Environmental Engineering at Cal Poly-San Luis Obispo

A Legacy of Learn by Doing

By Professor Harold Cota

March 17, 2018

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Dedicated to my wife Judy Cota, my family, many mentors, faculty and students who were so important in this journey, and all others working to make this world a better place.

Environmental Engineering
at Cal Poly-San Luis Obispo

A Legacy of Learn by Doing

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Introduction.

The story recorded here began with a timeline prepared by Professor Rod Keif outlining some of the important events in the formation of the Environmental Engineering Department at Cal Poly-San Luis Obispo. He expanded the timeline and added some comments in a 5-page History of Environmental Engineering at Cal Poly in 1998 (1).

Rod Keif was a key player in the Air Conditioning and Refrigeration Engineering Department that eventually became the Environmental Engineering Department. He prepared his students to be leaders in the industry, received the Distinguished Teachers Award in 1967, and was chairman of the Academic Senate in 1969. My association with Rod goes back to when he came to the University of Oklahoma to interview me after I had applied for a job at Cal Poly.

I expanded his timeline into a slide show, and remarks for the 40th Environmental Engineering [ENVE] Anniversary Dinner at Cal Poly-May 23, 2009. In preparation for the 50th Anniversary of when the Environmental Engineering Department was established, I decided to combine, expand and update these remarks. I hope the reader will understand this was originally written as a personal account and left unchanged.

I realize there were Cal Poly instructional staff working in the programs covered by the story whose names I did not record or know. It would have been interesting to include the names and story of each of our students as well but I will leave that task to the Alumni Office.

I want to acknowledge the assistance of the Cal Poly Archives at Cal Poly's Kennedy Library in finding pictures of some of the key players. In addition, thanks to proof readers Judy Cota, Cindy and Jesse Magliari, Ron and Jean Cota, Tim O'Conner, Doug Wolf and Sam Vigil who improved the story. The logo on the cover was created by Doug Wolf.

Environmental Engineering
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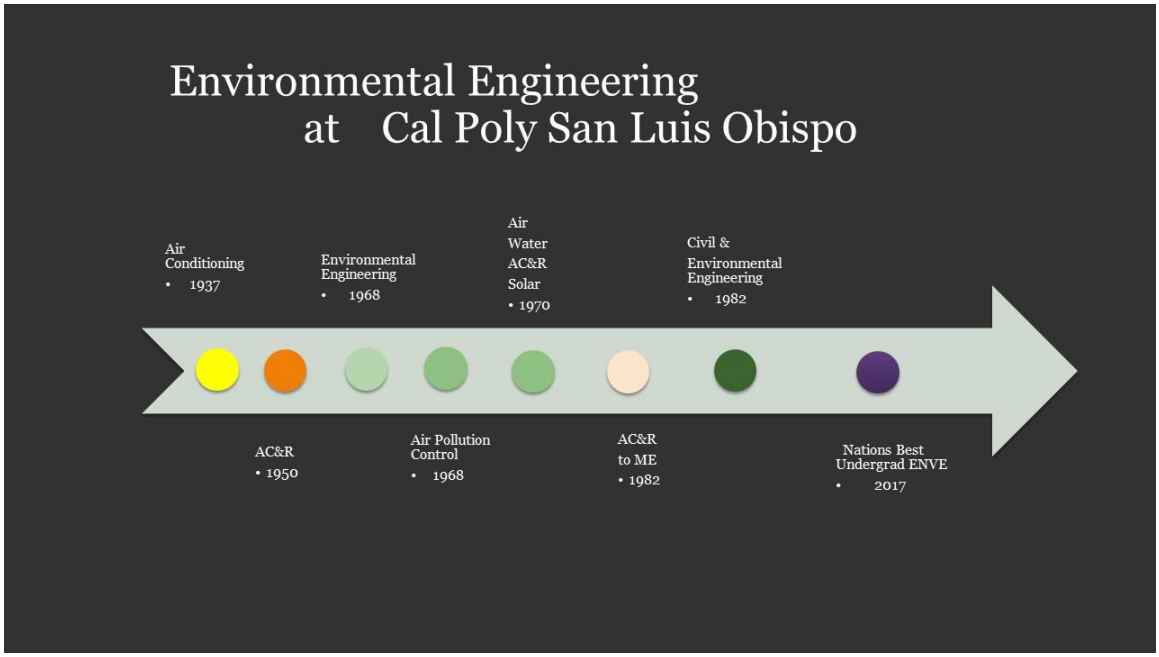
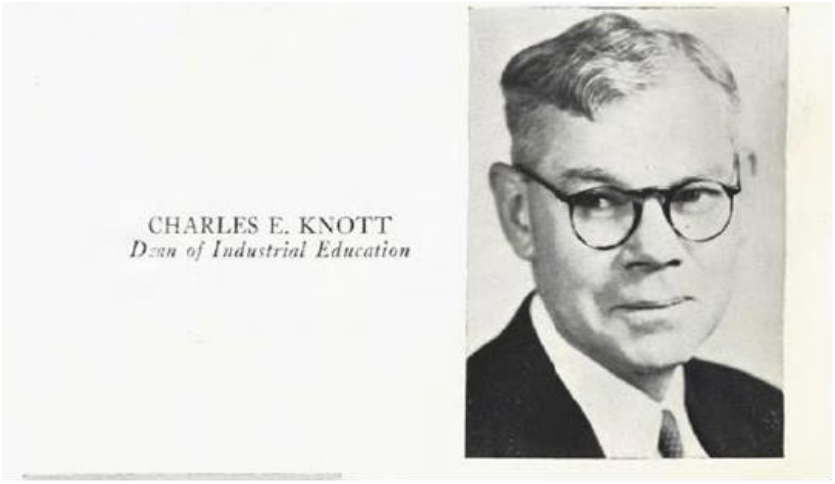


I'd like to tell you the story of the Environmental Engineering Program at Cal Poly.

You are all a big part of the story!

The story begins here in San Luis Obispo, 80 years ago. Mention needs to be made about early teachers whose influence left permanent marks on the school and help shape our program.

C. Elgin Knott holding B.S. and M.S. degrees in Mechanical Engineering from UC Berkeley came to Cal Poly in 1921. In time, Mr. Knott became Dean of Industrial Education.



Cal Poly Archives

Quoting from Cal Poly's Electrical Engineering's web page (2), "during the depression Elgin Knott traveled by train up and down the State securing employment for the Industrial Division graduates. His modest personality and intellectual honesty lent credibility to his claims of adequacy in training and worth as persons for the practically educated California Polytechnic graduates. This reputation with industry established so long ago is still attested today. To attribute to Mr. Knott the title, 'Father of Engineering at Cal Poly,' is certainly deserving and valid." Mr. Knott retired as Dean of Engineering in 1959.

Air Conditioning Program

In 1936, Instructor Norman Sharpe talked Dean Elgin Knott, into forming an Air Conditioning Program in the Industrial Division in addition to Aeronautics, Aero Drafting and Electrical Industries.

Norman Sharp 1937

Cal Poly Archives

Norman had known Dr. Willis Carrier, founder of Carrier Corporation, who had invented the world's first scientific air conditioning system in 1902. In 1937 the curriculum was a three-year tech program in Air Conditioning (AC). It turned into a four-year program in 1940.

Norman served as Chairman of the Department from 1941 until 1958. In 1946, Jim McGrath, joined the AC Department. He had just survived the notorious Bataan Death March and the POW Camp O'Donnell and HELL SHIP - Oyoku Maru as a prisoner of the Japanese during World War II (3).

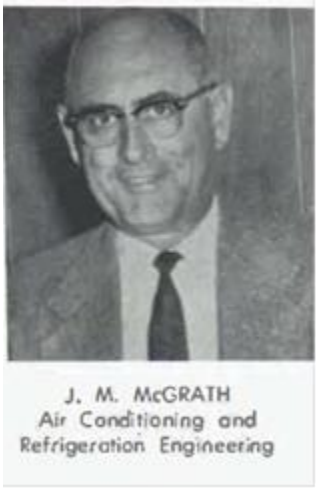
James M McGrath

http://archive.kitsapsun.com/news/local/a-survivors-story-ep-423174464-359043691.html

Air Conditioning & Refrigeration Department

The program became the Air Conditioning and Refrigeration (AC&R) Department by 1950. Jim took on the job of Department Head in 1958.

At that time, Cal Poly's highest priority was to hire faculty who had industrial experience and were dedicated to teaching.



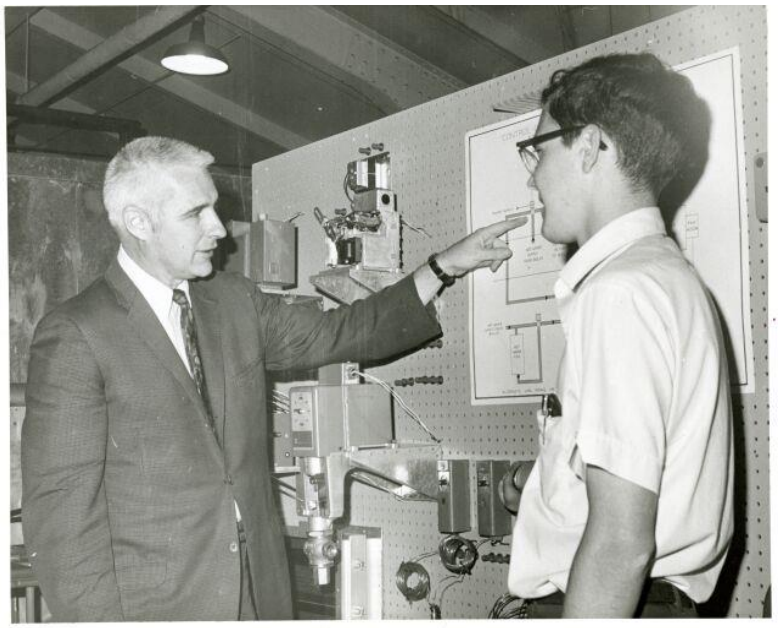
Cal Poly Archives

Ted Graves was hired in 1947. Ted taught mechanical drawing and several shop classes. He had experience as a high school teacher and lecturer at Santa Barbara State College (now UCSB). Former students remember him fondly.

Cal Poly Archives

Norman Sharpe center, Jim McGrath far right, Ted Graves to Norman's right

Skipping ahead to 1960, another important part of the story was the hiring of Rod Keif. Rod graduated in Mechanical Engineering from Kansas State University and had worked in air conditioning system design and sales in Kansas and Oklahoma and was a registered Professional Engineer in Oklahoma. Rod had great practical experience and was a master teacher. His classes were never dull and he engaged his students with his examples and one liners.



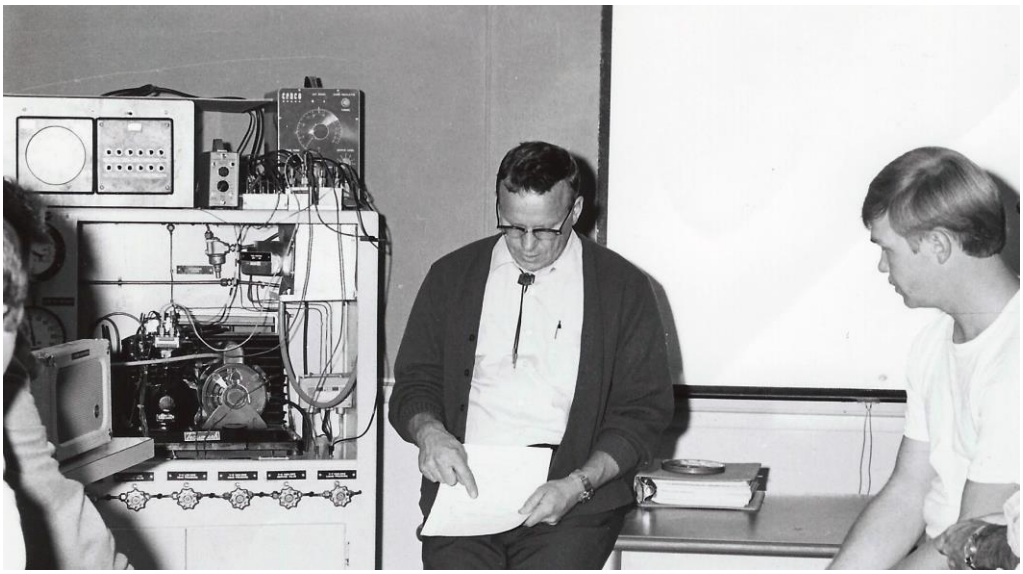
Rod Keif and Student Bernard Nagengast (Cal Poly Archives).

Ray Allen joined the Department from the Welding Department [Now Materials Engineering] in about 1965. Ray had been at Cal Poly since 1955.

Ray Allen

Ray brought his skill as a photographer into the classroom.
He was ahead of his time in that he used slides predominately in his lectures (kind of a forerunner of PowerPoint).

In 1963 William Phaklides was hired. Bill had graduated from the program in 1956 and had seven years of industrial experience. Bill was enthusiastic and well liked by his students.



Bill Phaklides teaching controls student Ray Hickey-to right .

The AC&R program was small. That was good news and bad. The advantage of this was faculty and students got to know each other which led to very effective teaching and loyal alumni. I was told the curriculum was designed so that each year a student completed they would be able to find employment at a progressively higher level. This idea was expressed in the 1940 course catalog.

The down side was there being constant pressure from the administration to increase the size of the department. Jim McGrath however took the heat and allowed the faculty to concentrate on teaching.

Air Pollution Control Concentration

In February 1964, Norman Sharp wrote a memo to the Dean of Engineering, Harold Hayes, suggesting adding an Air Pollution Control Concentration to the Air Conditioning & Refrigeration Department with the support of Jim McGrath.

Norman Sharp

Harold Hayes

Cal Poly Archives

Norman stated in the memo only a few new courses would be required, a common argument for developing new programs at the time. Unfortunately, he was not able to follow this up as he had to retire from Cal Poly due to illness in 1965.

Jim McGrath believed adding an Air Pollution Control Concentration was one way to help the department grow and it made sense to expand its interests to include the problem beginning to be recognized in Los Angeles in the outside air, namely air pollution.

So, in 1965, Jim McGrath or Harold Hayes decided to find someone who could develop a new program that would fit with the existing program.

In 1965, as a graduate student at the University of Oklahoma, I applied for an Engineering teaching job at Cal Poly. Dean of Engineering, Harold Hayes said there was an opportunity at Cal Poly to join the AC&R Department.

My concern, as a new PhD chemical engineer, was I knew little about air conditioning and refrigeration! I had worked summers for San Diego Gas and Electric Company, before receiving degrees in Chemical Engineering from UC Berkeley and Northwestern. I had decided to go back to school after working for Lockheed's electrochemistry research department on fuel cells. The main reason was interest in the public health applications of engineering.

Dean Hayes indicated that I would be teaching classes like thermodynamics, fluid mechanics and heat transfer, which were familiar subjects, and I would also be able to have a joint appointment in the metallurgy department [now Materials Engineering] which had many similarities to chemical engineering. But the most intriguing part of his offer was his mention of the opportunity to develop a new academic program in Air Pollution Control. This seemed to be a perfect way to work with engineering and public health issues. With this potential, I joined the AC&R Department in 1966.

Department photo 1966

In 1966 the University enrollment was around 7000. The engineering program was designed so students would find jobs when they graduated. And they did! Faculty were ranked as Vocational Instructor, Senior Vocational Instructor or Principal Vocational Instructor instead of Assistant, Associate or Full Professor.

Everything I was told by Dean Hayes was true except, the joint appointment and the fact I had to teach several advanced courses in air conditioning and refrigeration. These were senior classes where the students knew more about the practical aspects of the subject than me !

Shared offices were the rule of thumb. I had the good fortune of sharing an office with Rod Keif. Rod was a great resource for background information about teaching and the Cal Poly learn by doing approach to everything. I hoped that he would tell me what to teach by way of some outlines, but he was true to Cal Poly's approach… learn by doing. For the most part, I had to read journals and the literature to relate the theory to practice.

Noise and Vibration Control was one subject that I had to teach that was completely new. There were no textbooks on the subject so I spent a lot of time in the library and had to assemble a syllabus using reprints of articles from journals and technical publications. It turned out to be a subject that later led to consulting opportunities for me and job opportunities for our students.

Another surprise was that I was the first PhD faculty member hired in the School of Engineering since the early '50s. I learned to appreciate the fact that teaching was number one but found applied research complemented what went on in the classroom and involved students. The faculty were committed mentors.

I was busy teaching four new classes each quarter, as mentioned, many of them I had never studied before. In addition, work with students doing senior projects was required. The learn by doing method of instruction required time, in and outside the classroom. Faculty were expected to come to school every other Saturday to help students with their senior projects. Many of these projects took place in the AC&R Lab and adjoining Patio.

ACR&R Lab

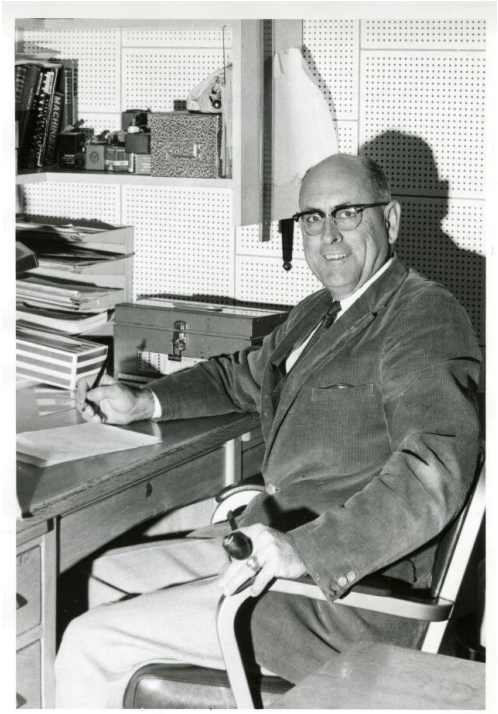
AC&R Patio

Photos courtesy Bernard Nagengast

I was impressed by the practical skills of the students. Some of the senor projects were comparable to a master's thesis at other schools. These projects required a lot of thought and time.

Jim McGrath routinely invited the faculty and their families over to his home which led to long friendships with all. I learned many lessons from my colleagues who all were people with industrial experience and were trained as teachers. The AC&R Department's close ties with industry had many advantages.

Jim McGrath went out to the supporters of the Department and raised $1000 [a large sum of money at that time] so I could travel around the country and ask people in industry, academia and the regulatory community what should be included in the first undergraduate curricula in air pollution control in the nation.



Jim McGrath encouraged adding Air Pollution Control Concentration

It seemed clear from my interviews that an applied chemical engineering curriculum was the type of background students would need to tackle the wide range of environmental problems facing industry and the country. The curriculum could be achieved by modifying the AC&R curriculum by adding some new courses, taking much more chemistry, and retaining Rod Keif's senior design Industrial Ventilation class, and the course in noise control.

Environmental Engineering Department

So, in 1966, the time was right at Cal Poly and California to think about bringing a new Air Pollution Control Concentration into the Department.

Rod Keif's Senior Design Class

I submitted my plan to Jim McGrath and recommended we change the name of the department to Environmental Engineering with two concentrations; Air Conditioning & Refrigeration Engineering and Air Pollution Control. After the faculty approved the concept, Jim went out to the alumni around the State and asked for their support in changing the Department name to Environmental Engineering. They believed it was a good idea.

Dean Harold Hayes retired at the beginning of 1966 and the new Dean John Hirt continued to support the concept of an Environmental Engineering Department.

John Hirt (Cal Poly Archives).

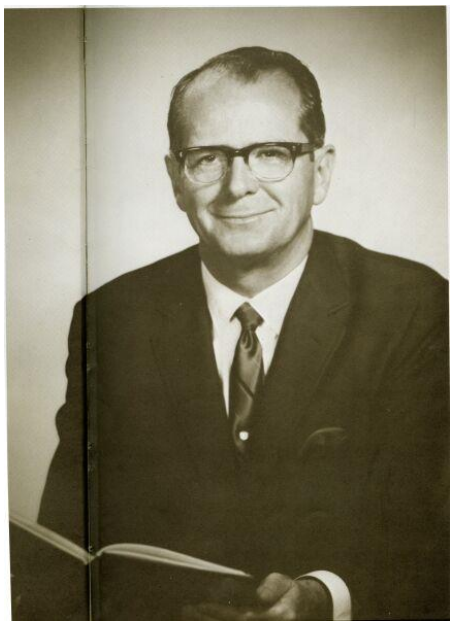
At the time, not everyone agreed that such a program made sense. Some people working in the field of air pollution control thought that the only thing a degree in environmental engineering and 10 cents would get you was a cup of coffee. There were no undergraduate environmental engineering programs in the country and no undergraduate programs that dealt with air pollution control. The programs that did exist were a few graduate programs in Mechanical Engineering, Civil Engineering, Public Health and Meteorology.

In 1967, Phil Niles joined the department faculty. Phil had done graduate work at UCLA, and had industrial experience at Rand Corporation and Rockwell International. Phil had great analytical ability and a rigorous background in mathematics. When we added Solar to the mix in the seventies, Phil concentrated on that.

The picture below shows the Air Conditioning & Engineering Department in 1967.

Class of 1967 Hal Cota, Ted Graves, Phil Niles-first row left

In May1967, Robert E. Kennedy was inaugurated as President of Cal Poly. President Kennedy, who joined the college in 1940, had served in several instructional and administrative assignments. In 1968, fifty years ago, with the support of Jim McGrath, the AC&R Alumni, the Dean of Engineering John Hirt, and President Robert Kennedy, Cal Poly approved the program and changed the name of the department to Environmental Engineering.



President Robert Kennedy approves ENVE in 1968.

The new Department consisted of a concentration in Air Conditioning and Refrigeration Engineering and one in Air Pollution Control and one in Solar.

Environmental Engineering 1968

Photo courtesy Tim O' Conner

In the late 1960's and 1970's a wave of international and out of state transfer students enrolled in the new ENVE program. At times academic red tape was often side stepped to get things done, as one transfer student from New York recalled.

"I was accepted to the ENVE program as a transfer student for the fall quarter of 1968, being short of money I took a job as a lab technician at Carrier Corp. in Syracuse.

I reapplied for the 1969 fall quarter but heard nothing at of my acceptance for months. By July 1969 I still heard nothing from Cal Poly. On a Thursday in mid-July I called the ENVE Dept. directly and spoke with Jim McGrath explaining my predicament, knowing classes were staring in just weeks. Jim McGrath said I will call you back next Tuesday, and he did just that. He said, Tim, just get in your car and drive to Cal Poly, you are now an ENVE student, I'll handle the paperwork. I did just that. " (6)

The result was an academic program dealing with both the inside and the outside air environment. [see appendix]

Industrial indoor air pollution
(Air Resources Board)

Outdoor air pollution
(EPA)

Many of the new courses in the Air Pollution Control Concentration required development of textbooks. The authors and editors of the professional journals were kind enough to allow us to duplicate their work at no cost so we could provide it to our students at no cost except that of duplication. So, our textbooks became sets of notes and published literature.

There was no internet, fast duplication machines, or word processors so this could only have been done with the help of many. Our secretary, Noni Smyth, did a lot of typing requesting permission to duplicate material and, as mentioned, the professional associations were for the most part kind in granting permission. The editor of the Journal of Air Pollution Control Association [now Air and Waste Management Association], Harold England was very supportive.

Our first class in the new Air Pollution Control concentration consisted of 2 or 3 students who were seniors in the Air Conditioning and Refrigeration concentration.

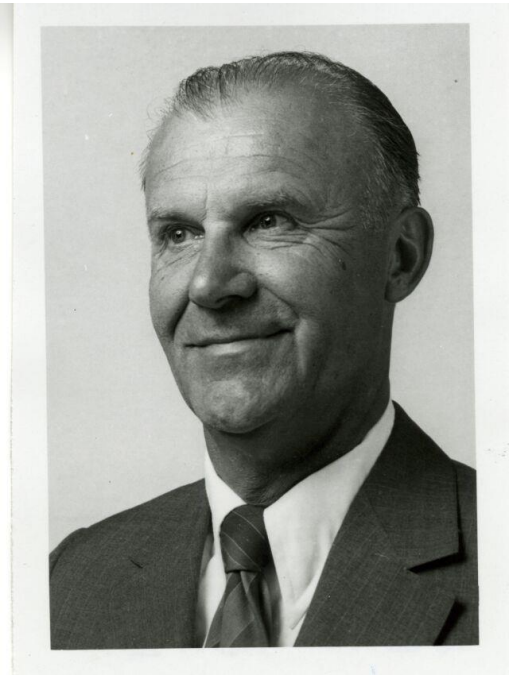
Hal Cota students Dave Rein, Dave Kelly

Ray Allen attended a special program for people working in Air Pollution Control that was put on at USC under the leadership of Frank King who later headed EPA's Air Pollution Institute. Ray's support in the early stages of our program helped.

In 1968, there were some other big changes at Cal Poly. Architecture left the Engineering Division, so five schools (Agriculture, Architecture, Applied Arts, Applied Science and Engineering) were created. In addition, President Kennedy was mandated by the Chancellor's office to get all programs accredited wherever possible. The new Dean of Engineering, Archie Higdon, had a lot of experience and contact with EPCD who accredited Engineering programs at the time. He created the Engineering Technology (ET) Department and encouraged faculty with non-Engineering degrees to transfer to ET. Higdon named Jim McGrath the Department Head of ET. Ray Allen and William Phaklides transferred to the Engineering Technology Department to begin an Air Conditioning and Refrigeration option in ET.

Walter Holtz transferred to the Environmental Engineering Department from the Mechanical Engineering Department at Cal Poly Pomona and took over the ENVE Department head assignment. Holtz had formerly been a faculty member in Mechanical Engineering at Cal Poly San Luis Obispo in 1954. He went to Cal Poly Pomona in January 1957 as coordinator of engineering and was appointed head of the Mechanical Engineering Department there in 1958. He returned to the Environmental Engineering Department on the San Luis Obispo campus in 1968, and was appointed head of that department in September 1969. He moved his family back to SLO to get away from the polluted air in southern California. Rod Keif said, "if that isn't poetic justice, I don't know what is!"

Walt had three degrees: Mechanical Engineering, Nuclear Engineering and Meteorology. He also had experience in industrial refrigeration.



Walter Holtz became ENVE Department Head in 1969.

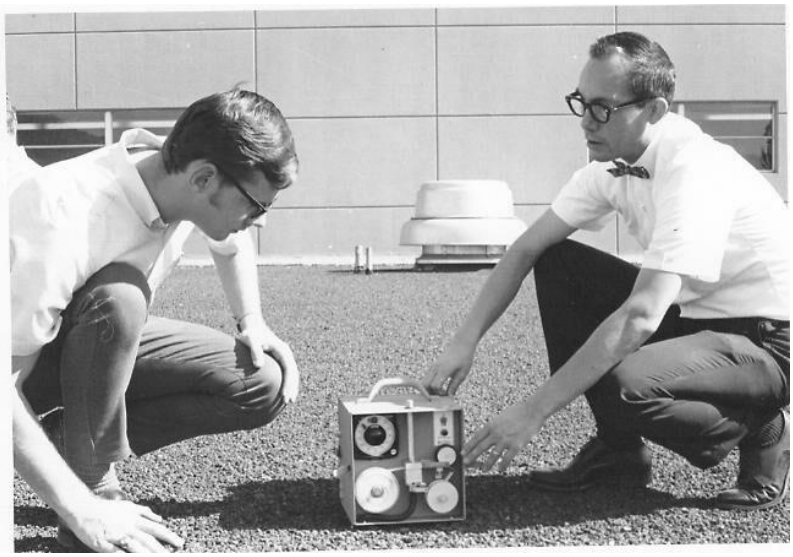
With this wide background, Walt made several innovative changes to the program. For instance, he added a new hands-on course in meteorology to the curriculum.

In 1969 all the Engineering programs at Cal Poly were accredited by EPCD, the Engineering Council for Professional Development.

In 1969, we applied for and received our first federal grant to offer several workshops on Air Pollution to California's High School Science Teachers.

Shortly after that, we applied for another grant from the then National Air Pollution Control Administration housed in the Department of Health Education and Welfare [now the Environmental Protection Agency] for equipment and funds to start our undergraduate program in air pollution control. They sent a team of Air Pollution Researchers out to inspect us. This was the first large grant request in the School of Engineering and President Robert Kennedy joined us at a lunch with the visitors. One of the visitors remarked to me, "how could anyone study, let alone measure, air pollution in San Luis Obispo."

Despite that comment, we received the grant for air pollution monitoring instrumentation for our undergraduate program.



Dan Mathews and Dr. Cota check out equipment from grant.

The Air Pollution Control concentration graduated a few students in 1969. The curriculum called for 210 quarter units but most students graduating had many more. It was typical, at this time, for all engineering students to take 5 years to graduate.

Initial support from the National Air Pollution Control Administration, was continued by the Environmental Protection Agency. The nature of the support was initially to not only provide equipment but also traineeships. Cal Poly was the only place in the country undergraduate students received such support. This enabled them to work during the summer for local agencies all over the state with stipends provided by the grant. Later, the support was changed to forgivable loans. The idea of these loans was to provide funds for students to study environmental engineering and upon graduation work for local air pollution control agencies. EPA's support continued in various forms through 2009.

In 1969 the department hired Tom Ward from the calibration section at Vandenberg AFB to be our equipment technician.

Tom Ward.

Tom was a technical genius who could get donated and surplus equipment to work and keep up with the rapidly developing environmental equipment evolution from mechanical-chemical to electronic. He made countless trips all over California to find equipment and supplies for our labs. Tom had a unique personality as well.

Tom Ward's retirement.

Air and Water Pollution Control Concentrations

Another important step in my and the Program's development was an offer to become a member of the Central Coast Regional Water Quality Control Board in 1970. This opened new opportunities for me to learn and resulted in our students being offered positions as interns at the Regional Water Board. I am sure the appointment is thanks to the insight and recommendations of both Jim McGrath and Cal Poly President Robert Kennedy. Serving on the Board made it clear that Environmental Engineering at Cal Poly should include water pollution control.

Late in 1970, Walter Holtz received approval to hire a new faculty member to develop courses in water pollution control. A former classmate of mine from Northwestern, Drago Misic, happened to be passing through town. He decided to interview for this job to expand Environmental Engineering [ENVE] into the area of water pollution control. He borrowed one of my suits and went to meet the Dean of Engineering, Archie Higdon.


Dr. Drago Misic.

Drago had a PhD in Chemical Engineering and was working on a Post Doc at UC Davis. He also had worked several years for Westinghouse and had experience with wastewater system design. Drago was offered the job on the spot, and soon after, developed the concentration in Water Pollution Control that was put into the 1972 catalog !

C**raig Anderson in our first Water Quality Lab.**

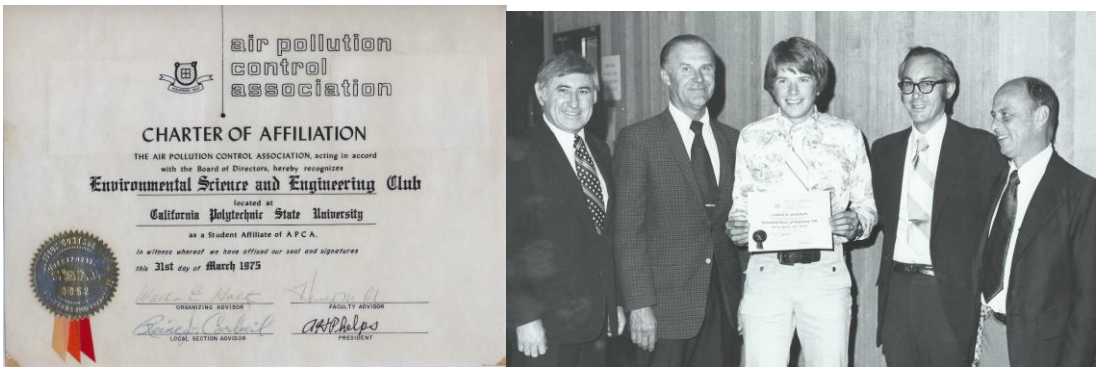
Drago was very outgoing. He had grown up in Yugoslavia and came to the US when his Mom, Dad and sister moved to the Chicago area. He was in Yugoslavia as a boy when the Germans occupied his city during WWII. He had to use his wits to survive. He spoke German, Russian, Serbian, and of course English. Frequently during his career at Cal Poly, he spent summers working on carbon adsorption research with a former Northwestern classmate who taught at the University of Tokyo.

In 1977, the ENVE Department hired Bill Clark who was a Mechanical Engineer working for Rockwell in Thousand Oaks.

Bill received his PhD from the University of Minnesota where he had studied aerosol size distributions and aerosol volume formation rates under Prof. Ken Whitby**.** Bill had also taken several courses in Heating, Ventilation and Air Conditioning (HVAC) at Minnesota.

Dr. Bill Clark (far right) became ME Department Head with students Jeff Kelly (standing) and Charlie DuVall.

Participation in professional organizations was [and continues to be] an important part of professional development for faculty and students. In 1975, the Society of Environmental Engineering and Technology [SENVE] became the second officially sanctioned student chapter of the Air Pollution Control Association [now the Air and Waste Management Association] in the United States.


air pollution control association

CHARTER OF AFFILIATION

THE AIR POLLUTION CONTROL ASSOCIATION, acting in accord with the Board of Directors, hereby recognizes

Environmental Science and Engineering Club

located at

California Polytechnic State University

as a Student Affiliate of A.P.C.A.

In witness whereof we have affixed our seal and signatures this 31st day of March 1975

ORGANIZING ADVISOR — FACULTY ADVISOR

LOCAL SECTION ADVISOR — PRESIDENT

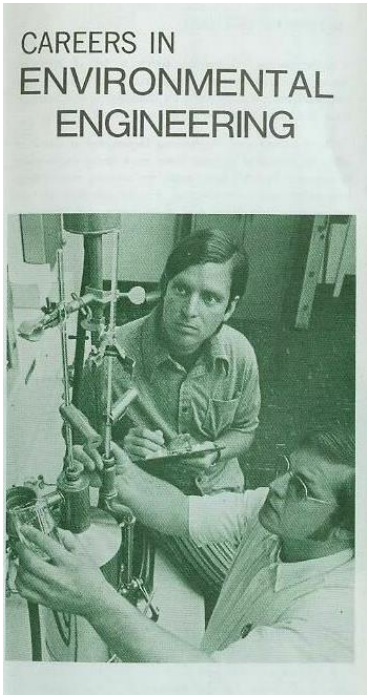
Mr. Corbeil APCA Chair, Walt Holtz. Eric Gobler, Hal Cota, Dean Valpey

This led to many Cal Poly scholarships and student papers and awards over the years from the West Coast Section. The first award was given in 1978 to Doug Wolf.

Doug Wolf receives award from Dan Pastell, Chair of West Coast Section

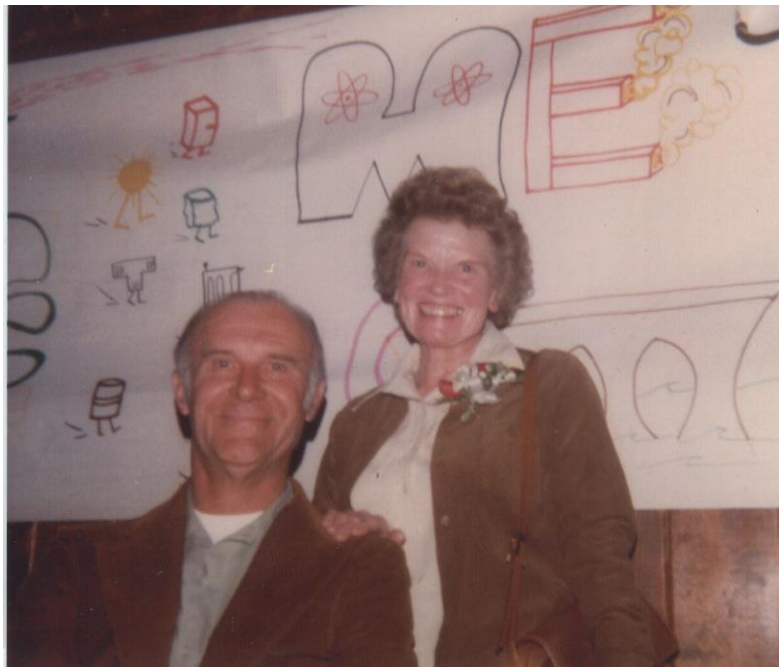
Because most of our students were taking both the air and water pollution control concentration in 1979 the ENVE Department combined the concentrations into the Air and Water Pollution Control concentration and added a concentration in Solar. But the Department was still small so we made an outreach to high school and community colleges throughout the state.

Pictured below is the information sent to high schools and community colleges.



Recruiting for the Air and Water Pollution Control Concentrations.

In 1982 Walt Holtz decided to retire as Department Head of ENVE.



ENVE Department Head Walt Holtz with wife Ruth.

A reception honoring him was held in the Staff Dining Room on June 7, 1982 where faculty, staff, and friends joined in wishing him well in his retirement. Walt and his wife Ruth were thanked by students and faculty for their years of service.

AC & R to Mechanical & Air and Water to Civil/ENVE

None of the faculty wanted to become Department Head but wanted to have a nation-wide search. We didn't know the big picture. President Baker had started a new Civil Engineering program and we learned that our Department was going to be split.

President Warren Baker
Cal Poly Archives

The current Dean, Robert Valpey, had retired and a new interim Dean, Bill Horton, was in place.

The ENVE faculty was given the option to go into Mechanical Engineering or the Civil Engineering Department. As mentioned, Cal Poly had just started a new Civil Engineering Department (1981) from the existing Transportation Engineering Department.

It was clear the AC&R and Solar faculty would be more at home in Mechanical Engineering. So, Phil Niles, Bill Clark and Rod Keif moved to Mechanical Engineering.

But it was not so clear for the two ENVE faculty, Drago Misic and I [Hal Cota], who taught the air and water pollution control classes and who were both Chemical Engineers. We both felt comfortable teaching in the Mechanical Engineering Department, but were concerned about the program in Air and Water Pollution Control.

Civil and Environmental Engineering

I met with the new head of Civil Engineering, Peter Lee, "for coffee".

 **Peter Lee, Civil Engineering Head**
https://raw.githubusercontent.com/wiki/jbclements/CSC-department-history/peter-lee.png

Dr. Lee said he would like Drago and me to join his Department. My colleagues who went into the Mechanical Engineering Department lost most of the air conditioning or solar courses they were teaching because Mechanical did not want to have concentrations in either Air Conditioning or Solar.

I told Peter Lee the only way we would join Civil is if he changed the name of the department to Civil and Environmental Engineering and offer two degrees, one in Civil and one in Environmental Engineering so we could keep the program intact.

After these negotiations, it was decided the best course of action for both the Air and Water Pollution Control Program and Drago and me was to move to Civil Engineering and **rename** the department to Civil and Environmental Engineering and offer two separated degrees, one in Civil Engineering and one in Environmental Engineering starting in September 1982.

Drs. Misic and Cota to the new Civil and Environmental Engineering Department

1982 last Environmental Engineering Department graduates.

In 1982 the new Civil and Environmental Engineering Department hired Sam Vigil, a bright, enthusiastic young faculty member who was working as a Principal Engineer with Brown and Caldwell Consulting Engineers. Sam had received a Civil Engineering degree from UC Berkeley then served as a Commissioned Officer with the US Navy Reserve. Dr. Vigil retired from the Navy Reserve in 1995 at the rank of Commander. He then completed a Masters Degree at Texas A&M followed by a Ph.D. in Civil Engineering at UC Davis concentrating in Environmental Engineering. Sam brought broad experience in consulting engineering and as an officer in the Navy Civil Engineer Corps to Cal Poly. His area of interest was solid waste management, energy recovery and waste water treatment.

Dr. Sam Vigil had environmental assignments with the Navy.

This added new dimensions to the ENVE program and it became truly multimedia, now dealing with issues of air-water/wastewater-noise-solid waste management. Sam's expanded areas of interest included sustainable environmental design, solid waste management, recycling and water and wastewater treatment. He co-authored two important texts- Integrated Solid Waste Management: Engineering Principles and Management Issues; and Civil and Environmental Engineering Design.

Sam became a good friend over the years both at Cal Poly and with the Air and Waste Management Association.

Dr. Vigil and Dr. Cota with Cal Poly students at A&WMA awards dinner.

Sam encouraged participation in professional organizations like A&WMA and becoming registered. Both he and Dr. Cota are Registered Professional Engineers and Board Certified Environmental Engineers.

He also participated in the Navy Reserve for many years in leadership roles with the Navy's Environmental Programs.

He reshaped the senior design class into a two-quarter senior project class.

Dr. Sam Vigil working with students in 2009.

Both he and his wife Eve were active in the community and served on the have served with Search and Rescue for 20 years.

In the early 80's, Cal Poly was selected by EPA as an-area-wide training center, one of eight centers named, located at key Universities around the country. The main purpose of the centers was to provide advanced training to staff of local and state regulatory agencies and Native American tribes throughout the western United States in subjects such as hazardous waste incineration, air pollution control, air modeling, and quality control and air toxics.

Dr. Hal Cota with EPA Course on Source Testing.

EPA source test class at stack.

The Cal Poly EPA Area-wide Training Center also provided support and resources to our students and faculty. I served as the center's Director. EPA discontinued the eight area-wide training centers in the United States in 2009.

Up until the late 1990s we provided EPA training center courses during the summer most often and at quarter breaks on campus. This enabled faculty in the various departments to participate as lecturers. Many alumni helped in these classes as well, especially John

Quiel, Jim Karas, Brian Aunger and Richard Smith. Our undergraduate students were also able to participate in these classes as assistants in the laboratory as well as in the classroom. As part of this work, EPA's air pollution training center frequently had meetings with the training center directors at the annual meeting of the Air and Waste Management Association which provided and opportunity for quality control.

In 1987, I developed a new course in Hazardous Waste Management which was an emerging environmental issue. It was necessary to again assemble a syllabus using reprints of articles from governmental publications and the literature since there were no suitable textbooks available.

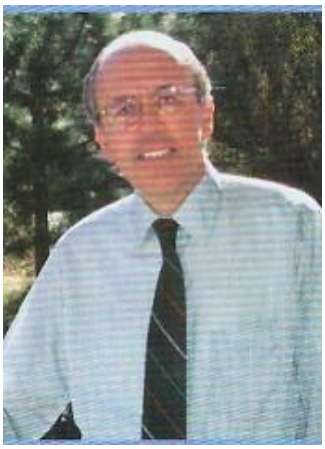
Rod Keif continued offering Industrial Ventilation to our ENVE majors until he retired in 1988. He was re-hired as a part time lecturer the following fall and even came back when he was 80 to teach that class. Rod may be the last of the "industrial background in HVAC" types to get a tenure track appointment at Cal Poly. He typed up his lecture notes and passed them on to Ray Gordon who continued teaching ENVE's HVAC. Rod has continued to support the program in retirement.

Rod Keif talking with Alum in 2009.

Drago Misic and I had many laughs about the small office we shared for many years with barely enough room for all our books. He was a big help in serving as a lecturer in the EPA Areawide Training Center Classes. Unfortunately, he developed Leukemia. He traveled to Santa Barbara and UCLA for treatment. After a few years, he retired. While he was recovering, he traveled with me to Las Vegas to help team teach an EPA course and was well enough to return to Cal Poly. In the early 90's Drago retired. Eventually his Leukemia got the best of him. It was like losing a brother. Drago was smart, personable, and an always helpful colleague with an amazing sense of humor. He set a high standard for his students and was respected by his colleagues. He was a good person and help make our work at Cal Poly a remarkable experience.

Dr. Drago Misic retires from ENVE.

Sam Vigil picked up all of Drago's courses. After a nation-wide search to replace Drago, Rob Lang joined the department in 1991 and began teaching water and wastewater treatment and introductory courses in Environmental Engineering.



Dr. Rob Lang joins the Department

Rob completed his BS, MS, and PhD in Civil Engineering at UC Davis where he was an outstanding student. Rob was also a Professional Engineer with over 13 years' experience in design and construction. His most recent experience prior to joining Cal Poly was Assistant manager/Chief Civil Engineer with the Imperial Irrigation District managing large water projects. He added several new graduate courses in water pollution control to the ENVE Program at Cal Poly. Rob was highly regarded by all his students and colleagues because he was always ready to assist them with their concerns. Dr. Lang eventually became the CE/ENVE Department Head.

Despite the budget crunch in 1993, the ENVE program was growing, which allowed us to hire Jeff Sczechowski in 1994.

Dr. Jeff Sczechowski.

Jeff received his BS in Chemical Engineering from the University of Colorado-Boulder and then a MS degree in Chemical Engineering from North Carolina State.
He then joined Photo-Catalytics, Inc., Boulder, Colorado before continuing and completing his graduate work at the University of Colorado-Bolder. He received his PhD in 1994 in Chemical Engineering with an emphasis on environmental applications.

At Cal Poly, Jeff was a Charter Member of the Environmental Biotechnology Institute and Project Director of the Environmental Protection Engineering Laboratory. His research interests included Photochemical Engineering, Pollution Prevention, Kinetics, Catalysis and Reactor Design, Water and Air Purification, Separations, Hybrid Treatment Processes, Natural Attenuation of Pollutants.

Jeff was innovative in the classroom and mentored a growing number of graduate students.

In 1995 Nirupam Pal joined ENVE from the Center of Environmental Engineering at Stevens Institute of Technology in New Jersey where he was an Assistant Professor. Nirupam had experience in the oil and natural gas industry. He received his PhD from the New Jersey Institute of Technology with an emphasis on biodegradation of hazardous waste. He had a MS and BS in Chemical Engineering from Calcutta University in India. Nirupam also received a BS degree in chemistry from Calcutta University.

Dr. Nirupam Pal.

Dr. Pal added course work in bioremediation to the curriculum. He became involved in several bioremediation and carbon dioxide reduction projects and is the Associate Director of the National Pool Institute Research Center at Cal Poly.

Jeff Sczechowski took a leave of absence in 1997 to move to France and become the Environmental Program Manager at STMicroelectronics. He then served 5 years as Program Manager of Sustainable R&D for STMicroelectronics. Jeff then served as Coordinator of Research Opportunities, College of Engineering and Applied Science, University of Colorado, Boulder and UC Santa Barbara. Jeff is currently teaching in the Chemical and Biological Engineering Department at the University of Colorado, Boulder.

In 1999 Yarrow Nelson was hired to continue the work of Jeff.

Dr. Yarrow Nelson.

Yarrow's academic background included an undergraduate degree in Chemical Engineering at UC Berkeley, a Masters in Agriculture and Biological Engineering and a PhD in Environmental Engineering from Cornell University. Before coming to Cal Poly his experience included working at an oil refinery and solar photovoltaic factory followed by 15 years of research and 3 years of lecturing at Cornell University. Yarrow worked to develop the Department's bioremediation research and courses and the ENVE graduate program. His research includes alternative wastewater treatment, bioremediation of groundwater contamination, sustainable design, and biodiesel production from algae.

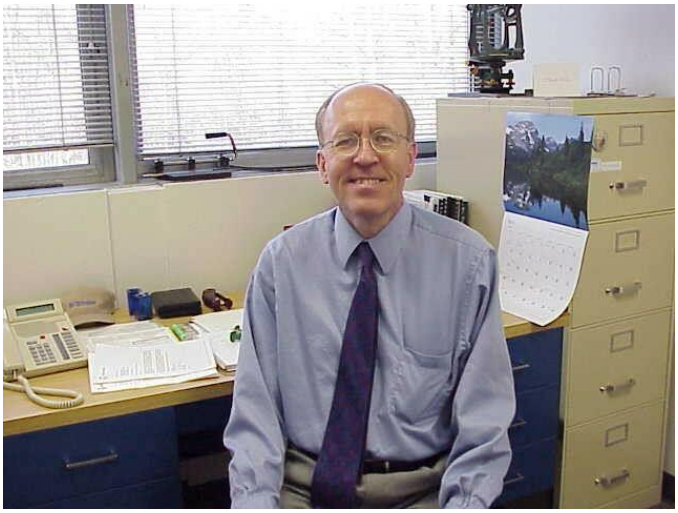
Sediment sampling.

Site lecture.

When asked why he chose to come to Cal Poly he replied, "I was attracted to Cal Poly because of the practical nature of the environmental engineering program and the kinds of applied research I could do here. I also liked the emphasis on the chemistry and chemical engineering aspects of the program. "

always innovative.

In 2003, Dr. Lang left Cal Poly to take a position as Dean of Engineering at the University of Alaska Anchorage Campus (UAA). He is still active at UAA as a Professor and Chair of the Civil Engineering Department. He remains also a good friend.



Dean Rob Lang at University of Alaska.

Parna Mukherjee was hired to replace Rob in 2004.

Dr. Parna Mukherjee.

Dr. Mukherjee was the ENVE program's first female faculty member. Her special research interest was the application of reverse osmosis in wastewater treatment.

In 2005, I [Hal Cota] retired to half -time teaching until 2010. After that I continued to teach part time.

Dr. Cota class on Environmental Modelling in 2010.

In 2006, after a nation-wide search, Tracy Thatcher was hired to strengthen the air program. Tracy had an undergraduate degree in Chemical Engineering from UC Davis and a Masters and PhD in Civil and Environmental Engineering from UC Berkeley. She had 5 years of industrial experience with Hewlett-Packard and 7 years of research experience at Lawrence Berkeley National Lab. She is a registered Professional Civil Engineer.

Dr. Tracy Thatcher.

Tracy made improvements in the undergraduate and graduate program and the air measurements laboratory. Her repour with the students and high expectations for the quality of their work were recognized by all.

Dr. Thatcher with students.

Dr. Thatcher is an outstanding teacher and mentor to the all the students in the program.

She continues her research work and consulting in indoor air quality. This work has important applications in the reduction of human exposure to air pollutants. Tracy served as member of the California Air Resources Board Research Screening Committee for many years. She is a mentor to all her students in the classroom, the laboratory in their research and in profession level competitions with other universities.

Dr. Mukherjee decided to leave Cal Poly's academic life to raise a family in 2006. This made it necessary to find someone who would continue the water and wastewater instruction.

After another nation-wide search, Tryg Lundquist joined us after completing his PhD work in Civil and Environmental Engineering at UC Berkeley. Tryg had international research and consulting experience and is a registered Professional Civil Engineer.

Dr. Tryg Lundquist.

Tryg has taken on the development of the water and wastewater control work in ENVE. He also co taught the senior project design series with Sam Vigil. His special areas of interest include municipal wastewater treatment, treatment of dairy wastes, and the use of algae to produce biodiesel fuels and other biofuels.

Sam Vigil retired in 2010 and continued to teach half time until 2015 and then part time after that.

Dr. Vigil retires to part time teaching in 2015.

Sam continued his research work involving the use of greenhouse gas emissions from landfills using data from satellites. In addition, he worked on the Air and Waste Management Association's technical programs on solid waste management.

Rebekah Oulton was hired in 2013 to strengthen the water quality program and hydrology.

Dr. Rebekah Oulton.

Rebekah, an expert in advanced water treatment and water quality, is developing an undergraduate research program for students interested in water and environmental chemistry, materials science, hydraulics, and water and waste treatment. She also took on the responsibility of codirecting the work in the senior project design series.

When asked about why she came to Cal Poly she shared, "I came to Cal Poly for several reasons, but mostly because I love interacting with students. I pursued a PhD after 15 years in industry and consulting, because I wanted to teach at a primarily Undergraduate Institution like Cal Poly, where I would have the opportunity to interact extensively with students. My favorite parts of my job are helping students understand tricky concepts (and sharing their sense of pride and accomplishment when they "get" it), and talking to them about what's next after they finish school. I also enjoy sharing my research into Clean Water Technologies with them, and helping them explore their own ideas about how to expand the limits of our knowledge in this field. Cal Poly challenges me to be the best instructor, mentor, researcher, and engineer I can be, and I love rising to that challenge every day."

She has taken an active interest in encouraging students to attend professional meetings and to mentor in their competitions at these meeting with other Universities.

Dr. Oulton with ENVE team as PSWC (where they placed first in their category, helping Cal Poly win first overall!)

Faculty remain active

All the faculty in recent years have continued to work closely with our students. Tryg Lundquist, received patents for a Field Water Purification System. It was designed for disaster relief zones when water accessibility and safety is critical. Three stages of the purification process are improved; transport, treatment and safe storage of water. One bag can treat enough water to supply a family of five for up to 10 days. His graduate student, Tricia Compas, won a Clinton Global Initiative award for her work testing the effectiveness of the purification system. She was honored with the Creativity Foundation's 2011 Legacy Medal.

Dr. Tryg Lundquist and Tricia Compas.

The Journal of Solid Waste Technology and Management presented Cal Poly environmental engineering professor Sam Vigil with the Iraj Zandi Award for his efforts in educating students about solid waste management in 2011. The Zandi Award is given annually to someone who has significantly contributed to the field of solid waste management and honors inspiring educator

Dr. Vigil.

In 2012, Sam was elected a Fellow of the Air & Waste Management Association. He was recognized for his leadership in applied research in the recovery of energy from wastes with gasification processes, the computer optimization of waste management systems, the development of sustainable waste management techniques, and the modeling and remote sensing of greenhouse gas emissions. A&WMA presented the Richard I. Stessel Waste Management Award to Sam in 2015.

He was also recognized for his co-authorship of the most widely used textbook in the solid waste management field, "Integrated Solid Waste Management: Engineering Principles and Management Issues." Published by McGraw-Hill, the book has been translated into Spanish, Japanese, and Korean and is used by universities throughout the world as well as by practicing environmental engineers.

In 2014 Yarrow Nelson, continued his study of the effectiveness of algae to treat NO_2 and NO in simulated flue gas.

Dr. Nelson algae studies.

In 2015 Yarrow Nelson was appointed Chair of the Civil and Environmental Engineering Department by the Dean of Engineering Debra Larson. During his 18 years at Cal Poly as

a faculty member he was able to get funding for research projects which supported about 40 graduate students and numerous undergraduate students. These students pursued research projects in bioremediation, phytoremediation, waste minimization, algae-based fuels, storm water treatment and many other topics.

In 2017, Dr. Cota continues to serve as Chairman of the California Air Recourses Board, Research Screening Committee and to serve on the Board of the West Coast Section of the Air and Waste Management Association and their Student Affairs Committee.

In addition to the tenured faculty, the Environmental Engineering Program is indebted to our many lecturers over the years. In 2016-2017 lecturers included Amro El Badawy (full time) and Mladen Bandov (part time). Mladen graduated from Cal Poly's Environmental Engineering program and a principal engineer at Rigi Engineering working on water reuse and recycling projects for nine years. Prior to that he spent five years at both large and small Environmental consulting firms getting experience with various remediation projects.

As of the Fall quarter 2017, Yarrow Nelson joined the teaching faculty half time as part of the early retirement program. Professor Charles Chadwell was named Department Head. Currently there is a search for a new faculty member for the Environmental Engineering Program.

In 2017, Cal Poly's Environmental Engineering Program was named the best undergraduate program in the nation by the US News and World Report.

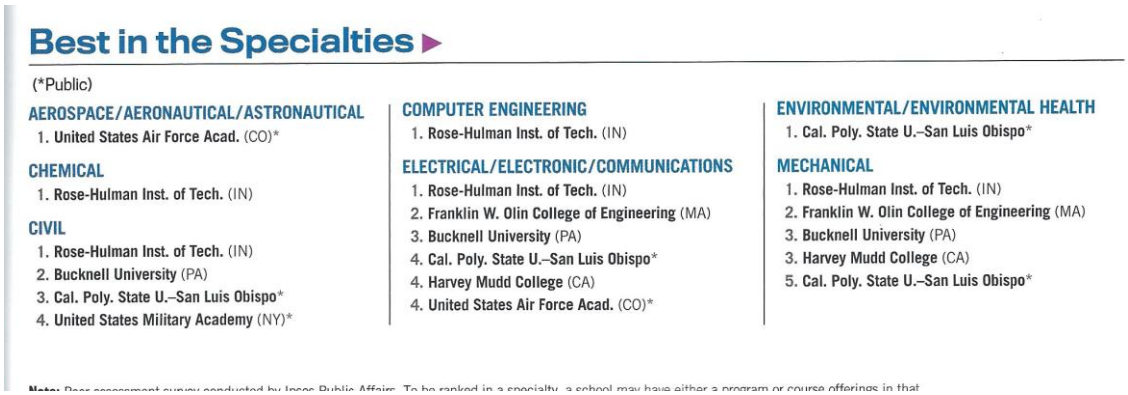
During the in 2018, Dr. Amro (or Amr) El Badawy was appointed as the newest faculty member in the Environmental Engineering Program.

Dr. Amro El Badawy

Amro received his PhD in Environmental Engineering from the University of Cincinnati and BS and MS from Mansoura University in Egypt. He joined Cal Poly as a Research Scholar and Lecture in 2016 after five years as a Post Doc with the Environmental Protection Agency in Cincinnati Ohio.

Amro's research is focused in several areas of Environmental Engineering, Analytical Chemistry and Atmospheric Chemistry and on assessment of the environmental implications of engineered nanomaterials. He served as the W.M. Keck Foundation Postdoctoral Fellow at the Global Waste Research Institute at Cal Poly in 2016.

See reference 4



Best in the Specialties ▶

(*Public)

AEROSPACE/AERONAUTICAL/ASTRONAUTICAL
1. United States Air Force Acad. (CO)*

CHEMICAL
1. Rose-Hulman Inst. of Tech. (IN)

CIVIL
1. Rose-Hulman Inst. of Tech. (IN)
2. Bucknell University (PA)
3. Cal. Poly. State U.–San Luis Obispo*
4. United States Military Academy (NY)*

COMPUTER ENGINEERING
1. Rose-Hulman Inst. of Tech. (IN)

ELECTRICAL/ELECTRONIC/COMMUNICATIONS
1. Rose-Hulman Inst. of Tech. (IN)
2. Franklin W. Olin College of Engineering (MA)
3. Bucknell University (PA)
4. Cal. Poly. State U.–San Luis Obispo*
4. Harvey Mudd College (CA)
4. United States Air Force Acad. (CO)*

ENVIRONMENTAL/ENVIRONMENTAL HEALTH
1. Cal. Poly. State U.–San Luis Obispo*

MECHANICAL
1. Rose-Hulman Inst. of Tech. (IN)
2. Franklin W. Olin College of Engineering (MA)
3. Bucknell University (PA)
3. Harvey Mudd College (CA)
5. Cal. Poly. State U.–San Luis Obispo*

See reference (4)

Best in Undergraduate Engineering

On these pages, *U.S. News* ranks undergraduate engineering programs accredited by ABET (formerly known as Accreditation Board for Engineering and Technology). The rankings are based solely on a survey of engineering deans and senior faculty at all accredited programs, conducted during the spring of 2011. Surveys sent to the dean and a faculty member at each accredited program asked them to rate programs with which they're familiar on a scale from 1 (marginal) to 5 (distinguished). Students who prefer a school that focuses on its undergrads can use the list below of top institutions whose terminal degree is a bachelor's or master's; universities that grant doctorates, whose programs are ranked separately, may boast a wider range of offerings at the undergraduate level. Thirty-five percent of those surveyed returned ratings of the group below; 54 percent did so for the doctorate group. Respondents were also asked to name 10 top programs in specialty areas; those mentioned most often appear here.

See reference (4)

Collectively, the faculty has experience and training in all the classical environmental engineering fields including air pollution control, noise control, solid and hazardous waste management, and water and wastewater treatment. They participate in research in emerging areas of sustainability engineering, bioremediation, biotechnology, biofuels production, and indoor air pollution. Currently five are registered professional engineers and two are Board Certified Environmental Engineers. The faculty are active participants in professional societies, involved in teaching, consulting and research.

ENVE faculty have long been recognized for their accessibility, guidance and mentoring, they have gone the extra mile to help students succeed. (6)

In summary, the ENVE major started with the indoor thermal environment and noise. Concern about outdoor environment and public health was added. Currently this includes: air pollution issues, total exposure including the indoor environment, water-wastewater system design, solid waste-hazardous waste management, remediation, and sustainability.

Many contributors.

It is important to remember that the success of the program depended on the contributions of many people over the years. In the early days, support from those within the University came from Dr. Billy Mounts, Director of the Cal Poly Health Center and Dr. Harry Fierstein who taught human anatomy at Cal Poly who gave lectures about the respiratory system in our introductory classes. Also Dr. Russell Tice assisted us will

analytical chemistry and Dr. V.L. Holland provide access to Biological Sciences microscope labs. Today that collegiality continues to make the program strong.

For many years, Dr. Harry White a worldwide expert in Electrostatic Precipitation travelled to Cal Poly and spent a week giving his international lecture series to our senior class at no cost. Many companies contributed equipment and services to help build the program as well.

The Environmental Protection Agency through Cal Poly's Areawide Training Center and staff of the Air Resources Board – Peter Ouchida, Dave Todd, and Cindy Castranova helped develop our Air Pollution Laboratory. Staff of the Bay Area Air Quality Management District, the South Coast Air Quality Management District, the San Diego Air Pollution Control District were also a big resource. The local San Luis Obispo Air Pollution Control District staff including Bob Carr, Larry Allan and Brian Aunger and many others were always ready to help in any way they could.

The Central Coast Region of the California Regional Water Quality Control Board executive officers; Ken Jones, Bill Leonard and Roger Briggs served as guest lectures and initiated and continued to hire our students to work as interns. Barry Hickenbottom, Dave Carpenter, and others with the Navy's NEESA source monitoring team, located at Point Hueneme, assisted our laboratory classes.

Other part time instructors over the years included former students Katie Anderson Disimone, Laura Nuzzo, Donna DiGangi, Jim Anderson, Brian Aunger, Mike Borger, Clay Bradfield, Oscar Daza, Helene Finger, Mladen Bandov, Michael Lehrer , Cherl Lenhardt, David Morrow, Veronika Pesinova , Adam Poll, Blaine Reely, Christopher Ringer, Ruth Spierling, Charles Virden II, Ian Woertz and Doug Wolf . Many of these also worked as local consultants at the same time.

Unfortunately, the records before 2001 are not complete so if your name should be included I am sorry. Please contact our Department Secretary so we can set the record straight.

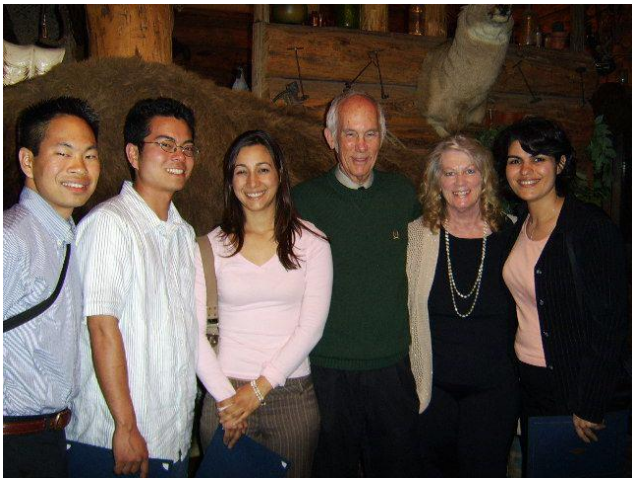
We have had Post Doc researchers help the program such as Amro El Badawy (mentioned above). Just as important were good support staff over the years. All our department administrative assistants and secretaries have made my job fun. They have typed reports, papers, exams, new curriculum proposals, and helped students in numerous ways. That support exists today through Amy Sinclair and Kay Kibbe.

Because we have had state of the art equipment and sometime little if any funding, our equipment technicians made our outstanding labs possible. Tom Ward learned what he needed to know to build and maintain our lab. The same thing applied to Doug Allen who replaced Tom when he retired. Xi Shen and Ron Leverett carry on that tradition.

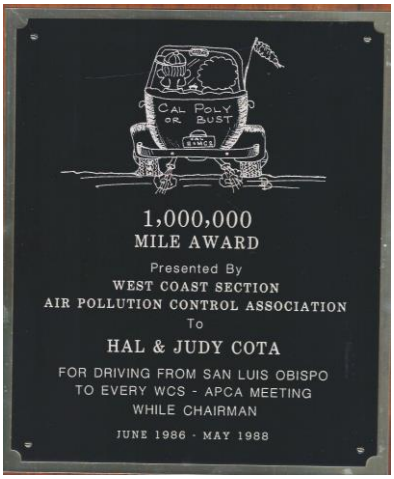
The Departments Industrial Advisor Committee has been an important resource in recent years. Several ENVE alumni have served on that Committee including John Blasius, Craig Anderson and Tim O'Connor.

Over the years the Air & Waste Management Association [formerly the Air Pollution Control Association], particularly the West Coast Section has supported students in our program in many ways. They have provided scholarships, encouraged them to write technical papers, invited them to meetings and dinners and helped them attend the Annual Meeting and Exhibition since 1978. This provided students the opportunity to get involved with those active in the profession.

My wife Judy Cota, was a constant supporter of our students at home and through the West Coast Section.



at A&WMA - Hal and Judy Cota and students.



at APCA

Alumni

You [our alumni] are a big part of this picture. You helped make the program one of the most respected in the country. We have and continue to benefit from your feedback on the Profession, our Curriculum, Lab development and Opportunities for Cal Poly students. Special thanks go to Doug Wolf and Laura Cremer.

You [our alumni] have helped to improve the environment in industry and in communities across the Nation and have been champions for the public's health. We have not solved all the environmental challenges and there are new challenges on the horizon. These are opportunities to continue to work together. Our mission at Cal Poly continues to be to insure graduates are ready to make informed decisions that will improve the environment and lead to better health both in industry and in our communities and lead to a strong economy.

Logos over the years created by Doug Wolf

Some final thoughts.

Over the years like other engineering disciplines there have been ups and down in employment opportunities. It is always a challenge when our political leaders forget the long-term benefits of protecting our environment and the health of our most sensitive (the very young and old). The Cal Poly Environmental Engineering program has always stood for protecting the environment and supporting the industry our society requires. This is done by providing cost effective technology and using professionals to design, build and use it. We can have clean air and water, deal with climate change in an economical and sustainable way through good science and engineering.

Sending polluting industries elsewhere, rather than cleaning them up, is like kicking the can down the road. The short term economic gain is unstainable. It costs jobs in this country now and ultimately effects the health and welfare of other countries.

As we consider future opportunities, I would like to share some thoughts from two of our long-time alumni who have had many years' experience.

The first come from Richard Smith who served many years as Air Pollution Control Officer of San Diego County. As previously mentioned Richard helped the Cal Poly EPA Areawide Training Center as well as the ENVE program. When asked to reflect on the opportunities and challenges facing the profession, he wrote,

"For the foreseeable future, environmental engineers will play a significant role in addressing the nation's air pollution, water pollution, hazardous waste, solid waste and other environmental problems. Environmental engineers will be asked to provide technical input and recommendations to federal, state and local decision makers who will establish environmental standards that businesses and governmental agencies will have to meet to reduce their pollution footprint. Those industries and governmental agencies will need to rely on environmental engineers to comply with those standards in a cost-effective manner. They will most likely do so by employing in-house environmental engineers and/or hiring environmental engineering consulting firms to do the engineering evaluations necessary to comply with applicable pollution control standards. Similarly, environmental engineers will be needed to help define and implement strategies to reduce carbon dioxide and other greenhouse gasses."

Since he retired 10 years ago, Richard has continued his service to the community through organizations such as Habitat for Humanity, International Relief Team and Project Mercy. He has worked on over 50 homes that have gone to low income families and is building houses in the poor sections of Tijuana one Saturday a month.

The second comment is from Victoria Conway, Departmental Engineer, Wastewater Management Department at the Sanitation Districts of Los Angeles. Victoria and husband Bob both received their BS degrees in Mechanical Engineering from Cal Poly and returned to complete the Master degree in Environmental Engineering. Victoria wrote the following:

"Although both air and water quality conditions have improved over the past few decades, there are still many environmental issues needing to be addressed. For instance, trends in solid waste disposal and recycling have been dynamic. As society moves away from landfilling organics and increased recycling efforts new challenges have emerged, such as establishing reliable uses for biogas production and identifying reliable markets for recycled materials. Historic uses of biogas, such as use in internal combustion engines, has proven more difficult with more restrictive air quality regulations. An attractive option, such as direct injection of biogas into natural gas distribution systems has been met with resistance from pipeline owners and operators. In terms of recycled materials extracted from solid waste streams, market stability plays an important role in reliable recycling of materials. Just recently China, which was a major consumer of recycled materials, has placed restrictions on imported recycled materials. As a result revenues for major Material Recycling Facilities (MRFs) have dropped nearly 60% and left no outlet to place recycled materials, which are now being redirected back to landfills, contrary to solid waste diversion goals.

Similar regulatory and market drivers create challenges for wastewater recycling. After nearly a decade of drought conditions, wastewater recycling is still a challenge in terms of costs and in some cases water quality regulations. Even in the most densely populated areas, non-potable reuse is a challenge due to the costly infrastructure needed to distribute the commodity. More and more water and wastewater agencies are looking at potable reuse options whether they are direct (injected into water distribution systems) or indirect (GWR or surface water augmentation). The cost of advanced treatment, namely MF/RO/UV, and then brine disposal, is still significantly more costly than local or imported water supplies. However, the investment is still being considered since wastewater recycling provides a guaranteed water source that is essentially drought proof.

Living in highly urbanized areas does concentrate impacts of human and industrial activities. One such impact is air quality as a result of the use of fossil fuels. Ever increasing restrictive air quality regulations create significant challenges in keeping essential public services, such as wastewater treatment facilities, operating reliably.

In the last 30 years there has not been a reduction of challenges facing environmental engineers and nor is there one in the foreseeable future. Once solutions to environmental issues/problems are found they are typically temporary in nature as regulations and public expectations continue to evolve. There is a strong need for environmental engineers now

and into the future as more focus is also put on increasing resiliency of public utilities. Consequently, more holistic solutions will be required to meet challenges. Solutions will be needed to address current environmental problems and future challenges/problems as a result of changing manmade and natural environmental conditions."

The University Catalog reflects how the objectives and course of study has changed to meet the challenges of the day (Appendix A). This is a result of continued input from faculty, research, professional societies, alumni, and the department's industrial advisory committee. This has led to a dynamic and successful program.

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References

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3. http://archive.kitsapsun.com/news/local/a-survivors-story-ep-423174464-359043691.html
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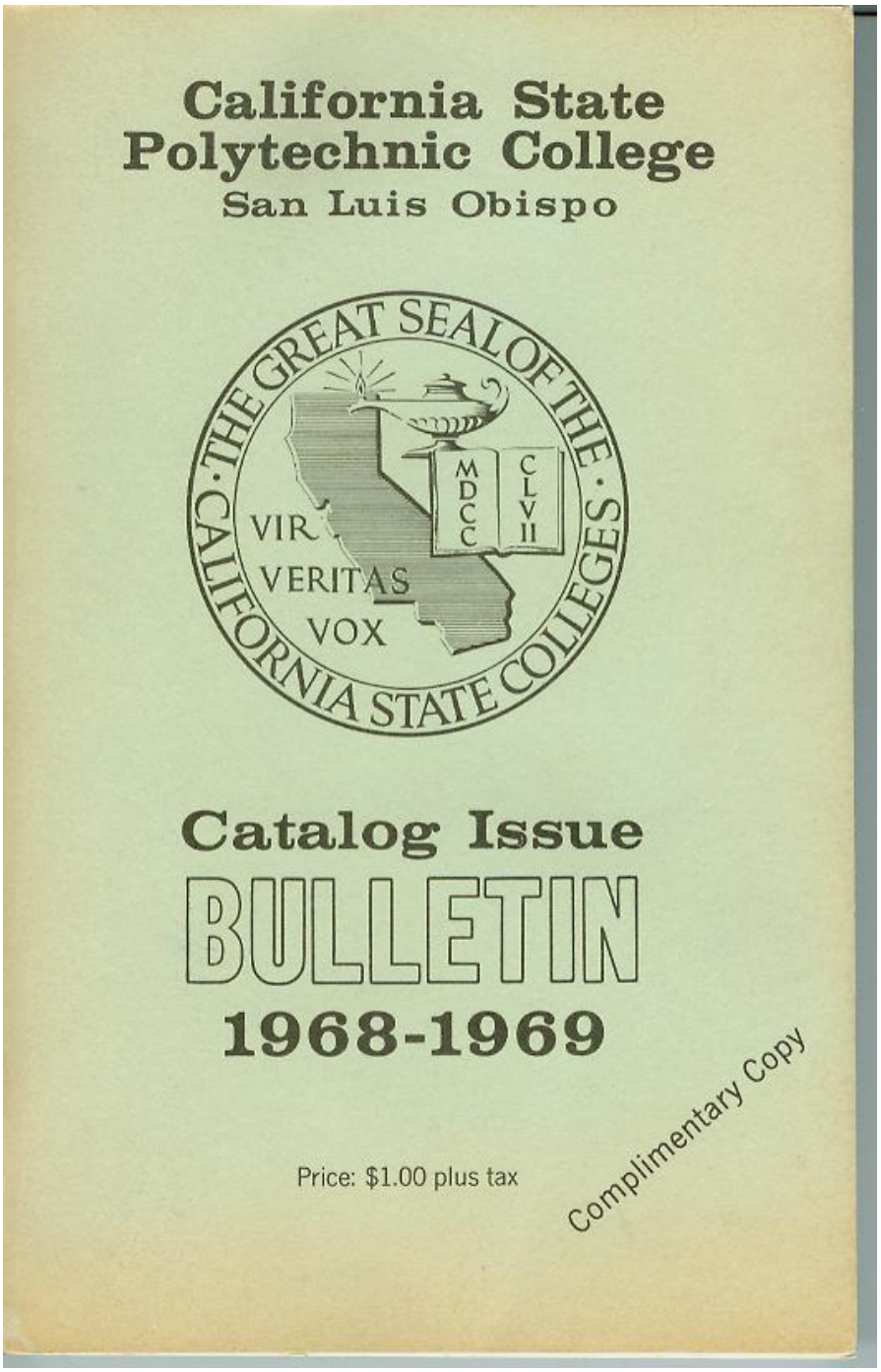
5. Appendix Cal Poly Catalog archives and Cal Poly On-line Catalogs
6. Private Communication, 12.18.2017, Timothy O'Connor, P.E. ENVE 1973

APPENDIX (5)

THE FIRST CAL POLY CATALOG LISTING ENVE



ENVIRONMENTAL ENGINEERING DEPARTMENT

Department Head, James M. McGrath

Ray Allen Rodney G. Keif Philip W. B. Niles William J. Phaklides
Harold M. Cota Theodore G. Graves

Environmental Engineering is concerned with the interrelation of man, materials, and processes in a complex and changing environment. The broad field of Environmental Engineering includes Control of Air and Water Pollution, Industrial Hygiene, Reduction of Noise and Vibration, Air Conditioning, Heating, Ventilation, and Refrigeration.

The program offers a sound background in the fundamentals of thermodynamics, heat transfer, fluid mechanics, mass transfer, and physico-chemical characteristics of living and inanimate matter. The student will specialize in one of the curricular concentrations described below. The problem-oriented approach to instruction, in modern well-equipped laboratories, shops and design rooms, provides the student an excellent opportunity to gain understanding and experience as a joint exploration with the faculty.

A student branch of the American Society of Heating, Refrigeration, and Air Conditioning Engineers offers the student a vigorous program of technical and other activities, including field trips each year to the Los Angeles and San Francisco areas to study typical installations of systems.

Graduates obtain employment primarily with consulting engineers, manufacturers, contractors, and governmental agencies.

CURRICULAR CONCENTRATIONS

Air Conditioning and Refrigeration

This concentration prepares students to enter those phases of engineering dealing particularly with thermal systems and their control in a variety of applications ranging from cold storage plants and modern buildings to hypersonic aircraft and missiles.

Air Pollution Control

This concentration provides training in the field of air pollution control. An engineering approach to the subject prepares the student to enter careers in air quality management, and industrial, public and private agencies concerned with solving problems of air pollution.

CURRICULUM IN ENVIRONMENTAL ENGINEERING

Freshman	F	W	S
Environmental Graphics (EnvE 121, 122, 123)	2	2	2
Elements of Electronics (EL 101, 102)	2		2
Electronics Laboratory (EL 141, 142)	1		1
Manufacturing Processes (EnvE 141, MP 141, 142)	1	1	1
(IE 141, WM 141, 142)	1	1	1
Analytic Geometry and Calculus (Math 141, 142, 143)	4	4	4
General Physics (Phys 131, 132)		4	4
Freshman Composition (Eng 104, 105)	3	3	
Public Speaking (Sp 201)			2
Health Education (PE 107)		2	
Physical Education (PE 141)	½	½	½
**Life Science	3		
	17½	17½	17½

** To be selected from General Education list.

Sophomore	F	W	S
Heating and Ventilating (EnvE 201, 202, 203)	3	3	2
Engineering Problems—Digital Computers (EnvE 250)		1	
Fluid Systems (EnvE 231, 232, 233)	2	2	2
Analytic Geometry and Calculus (Math 241)	4		
Differential Equations (Math 242)		4	
Advanced Engineering Mathematics (Math 318)			4
Engineering Mechanics (ME 211, 212)		3	3
General Physics (Phys 133)	4		
General Chemistry (Chem 321, 322, 323)	4	4	4
Strength of Materials (ME 202)			3
Sports Education (PE 241)	½	½	½
	17½	17½	18½
Junior			
Automatic Process Control (EnvE 316)			2
Thermodynamics (EnvE 301)	3		
System Design (EnvE 341)	2		
Noise and Vibration Control (EnvE 307)	2		
Thermal and Fluids Laboratory (EnvE 331, 332)	2	2	
Heat Transfer (EnvE 313)			3
Introduction to Air Pollution (EnvE 324)	3		
Introduction to Literature (Eng 207)			2
Electrical Engineering (EE 207, 208)	3	3	
Electrical Engineering Laboratory (EE 251, 252)	1	1	
Electronic Engineering (EL 321)			3
Electronic Engineering Laboratory (EL 354)			1
Fluid Flow (ME 311)		3	
§ Electives and courses to complete major		8	6
	16	17	17
Senior			
Advanced System Design (EnvE 441)	3		
Senior Project (EnvE 461, 462)	2	2	
Undergraduate Seminar (EnvE 463)			2
General Psychology (Psy 202)			3
American Government (Pol Sc 301)	3		
Growth of American Democracy (Hist 304)		3	
U.S. in World Affairs (Hist 305)			3
Survey of Economics (Ec 201)	3		
Business Law Survey (Bus 301)		3	
** Literature or philosophy			3
§ Electives and courses to complete major	7	10	7
	18	18	18

DESCRIPTIONS OF COURSES IN ENVIRONMENTAL ENGINEERING

EnvE 121, 122, 123 Environmental Graphics (2)(2)(2)

Principles and practices of mechanical and architectural graphics applied to the development of the spatial concepts essential to the design and installation of environmental systems. 1 lecture, 1 laboratory.

EnvE 141 Manufacturing Processes (1)

Methods of identification, classification and listing of the physical properties of metals used in fabrication processes. Engineering problems in processes used to control the effects of environment on gage metal components. 1 laboratory.

** To be selected from the General Education List.

§ 26 of the elective units must be chosen with the approval of the adviser according to the field of concentration.

EnvE 201, 202, 203 Heating and Ventilating (3)(3)(2)

Heating and ventilating equipment and its application to industrial and public buildings. 3 lectures, fall, winter; 2 laboratories, spring. Prerequisite: Phys 132. Concurrent Chem 321, 322

EnvE 231, 232, 233 Fluid Systems (2)(2)(2)

Materials, equipment, principles, and techniques used in designing and installing environmental fluid flow systems. 1 lecture, 1 laboratory.

EnvE 237 Boilers and Steam Equipment in Agriculture (2)

The operation and maintenance of steam equipment as applied to the agricultural industry. Course designed for students in Agriculture. 2 lectures.

EnvE 238, 239 Refrigeration in Agriculture (2)(2)

Basic principles of refrigeration, compression systems, refrigerant control valves, motors, service analysis, operation and maintenance of refrigeration equipment. Course designed for students in Agriculture. 2 lectures, winter; 1 lecture, 1 laboratory, spring.

EnvE 240 Additional Engineering Laboratory (1-2)

Elective project work. Total credit limited to 4 units with not more than 2 units in any quarter. 1 or 2 laboratories.

EnvE 250 Engineering Problems—Digital Computers (1)

Solution of selected engineering problems by means of digital computers. 1 laboratory. Prerequisite: Math 143

EnvE 301 Thermodynamics (3)

Basic concepts and definitions. Properties of pure substances. Work and heat. First law of thermodynamics. The second law of thermodynamics and entropy. Irreversibility and availability. 3 lectures. Prerequisite: EnvE 203, Phys 133

EnvE 302 Thermodynamics of Refrigeration (3)

Thermodynamic relations, mixtures, combustion. Analysis of refrigeration. 3 lectures. Prerequisite: EnvE 301, Chem 322

EnvE 303 Advanced Thermodynamics of Refrigeration (3)

Refrigeration and power cycles, components and controls. 3 lectures. Prerequisite: EnvE 302

EnvE 306 Survey of Heating and Air Conditioning (3)

Basic principles concerning comfort, thermal types of equipment and systems, space requirements and energy sources. Course designed for students not majoring in Environmental Engineering. 3 lectures. Prerequisite: Phys 131

EnvE 307, 308 Noise and Vibration Control (2)(2)

Behavior of sound waves, selection of instrumentation, practical measurements, criteria for noise and vibration control in environmental systems. 2 lectures. Prerequisite: Phys 133, Math 241

EnvE 313 Heat Transfer (3)

Basic principles of heat transfer, radiation, conduction, convection in gases and liquids, boiling and condensing of fluids during forced and gravity flow conditions. 3 lectures. Prerequisite: ME 311

EnvE 316 Automatic Process Control (2)

Introduction to automatic control instrumentation. Graphical method for analysis of control systems. Analytical determination of control response. 2 lectures. Prerequisite: Math 242

EnvE 324 Introduction to Air Pollution (3)

Causes and effects of air pollution on the individual, the community and industry. Legal and public relations aspects. 3 lectures.

EnvE 325 Air Pollution Measurements (3)

Planning and conduct of atmospheric surveys. Collection, evaluation, and interpretation of data as they pertain to the concentration of pollutants sampled. 2 lectures, 1 laboratory. Prerequisite: Chem 323, EnvE 324

EnvE 331, 332, 333 Thermal and Fluids Laboratory (2)(2)(2)

Laboratory tests in controls, thermodynamics, fluid flow, heat transfer, and vibration. Performance testing of refrigeration systems, evaporators, condensers, fans, air washers, boilers, grilles, etc. 1 lecture, 1 laboratory, fall and winter; 2 laboratories, spring. Prerequisite: EnvE 203, 233

EnvE 341, 342, 343 System Design (2)(2)(2)

Individual and team project work in designing systems for heating and refrigerating applications. 2 laboratories. Prerequisite: EnvE 203. Concurrent EnvE 301, 307

EnvE 400 Special Problems for Advanced Undergraduates (1-2)

Individual or group investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

EnvE 401 Advanced Mass and Energy Transfer (3)

Thermodynamic properties of moist air. Humidity measurements, direct contact transfer processes, heating and cooling by extended surfaces, solar radiation. 3 lectures. Prerequisite: EnvE 313

EnvE 402 Advanced Fluid Mechanics (3)

Fluid dynamics and fluid machinery. Centrifugal and axial fans, pumps and compressors. Turbines. Fluid flow in ducts. 3 lectures. Prerequisite: ME 311, EnvE 401

EnvE 411 Air Pollution Control (3)

Theory, principles and practices related to the control of particulate emissions. Mechanical separations. Cost and design of control systems. 2 lectures, 1 laboratory. Prerequisite: EnvE 325

EnvE 421 Advanced Air Pollution Control (2)

Theory, principles and practices related to the control of gaseous emissions. Process characteristics. Odor control. Mass transfer operations as applied to environmental control. 2 lectures. Prerequisite: EnvE 411

EnvE 422 Environmental Radiation Surveillance (2)

Sources of radioactive contaminants, biological effects, radiation protection. Environmental sampling and analysis of airborne radiation. Controls and disposal of wastes. 2 lectures. Prerequisite: EnvE 421

EnvE 423 Industrial Environments (2)

Effects of the environment in relation to health and the performance of work. Adverse and favorable temperatures and pressures, atmospheric impurities, toxicants. Control of occupational hazards and disease. 2 lectures. Prerequisite: EnvE 421

EnvE 441, 442, 443 Advanced System Design (3)(3)(3)

Individual and team project work in designing systems for air conditioning. 1 lecture, 2 laboratories. Prerequisite: EnvE 341, ME 311

EnvE 461, 462 Senior Project (2)(2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum of 120 hours total time.

EnvE 463 Undergraduate Seminar (2)

Special studies and technical developments in the field. Individual reports on important research in the environmental engineering field. 2 lectures.

DESCRIPTION OF COURSE IN METEOROLOGY

Met 424 Meteorology (3)

Weather instruments; insolation, convection and advection; land and sea breezes; fog, smogs, clouds, and showers; thunderstorms; lapse rate and temperature inversions; cyclones; anti-cyclones; tornadoes and waterspouts; stacks and plumes; meteorological conditions under which air pollution accumulates. 2 lectures, 1 laboratory.

- Civil & Environmental Engineering

Civil & Environmental Engineering

Engineering Bldg. (13), Room 266
Phone: 805.756.2947
Email: ceenve@calpoly.edu
http://ceenve.calpoly.edu

Department Chair: Yarrow Nelson
College of Engineering Advising Center
Engineering South (40), Room 111
Phone: 805.756.1461

Academic Programs

PROGRAM NAME	PROGRAM TYPE
Civil Engineering	BS
Environmental Engineering	BS
Civil and Environmental Engineering	MS

Program Names

The Civil and Environmental Engineering Department at Cal Poly, San Luis Obispo offers a rigorous and engaging educational experience that fully embraces Cal Poly's "Learn by Doing" approach.

Undergraduate Programs

BS Civil Engineering
BS Environmental Engineering

BS Environmental Engineering

The BS program in Environmental Engineering is concerned with the interrelation of people, materials, and processes in a complex and changing environment. The broad field of environmental engineering includes control of air and water pollution, environmental health and safety, solid waste, hazardous waste management, and pollution prevention.

The program offers a sound background in the fundamentals of thermodynamics, fluid mechanics, mass transfer, water resources, and geotechnical engineering. The problem-oriented approach to instruction, in modern well-equipped laboratories, provides an excellent opportunity to gain understanding and experience of the discipline. The program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The focus of the program is to prepare graduates for practice in professional engineering. Thus, Cal Poly's "learn by doing" philosophy is emphasized by integrating design throughout the curriculum, especially in the numerous design-centered laboratories. In the required senior design project, which is completed in a two-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

The Environmental Engineering program educational objectives are that its graduates will:

- Apply environmental engineering principles to analyze and solve real-world engineering challenges.
- Think independently, engage in life-long learning, and continue their development as professionals.
- Be prepared to pursue graduate study and licensure.
- Communicate effectively, both orally and in writing, and collaborate successfully in teams.
- Address the ethical, societal, and global issues encountered in environmental engineering.

An engineering approach to the subject enables graduates of the program to pursue careers in industry, consulting firms, and public agencies concerned with air and water pollution control, groundwater, potable water treatment, solid waste management, and hazardous waste management.

Various program constituencies, such as graduates and employers, are consulted periodically for input on the appropriateness as well as the attainment of the educational objectives. Other indicators such as student/alumni placement and success rates in the statewide fundamentals in engineering examination are also used to evaluate attainment.

The Society of Environmental Engineers offers technical programs and other activities, including field trips to study typical installations of systems. Student memberships also are available in the Air and Waste Management Association, the California Water Pollution Control Association, and the Water Environment Federation.

BS Environmental Engineering

Program Learning Outcomes

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve engineering problems
6. An understanding of professional and ethical responsibility
7. An ability to communicate effectively
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. A recognition of the need for, and an ability to engage in life-long learning
10. A knowledge of contemporary issues
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Degree Requirements and Curriculum

In addition to the program requirements listed on this page, students must also satisfy requirements outlined in more detail in the Minimum Requirements for Graduation section of this catalog, including:

- 60 units of upper division courses
- Graduation Writing Requirement (GWR)
- 2.0 GPA
- U.S. Cultural Pluralism (USCP)

Note: No major or support courses may be selected as credit/no credit.

MAJOR COURSES		
CE 113	Computer Aided Drafting in Civil Engineering	2
CE 204	Mechanics of Materials I	3
CE 207	Mechanics of Materials II	2
CE 251	Programming Applications in Engineering	2
CE 336	Water Resources Engineering	4
CE 337	Hydraulics Laboratory	1
CE 381	Geotechnical Engineering	4
CE 434	Groundwater Hydraulics and Hydrology	4
CE 465	Civil Engineering Professional Practice	1
ENVE 111	Introduction to the Environmental Engineering Profession	1
ENVE 264	Environmental Fluid Mechanics	4
ENVE 304	Process Thermodynamics	3
ENVE 309	Noise and Vibration Control	3
ENVE 325	Air Quality Engineering	4
ENVE 331	Introduction to Environmental Engineering	4
ENVE 421	Mass Transfer Operations	4
ENVE 426	Air Quality Measurements	3
ENVE 434	Water Chemistry and Water Quality Measurements	4
ENVE 438	Water and Wastewater Treatment Design	3
ENVE 450	Industrial Pollution Prevention	4

ENVE 466 & ENVE 467	Senior Project Design Laboratory I and Senior Project Design Laboratory II	4

Select from the following:		12
ENVE 411	Air Pollution Control	
ENVE 436	Introduction to Hazardous Waste Management	
ENVE 439	Sustainable Solid Waste Engineering	
ENVE 443	Bioremediation Engineering	
ENVE 455	Environmental Health and Safety	
ENVE 480	Environmental Engineering of Energy	
Technical Electives [1, 2]		10

Select from the technical electives list below		
SUPPORT COURSES		
CHEM 124	General Chemistry for Physical Science and Engineering I (B3 & B4) [3]	4
CHEM 125	General Chemistry for Physical Science and Engineering II	4
CHEM 126	General Chemistry for Physical Science and Engineering III	4
CHEM 312	Survey of Organic Chemistry (trans equiv CHEM 212)	5
ENGL 149	Technical Writing for Engineers (A3) [3]	4
MATH 141	Calculus I (B1) [3]	4
MATH 142	Calculus II (B1) [3]	4

MATH 143	Calculus III (Add'l Area B) [3]	4
MATH 241	Calculus IV	4
MATH 244	Linear Analysis I	4
MCRO 221	Microbiology (B2) [3]	4-5
or MCRO 224	General Microbiology I	
ME 211	Engineering Statics	3
PHYS 141	General Physics IA (Add'l Area B) [3]	4
PHYS 132	General Physics II	4
PHYS 133	General Physics III	4
STAT 312	Statistical Methods for Engineers (B6) [3]	4
GENERAL EDUCATION (GE)		
(See GE program requirements below.)		40
FREE ELECTIVES		
Free Electives		0
Total units		**190-191**

[1] To be selected in consultation with your academic advisor.

[2] A student may petition to take a course not included in the list of electives and receive major technical elective credit, but they must first obtain approval from a faculty advisor, before taking the course.

[3] Required in Support; also satisfies GE.

Technical Electives

Technical Electives may be chosen from any 300-500 level CE/ENVE courses not taken to satisfy other curriculum requirements, with the following exceptions: senior project, co-op, graduate seminar, comprehensive exam, and thesis; and ENVE 324, ENVE 323, ENVE 570, ENVE 571.

Technical Electives cannot be used to satisfy other major, support, or general education requirements. No double counting is allowed.

No more than 4 units in total from CE 400/ENVE 400, CE 500/ENVE 500, ENVE 405, ENVE 407, and ENVE 471 combined can be counted towards technical electives.		
No more than 4 units of coursework other than CE/ENVE may be used to satisfy the ENVE Engineering technical elective degree requirement.		
Air Quality and Climate		
ERSC/GEOG 414	Global and Regional Climatology	
PHYS 313	Introduction to Atmospheric Physics	
Appropriate Technology		
PSC/UNIV 492	Appropriate Technology for the World's People: Design	
Biology/Biochemistry/Microbiology		
BIO 401	Principles of Conservation Biology	
ENGR/ENVE 581	Biochemical Engineering	
MCRO 342	Public Health Microbiology	
MSCI 307	World Aquaculture: Applications, Methodologies and Trends	
Computer Applications and Computations		
LA/NR 317	The World of Spatial Data and Geographic Information Technology	

STAT 313	Applied Experimental Design and Regression Models	
STAT 323	Design and Analysis of Experiments I	
Chemistry		
CHEM 313	Survey of Biochemistry and Biotechnology	
CHEM 341	Environmental Chemistry: Water Pollution	
CHEM 350	Chemical Safety	
Energy		
BRAE 448	Bioconversion	
PHYS 310	Physics of Energy	
Hydrology and Soils		
BRAE 532	Water Wells and Pumps	
Law and Policy		
CRP/NR 404	Environmental Law	
CRP/NR 408	Water Resource Law and Policy	
IME 314	Engineering Economics	

General Education (GE) Requirements

- 72 units required, 32 of which are specified in Major and/or Support.
- See the complete GE course listing.
- Minimum of 8 units required at the 300 level.

Area A	**Communication**	
A1	Expository Writing	4
A2	Oral Communication	4
A3	Reasoning, Argumentation and Writing (4 units in Support) [1]	0
Area B	**Science and Mathematics**	
B1	Mathematics/Statistics (8 units in Support) [1]	0
B2	Life Science (4 units in Support) [1]	0
B3	Physical Science (4 units in Support) [1]	0
B4	One lab taken with either a B2 or B3 course	
B6	Upper-division Area B (4 units in Support) [1]	0
Additional Area B units (8 units in Support) [1]		0
Area C	**Arts and Humanities**	
C1	Literature	4
C2	Philosophy	4
C3	Fine/Performing Arts	4
C4	Upper-division elective (PHIL 340 or NR 360 recommended)	4
Area D/E	**Society and the Individual**	
D1	The American Experience (Title 5, Section 40404 requirement)	4

	(40404)	
D2	Political Economy	4
D3	Comparative Social Institutions	4
D4	Self Development (CSU Area E)	4
Total units		**40**

[1] Required in Support; also satisfies GE