet LEED standards. LACCD co-sponsors an annual sustainability conference with the U.S. Green Building Council. *Source*: Flex Your Power website

- CCSF (City College of San Francisco): is interested in offering credit for PEC courses
- Lane Community College (Oregon): Commercial Energy Analysis Associate degree; easy for graduates to move into Cx/RCx with some on-the-job training
- NSBAP (National Sustainable Building Advisor Program): designed for working professionals wishing to apply sustainable concepts to the buildings they design, develop, and construct, buildings that are energy and resource efficient, healthy working and living environments, environmentally responsible, and cost effective. (www.nasbap.org) This is a new nonprofit in Washington State, offering the 9-month program through several community colleges; it has a curriculum and certifies Sustainable Building Advisors via exam.
- NSF grant program for curriculum development (e.g., Laney)
- Southern Methodist University Sustainable Design: Bringing together leaders from industry, government and academia, SMU is working to develop an advanced degree program in sustainable design that combines ideas from engineering, architecture and technology into a forward-looking Master's degree program
- UC Davis CARB Initiative
- UC Davis Energy Management Certificate Program (listed under both Business & Management and Green Building & Sustainable Design)
- Unions, equipment manufacturers, controls developers: train members, vendors, contractors. Unions have sophisticated training programs and resources
- University of Colorado Building Systems Program (graduate level)
- University of Nebraska mobile building automation systems laboratory
- University of Wisconsin–Madison courses for engineering professional development

OTHER RESOURCES & ORGANIZATIONS

- ACEEE (American Council of Energy Efficiency Engineers): relevant conferences and a great “clearinghouse”-like website: events, reports, tools, calendar
- Alliance for Climate Protection: based in Palo Alto; board chair Al Gore; large-scale outreach campaign in the U.S. (first in either Canada or Australia)
- ACTE (Association for Career Technical Educators)
- Association of Physical Plant Administrators: for educational institutions only; (exam leads to certification as Educational Facilities Professional)
- ATEEC (Advanced Technology Environmental Education Center): funded by NSF
- Berkeley Center for Science and Engineering Education: cutting-edge science and engineering projects

- <http://buildingcommissioning.wordpress.com/> [a blog on building commissioning]; includes articles, lists of resources, lots of links; visually lively
- California Institute for Climate Solutions, established by 9-20-07 ruling
- CEWD (Center for Energy Workforce Development): <http://www.cewd.org/> ; for utilities (emphasis is on line workers, technicians, power plant operators, pipe fitters)
- CIEE (California Institute for Energy and Environment), a branch of the UC Energy Institute (<http://ciee.ucop.edu/>)
- CCSE (California Center for Sustainable Energy), formerly SDREO
- Energy Design Resources website “Resources for Building Commissioning”—including a description of Performance Assurance process; links Cx w/ design (<http://www.energydesignresources.com/>)
- GGHC (Global Green Hospitality Consortium): Recently founded consortium hopes to increase sustainability practices in the hospitality industry by providing a clearinghouse of standards, certifications, and opportunities
- www.greenerbuilding.com: newsletter produced by greenbiz.com on green design and construction, and sustainable practices, including energy use and facility management
- LBNL (Lawrence Berkeley National Laboratory) Energy Efficient Buildings Program
- NCEMBT (National Center for Energy Management and Building Technologies): <http://www.nemionline.org/downloads/index.html>
- NEMI (National Energy Management Institute): www.nemionline.org; see market assessments: *Building Cx Market – Industry Analysis* (2001) & *Retro-commissioning – Existing Building Inventory* (2002)
- National Institute of Building Science
- NEMA (National Electrical Manufacturers Association): “an industry at the heart of energy solutions”; recently held a forum on high performance buildings but did not appear to include commissioning
- PETE (Partnership for Environmental Technology Education)
- UC Berkeley, Building Science, College of Environmental Design