Mohave Community College

EGR Program Review 2016

Presented by Russell Cox, Richard Hibbard, Tricia Hanks, Celeste Lucier, Nick Altman
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Contents

EGR Academic Program Review 2016

Mohave Community College Mission Statement:

The mission of Mohave Community College is to be a learning-centered college, serving all constituencies, inspiring excellence through innovative learning methodologies and empowering students to succeed.

EGR Program Mission Statement:

The Engineering program is designed to prepare students to have the skills, the competencies, and the knowledge to succeed in their chosen discipline of engineering and complete transfer pathways in these areas with in-state universities and other university partners.

Program Goals and Objectives for 2016

- Continue the steady increase in MCC engineering enrollment to an academically sustainable level via use of grant-based STEM recruiting and consistent course offerings
- Implement an electrical engineering focus by offering a circuit analysis course
- Found an engineering club on the Kingman campus, focusing on student engineering projects and learning specific skill sets not taught in undergraduate engineering courses
- Improve curriculum for the introduction to engineering class, making it more project oriented and less theoretical
- Explore dual enrollment options with the high schools and reduction in required non-AGEC classes needed to earn an A.S. in Engineering

Data

The data review in this report mainly originates from enrollment and industrial data. The learning objective that was chosen to be evaluated in EGR 210 (2.1: Presents substantially error-free prose in both argumentative and narrative forms to general and specialized audiences) only had one semester's worth of data and only represented two groups' projects. Both groups succeeded in meeting the standard. However, it would be inappropriate to draw conclusions or make recommendations based on such a small sample size.

In order to increase sample size and thus allow for metric based improvement to the engineering program, it is important to grow the number of interested students in engineering at MCC. Looking at previous trends in enrollment and the current situation will aid in identifying ways of growing the engineering cohort.

The engineering program is relatively new. It was started at MCC during the 2012-2013 school year with 3 students in both 2014 and 2015 receiving associate degrees in engineering. Efforts in the 2013-2014 school year to increase enrollment by recruiting juniors and seniors in high school via use of grant funds are just starting to pay off. There are 5 students planning on graduating this year and a further cohort of 7 or more planning to graduate in 2017.

While engineering and other upper level STEM courses are consistently offered to allow for graduation in two years, consistent passing of classes is not guaranteed. Failing a required course usually leads to a student transferring to the university without a degree. (Reverse transferring of credits for graduation at MCC is seen as inconsequential as job prospects are only found at the bachelors level.) To get a better understanding of the cohort of engineering students, one can look at the number of university transfers and declared engineering majors.

Transfer students also include non-EGR declared students taking MCC engineering courses that went on to declare an engineering major at other universities. The numbers have increase from 6 in 2013, to 8 in 2014, to 11 in 2015. This number is also expected to increase in 2016. The majority of non-declared engineers at MCC have been chemical engineers, as a chemistry A.S. from MCC maps more closely to standard chemical engineering degree programs. A chemistry specialization for engineers at MCC was considered, but rejected, in the last review. It was felt that the students could be advised on a one to one basis, and the specialization would also reduce engineering enrollment.

The number of declared engineering majors is both encouraging and misleading. The number of declared students has risen from 24 in 2013, 51 in 2014, and 67 in 2015. The number of current students declared in the program is 40. These numbers, while encouraging, reflect the fact that students can declare engineering as a major at any level of mathematical competency. In order to sign up for introduction to engineering, one must have passed or tested out of 5 math classes offered at MCC (TRM 090, TRM 091, MAT 121, MAT 151, and MAT 181). Appendix B shows highest level of math for the current 40 EGR students. (2014-15's data antidotally was more spread-out, but is no longer available). The number of students in each cohort varies from 3 to 11. The good news is that high school students who come to MCC directly do not factor into these numbers, and should be placed in MAT181 or higher due to current graduation standards. There is also a slight smearing of the cohorts due to class failures and delays in program.

In order to produce more graduates, two curriculum based changes should be investigated.

1. Reduction of overall credit load at MCC to get the EGR associates degree.
2. Increase the percent of classes relevant to particular engineering disciplines

The current credit load to obtain an EGR degree at MCC is 64-65 credits over four semesters, or 16-17 credits a semester. This is misleading as it assumes that the student has completed all transitional (TRE/TRM) courses, 3 required MAT courses and one extra computer class (CIS 120). The bulk of the required courses are part of the AGEC-S sequence, which require several elective courses that normal engineering students wouldn't take until their third or forth year at a university. To correct for this front loading of electives, several community colleges in Arizona have rebranded their pre-engineering programs as A.A.S. degrees which do not require the

AGEC-S to be completed. However, recently, the Higher Learning Commission (HLC) has started to discourage the offering of A.A.S. degrees to give the students more flexibility in their choice of majors, thus discouraging this option.

In order to decrease the number of credits and reduce the time to graduation, two options present themselves: Reducing required non-AGEC-S classes and shifting some of the credit burden to dual-enrollment classes taken before enrollment at MCC.

Dual-enrollment classes, such as introduction to engineering, would be viable if the appropriate pre-reqs (MAT 181) and appropriate instructor credentialing (masters level or higher in an engineering related field) could be satisfied at the high school level. For example, Kingman High School currently is looking at offering a STEM-centered curriculum with an introduction to engineering class and eventually a wave-JTED funded engineering building. Appropriate pre-reqs could be met if more dual-enrollment math was offered at the high schools. Appropriate credentialing could be handled via online instruction, like with the nascent introduction to mining engineering program which is going to be taught at the local high schools via University of Arizona.

Reducing required non-AGEC-S classes (Engineering Core Requirements) becomes problematic when compared to the second curriculum change. The 6 or 7 non-AGEC-S classes were chosen originally as they are required in the first two years of most engineering disciplines. The 2 required chemistry courses are found in most, if not all engineering disciplines. Differential equations (MAT 260) is found in some, normally replaced with linear algebra in the less physics and more computer oriented disciplines (e.g. chemical engineering, computer science). Some form of introduction to “discipline name” engineering is found in all disciplines, and also can be taught as a dual enrollment course.

It is the Computer science 1 (CSC 110) and its pre-req of CIS 120 which do not seem to fit. At the universities, each engineering discipline has at most one computer science course in its program. However, the focus, level, and programming language change with discipline. Likewise, Computer Science 1 (CSC 110) offered at all other Arizona community colleges have no other non-math pre-reqs. While this is an internal matter for the computer science program, removing the pre-req of CIS 120 for CSC 110 or swapping the Engineering Core Requirement of CSC 110 to CIS 120 would reduce the number of credits by 3. Discussion with the computer science faculty is advised.

The second curriculum based change looks at what percent of classes in the engineering degree map to classes offered at the university. This ultimately depends on which discipline the student goes into. The original MCC program was designed around the top two disciplines in engineering: Mechanical and Civil, which covers 23% and 12%, respectively, of the national engineering graduates in 2014 (2015 numbers have not been released yet). While the growth between 2010 and 2014 in civil engineering is flat, the number of mechanical engineers has increased by 23%. Offering of statics (EGR 210) and dynamics (EGR 212) are therefore important to those majors, as well as disciplines that these courses might be beneficial to, such as Aerospace, Architectural, Environmental, and Industrial/Manufacturing engineering which encompass another 10% of engineering graduates.

In the previous program review, it was found that these courses did not benefit electrical/computer engineers (18%) or chemical/biomedical/biological engineers (14%). Chemical engineering students would be advised to get chemistry degrees from MCC, while biomedical/biological engineers would be encouraged to get a degree in biology. No equivalent degree exists at MCC for electrical/computer engineers, so an electrical focus that swapped circuit analysis (EGR 202) for statics and dynamics was proposed. This summer will be the pilot offering of the course, and it is expected to be offered from then on in the spring semester.

It is important to note that while computer science is not always considered an engineering discipline, it makes up ~13% of the graduates considered in the referenced survey. It is therefore important to have some exposure to computer science classes in the degree. It is also important to note that while mining is a big industry around MCC, the number of mining engineers that graduated nationally in 2014 was 324, or 0.3% of all engineering graduates. It is thus advised that focusing on curriculum for mining engineers should not be a high priority.

SWOC analysis for 2016 program review

Strengths

- One of the biggest strengths in the program has been the partnership with ASU and its Motivated Engineering Transfer Student (METS) program. The program not only has increased community awareness by bringing engineering professors to high school campuses, but has helped pay for equipment and student scholarships. The program is running out, but is up for re-disbursement. Thus, it will soon turn into either a threat or an opportunity
- In a more broad sense, the engineering program gets free promotion through all the on-going STEM promotion efforts that other programs don't get. One example on campus is the AZSF+8 STEM summer camp grant, which puts on summer camps for engineering and computer coding for high school students. Other high school and middle school ventures are listed in the opportunities section.
- One strength of the program for now is the class size (as it relates to students). The upper level EGR classes have ranged from 2 to 4 students, allowing for very focused instruction. Lower level classes have had larger class sizes, but still not to the point of diminishing the quality of teaching.
- A small program and class sizes also allow the engineering program to be tailored to particular students needs. Particular electives or projects can be undertaken that will help particular students, whereas with a larger cohort, topics and projects would need to be more generalized.
- Tag agreements with universities are already in place.

Weaknesses

- The weaknesses identified by the committee are ones that are commonly found in small programs. Even though a low number of students in the program are good from the perspective of lower student to teacher ratio, they are bad in an administrative sense. Also, due to the project based nature of some of the assignments, having low enrollment is bad for diversity of projects that the students can choose to take on.
- Low enrollment causes the second year STEM classes (e.g. engineering, physics, and capstone math courses) to only be offered once a year. While it is better than once every two years, which would make it impossible for some of the students to complete their degree on time, it still means that students who fail/forget to sign up/drop a class will be behind an entire year in their program.
- Low enrollment also means that only one full time instructor can be supported by the program. This limits the diversity of instruction and causes serious disruption to the program if that instructor is unable to teach in a particular semester.
- Since the MCC advisors do not see as many engineering students, they can't adequately advise them. This can be simply corrected on the Kingman campus by the engineering instructor, but not as easily corrected on other campuses
- Most of the engineering industry of the state is located in Phoenix. It is thus advantageous for students to go directly to the university if they are planning on having an industrial internship in the first two years of their education. Lack of local industry input also hurts the program.
- Specialized engineering software is more extensively used at the upper levels of engineering education. Since it is discipline specific and doesn't normally contribute to first and second year education, there is no rational for purchasing it at MCC. Students wishing to use/familiarize themselves with these programs thus cannot.

Opportunities

- The main opportunities identified by the committee were grant based STEM programs at the universities, MCC, the local high schools, and middle schools.
    - MCC is pursuing many different grants
        - MCC is attempting to close out the Motivated Engineering Transfer Student grant, which supported many different activities and scholarships for the first four years of the program
        - MCC is also using funds from the AZSF+8 grant to put on engineering (and computer science) summer camps
        - MCC is pursuing several STEM based grants with ASU
    - Besides ASU, NAU has a Transfer-GEMS (Transfers to Graduates in Engineering, Math and Science) Scholarship program and UoA is working with MCC to create a mining engineering dual enrollment program.
    - Kingman high schools are promoting STEM based education
        - Lee Williams has a Cambridge academy program that allows students to earn credits towards a community college degree in high school if they graduate early.
        - Kingman High is working with wave-JTED to turn their high school into a STEM centered school
        - Kingman academy is also putting emphasis on STEM education, with events like the STEM night
        - Other schools outside of Kingman might also be doing things, but there is no faculty there to participate.
    - Kingman area FIRST robotics is a nationally renowned multi-school group that also focuses on engineering. A scholarship for participation in FIRST was set up, but has not been utilized yet.
    - Kingman middle school is using a "21st century grant" in order to do STEM clubs. More involvement with these programs could also be beneficial in the long run.
- Besides grant run programs, an ongoing opportunity of the program is the increased need for engineering graduates both locally and nationwide. This, regardless of funding sources and activities, will attract students into the program.
- The Kingman Airport industries have some need of qualified engineering students. Two students currently work in the industry (at Laron and Bracket Aviation). The local government is also looking for engineering students to work on the planned construction of HWY 11 and the Kingman crossing interchange.
- Open source resources (software/hardware/textbooks) can decrease the need for expensive materials for engineering classes.
- Student projects both in and out of class can also be used as PR opportunities for the program

Threats

- One of the main threats to the program is the lack of math preparedness, coming mainly from the lack of trained high school teachers. Both Kingman academy and Kingman High lost there upper level math faculty, leading to a shortage of students prepared to take calculus and a point of contact in the high schools for STEM program interaction.
- Outreach to the local area high schools is essential for growing the program. However, both the engineering faculty and the engineering students are too busy with non-engineering related activities to properly do outreach
- HLC accreditation rules could soon come into effect that will potentially disqualify all university physics teachers, which would either leave a gap in the program schedule or necessitate the hiring of a physics major to teach those classes
- The main competition to the EGR program has always been university programs. UoA and ASU are both experimenting with online offerings of certain engineering disciplines. Should these offering become more popular, the MCC advantage of being close to home will be countered.

Technology Requests and Action Recommendations

1. One of the EGR program's biggest strengths is that all the core EGR and PHY classes are taught in online or plural formats. This necessitates smart-board or smart-podium class rooms for these classes on the Kingman campus, if not on every campus. A functioning IT solution for synchronous online collaboration is required. Though the current IT solution (BBB) is mostly working, every solution (ITV, Collaborate, Panopto, BBB) and room iteration seems to have some initial difficulty. It would be beneficial to have IT staff available to consult during the scheduled class time. (Prior semesters have had classes scheduled from 9 to 10:15 AM, while the IT staff gets in at 10:30 AM).

2. Technology requests by the EGR program are nearly impossible to predict due to the project-based nature of the program. The EGR program has sought to organically grow the tools and consumables it has at its disposal. While some of the non-consumables have been reusable, certain tools and consumables are still needed. These include mechanical tools (wrenches/ screwdrivers/saws etc…) and electrical tools (see below). Most needs can be met by borrowing things found in maintenance, science equipment, or reusing other projects. A fixed set of tools for student use, though, would be appreciated.

3. While Introduction to Engineering has been taught many semesters, circuit analysis has not been taught before. This class will require particular tools to be taught. Currently, over the summer, a Digilent's Analog Discovery Oscilloscope and Analog Parts Kit are being evaluated for use. This set up is the same as the ASU online circuits course, and should work. If successful, either students will be required to purchase these two things on their own for the class, or the class will have a set number of the kits and oscilloscopes to be loaned out on a by-need basis. If the school owns the equipment, some sort of computer to interface with the Analog Discovery will be required. Keeping MATLAB licenses up-to date for use with numerical simulations will also be needed. A couple more multimeters (basic electrical measurement tools in the ~$10 range) with capacitance and inductance measuring capabilities would also be nice.

4. Action Requests: Outside of technology, outreach to build the program is needed. While release time to visit and promote the program to local high schools by the engineering faculty would be desired, it might not be economically feasible. At the very least, scheduling accommodations should be made such that the engineering faculty is not perpetually on overload (~90 credit hours over the course of 4 semesters).

5. Finally, discussing the CSC 110 pre-reqs with the computer science faculty or switching it with CIS 120 in the engineering plan should be investigated.

Post Review Discussion Additions

EGR Marketing Plan

Action	Timeline
Run AZSF sponsored engineering summer camps to promote engineering during the summer	2 weeks during the summer semester, date to be determined yearly
Attend events such as the College and Career Fair - CRUHSD School District on March 4 to promote the EGR program to area High Schools	Ongoing
Contact Kingman High School and Lee Williams about possibility of offering dual enrollment introduction to engineering or other dual enrollment STEM courses.	Before Summer
Reapply for NSF METS-STEP funding through ASU in order to continue offering Scholarships and high school exploratory trips.	Ongoing
Be available for speaking to community groups	Give contact information to PIO and Campus Deans
Found Engineering Club on Kingman campus and hold meetings and presentations to promote engineering	Ongoing
Work with UoA on getting mining engineering courses articulated	By April Curriculum Committee
Speak to high school math classes about engineering option	Ongoing

Supporting Data

Appendix A: Engineering Declared/Transfer/Graduates 2013-2015

	Declared	Transferred	Degrees
2012-13	24	6	0
2013-14	51	8	3
2014-15	67	11	3
2015-16	40		

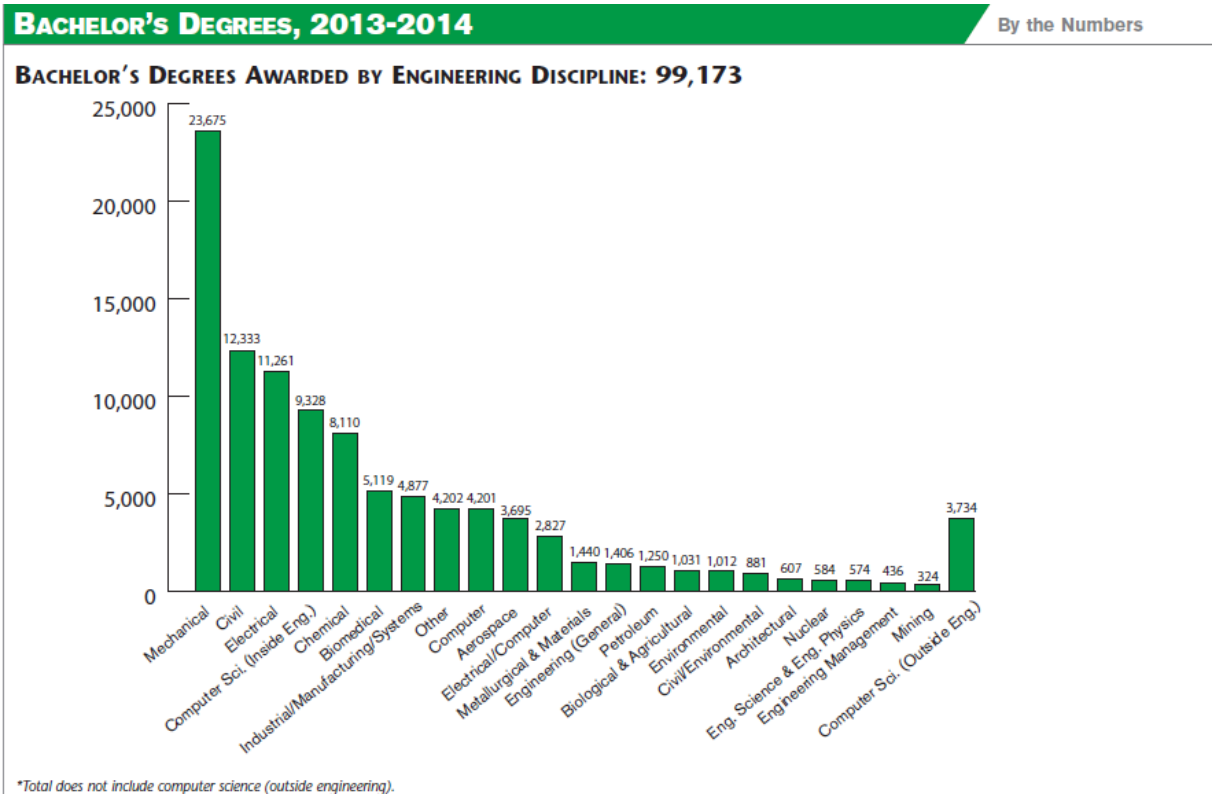
Appendix B: Highest Level Math of the Current 40 MCC Engineering Students and Projected Cohorts

No MAT	TRM 91	MAT121 or MAT142	MAT151	MAT181	MAT211	MAT221	MAT231	MAT241	MAT260
4	3	3	8	3	0	3	8	1	7

2019+	2018-19	2017-18	2016-17	2015-16
10*	11*	3*	9	7

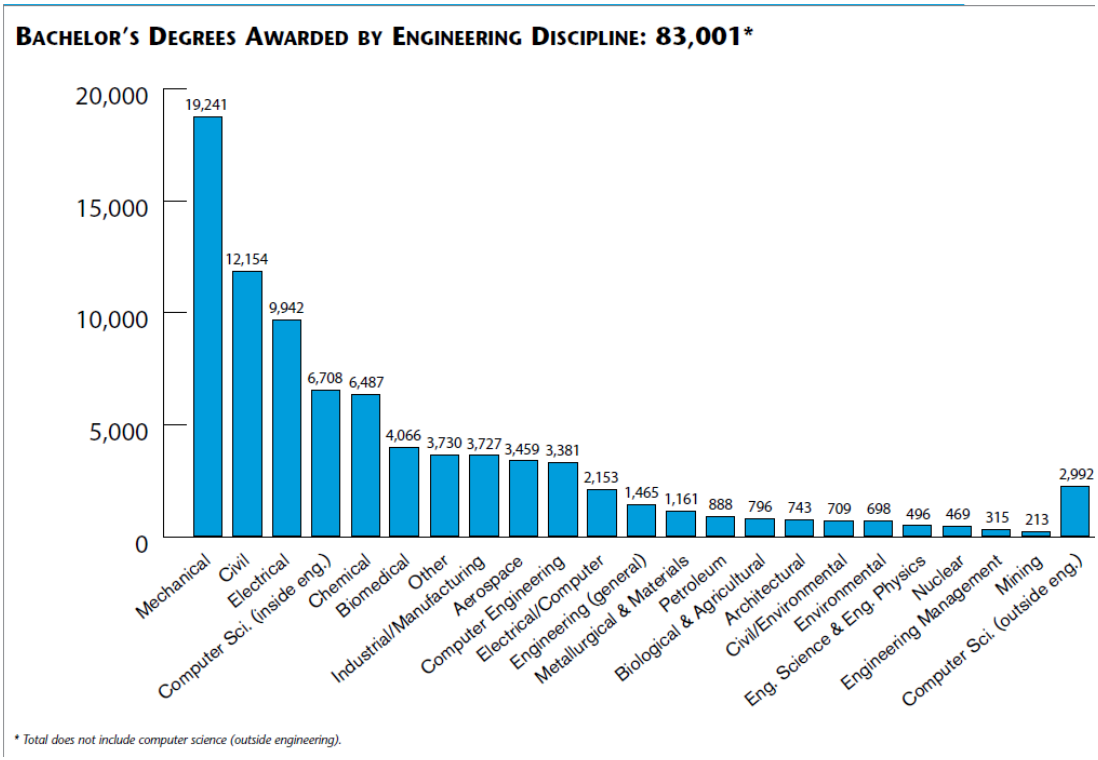
*Note: Does not include increases from high school students testing in, or decrease from MCC students failing courses/dropping out

Appendix C: Bachelor's Degrees Awarded by Engineering Discipline 2013-2014



From: Engineering by the Numbers by Brian L. Yoder, Ph.D. Amer. Soc. Eng. Educ., Washington, DC, USA, 2014

Appendix D: Bachelor's Degrees Awarded by Engineering Discipline 2010-2011



From: Engineering by the Numbers by Brian L. Yoder, Ph.D. Amer. Soc. Eng. Educ., Washington, DC, USA, 2011

Appendix E: EGR ATF report, 2015

There are several new schools offering engineering courses. Namely, Dine College, North Pioneer College, and Central. All are having trouble finding engineering faculty and well as Cochise and AWC, which might make offering multi-college engineering courses with Mohave more likely. Also it will get harder to find faculty after the new HLC rules come into effect.

The big three are offering new engineering degrees and program:
-NAU now has a school of Informatics and Cyber security
-ASU has new system engineering and engineering education Ph.D. programs
-ASU Tempe and polytechnic campuses have merged
-UoA now offers environmental engineering degree separate from civil

Population of upper division students is up in the big three. ASU has 2,000 transfer students and 3,000 online students, as well as highest number of on ground students ever. NAU has grown from 1,000 to 2,500 engineering students. UoA is at 2,850 engineers. However, half of these students leave the state. CCs want a way of tracking these students that is not the ASSIST program.

The CCs all have different grants that they are applying for or getting.
-Dine college got a grant to start their program. Has EE lab equipment but no students.
-Northern Pioneer College got a grant for wielding program through JTED, wants to put in a mechatronics program.
-Yavapi got a grant through JTED and bought 3D printers and is running engineering summer camps (sounds familiar). Difference from Mohave, they have 3D printer/CNC design classes offered during the school year.
-AWC got a STEM teachers grant
-Pima got a grant that lead to a presentation on problem solving skills at the meeting. No mention of from whom or how much.

An engineering AP exam is coming soon. No one knows anything about it. IB exam still wants us to count it as college credit. We still say no. Mesa brought up lowering math pre-reqs for EGR 102. Everyone else said no, that would lead to a gap in curriculum (no engineering courses for a year). Someone mentioned adding EGR 210 / 212 to the list of common courses. The rest said no, not all CC Eng. degrees require them.

Next year it will be hosted at ASU, and online lab equipment will be made available for demonstration.

Appendix F: National Statistics for Engineering Occupations - BLS – May 2013

From http://stats.bls.gov/oes/2013/may/oes170000.htm

1. 17-0000 Architecture and Engineering Occupations (Major Group)

This major group comprises the following occupations: Architects, Except Landscape and Naval ; Landscape Architects ; Cartographers and Photogrammetrists ; Surveyors ; Aerospace Engineers ; Agricultural Engineers ; Biomedical Engineers ; Chemical Engineers ; Civil Engineers ; Computer Hardware Engineers ; Electrical Engineers ; Electronics Engineers, Except Computer ; Environmental Engineers ; Health and Safety Engineers, Except Mining Safety Engineers and Inspectors ; Industrial Engineers ; Marine Engineers and Naval Architects ; Materials Engineers ; Mechanical Engineers ; Mining and Geological Engineers, Including Mining Safety Engineers ; Nuclear Engineers ; Petroleum Engineers ; Engineers, All Other ; Architectural and Civil Drafters ; Electrical and Electronics Drafters ; Mechanical Drafters ; Drafters, All Other ; Aerospace Engineering and Operations Technicians ; Civil Engineering Technicians ; Electrical and Electronics Engineering Technicians ; Electro-Mechanical Technicians ; Environmental Engineering Technicians ; Industrial Engineering Technicians ; Mechanical Engineering Technicians ; Engineering Technicians, Except Drafters, All Other ; Surveying and Mapping Technicians

Employment (1)	Employment RSE (3)	Mean hourly wage	Mean annual wage (2)	Wage RSE (3)
2,380,840	0.5 %	$38.51	$80,100	0.2 %

Percentile wage estimates for this major group:

Percentile	10%	25%	50% (Median)	75%	90%
Hourly Wage	$19.68	$26.51	$35.83	$47.55	$60.70
Annual Wage (2)	$40,940	$55,140	$74,530	$98,910	$126,250

1. Industry profile for this occupation: Top

Industries with the highest published employment and wages for this occupation are provided. For a list of all industries with employment in this occupation, see the Create Customized Tables function.

Industries with the highest levels of employment in this occupation:

Industry	Employment (1)	Percent of industry employment	Hourly mean wage	Annual mean wage (2)
Architectural, Engineering, and Related Services	654,300	49.02	$36.21	$75,320
Federal Executive Branch (OES Designation)	123,380	6.14	$46.23	$96,170
Aerospace Product and Parts Manufacturing	109,250	21.73	$43.36	$90,180
Semiconductor and Other Electronic Component Manufacturing	99,170	26.37	$40.04	$83,270
Scientific Research and Development Services	97,080	15.36	$45.40	$94,430