Biological Sciences Planning Vision Summary 2014

What forces are shaping our discipline today?

Health care and public health challenges
- An aging population and changes in our healthcare system are resulting in shortages of a variety of health professionals
- Public health problems such as emerging infectious diseases and antibiotic resistance require effective responses
- Emerging biological techniques and knowledge may change health care (e.g. genomics, gene therapy, stem cells)

We live in a digital age
- Large amounts of data and information are available online -- students need to be able to manage, analyze and evaluate
- Computers, math and statistics are more critical for biology, and in general

Environmental issues are critical
- Climate change, overpopulation, loss of biodiversity and related problems require effective responses

Molecular biology tools are being used across biological disciplines
- DNA sequence data is increasingly available for a variety of organisms, and affects our understanding of evolution, human health, etc.

Integrative, holistic and systems-level approaches to problem solving are increasing
- More interaction is required between folks of varying expertise
- Facilitated by capacity to work with large amounts of data, modeling and computational analyses

The general public needs stronger understanding of biology
- Critical thinking about biology topics is important for many everyday issues
- Better communication by scientists and teachers is needed

Money is scarce
- Shrinking resources for the CSU may threaten our laboratory-intensive curriculum
- Funding shortfalls at national agencies (NIH, NSF) make it harder to carry out research

What will our incoming students be like in 2030?

They will be digitally literate
- Used to rapid information uptake and processing
- Possibly lower attention spans
• Used to looking things up online
• Accustomed to interfacing with machines of many different types

They will be more diverse
• More will be people of color
• A higher proportion of Hispanics is expectable
• A higher proportion of women is expectable
• A higher proportion of low socioeconomic status is possible

They will have expectations
• More may have high environmental awareness and demand a focus there
• More may expect instant results or rewards
• They will expect access to state-of-the-art equipment and databases
• They will want training relevant to a career (esp. health-related)
• They will want real-world experiential training

Some will be more prepared
• Assuming “common core” standards remain active, more should be ready for a critical thinking approach to learning, and used to working in groups
• More basic biology will be covered in High School
• Because Cal Poly’s application pool is deep and competitive they will continue to be the motivated, intelligent self-learners

Some may be less prepared
• Many (especially from urban areas) will lack experience and understanding of the natural world
• Many will have poor quantitative reasoning skills and be less literate.

What will we be preparing our graduates to do in 2030?

Graduates should be able to think critically
• Analyze complex problems and know how to approach solving them
• Test assumptions with data, use available literature

Graduates should be prepared to adapt to changing conditions
• Change and uncertainty will accelerate
• New technologies and tools will enter the workplace regularly
• Able to continue learning throughout their lives
• Able to balance aspects of their lives -- time management

Graduates should be good communicators
• Convey the complexity of science to non-experts
• Convey the complexity of their specialty to other experts
● Both written and oral

Graduates should be good collaborators
● Able to use and understand the use of computers in analysis of big data sets
● Knowledgeable about industry interactions with their discipline
● Working with other professionals in related disciplines
  ○ engineering
  ○ computer science
  ○ other fields of biology

What will students in 2030 need to learn to be successful?

How to think critically
● Basics of logic
● Distinguish data-supported from unsupported assertions
● Learn to critically read the literature

How to communicate effectively
● Math, statistics, writing, presenting

Basic skills for learning
● How to study, read the literature, take notes, memorize
● Knowledge of biodiversity and natural history
● Time management, life balance
● Keeping learning as a constant in your life

Relevant training in complex skills specific to sub-fields
● Hands-on, rigorous research experiences
● Practical experience with tools of the trade and technology in their field
● Internships
● Entrepreneurial and innovation experiences
● Vocationally relevant experiences

How to problem solve and innovate
● Posing questions, following scientific method
● Research experience

How to work computationally with large data sets
● Learn programming skills
● Understand the “-omics” revolutions (genomics, transcriptomics, proteomics, metabolomics)
● Work with modeling and statistics
● Manage and manipulate large databases
How to collaborate with colleagues

- Work in multidisciplinary teams, teamwork soft skills
- Work with the edges where science meets society
  - policy makers
  - engineers
  - community and social relevance

What level(s) of education will students need in 2030?

There will be continued demand for well-trained Bachelor’s level graduates
- Our existing reputation will still serve students well.

More than in the past, students will need postgraduate degrees
- Health-related professions will require more post-graduate training
  - MD, DO, ND, etc...
  - PA, Nursing, MPH, etc...
  - CLS, etc...
- To compete well for lower level jobs, many will want more certifications
  - Masters
  - Certifications (e.g. Wildlife, Ecology, etc…)

More than in the past, the quality of their education will matter most
- Skill sets as opposed to degree qualifications
- “What can you do?” over “What do you know?”
- “What experiences have you had?” over “What classes did you take?”
- Distinguishing experiences that separate them from the competition
Academic Plan for Enrollment

Department of Chemistry and Biochemistry

Chemistry is the “Central Science.” No matter in what direction any of the science or engineering fields head, chemistry will be fundamental to their success. At Cal Poly, the vast majority of the teaching load in the Department of Chemistry and Biochemistry is in support of other departments. The impact of programmatic changes in our department will be felt widely throughout campus.

Tier 1: Higher Education Today

1a. What forces are shaping Cal Poly (and your discipline) today (which are likely to continue into the future and what new forces may come into play by 2030)?

Challenging Forces

We have been witnessing a move away from the “Sage on the Stage,” where students are passive vessels receiving information from an expert, to active learning where students are engaged and working during class time. The ultimate goal of the new model is for students to ‘discover’ the concepts and own them in a way passive learning can’t achieve. This method dovetails well with the challenges of the modern students, who are easily distracted, have information readily available 24/7 on digital devices, and are resistant to being passive players in their own lives. Over the last couple of generations we have watched a patriarchal society (“Father Knows Best”) become much more egalitarian. Even the youngest of modern children address their parents’ friends by their first names, with formality and titles largely forgotten. This change in societal structure is reflected in a modern classroom, where “learn this because I say it’s important” falls on deaf ears. Students demand, and deserve, to be co-players in their own education.

In the Chemistry Department, this change in structure is accommodated by new modes of teaching, which we see lasting well into the future. Our studio classrooms are designed for active, team-based learning, where the students are actively engaged in their own education during relatively long blocks of time. The challenge we have moving forward is that our brand-new building is already too small! Our studio classrooms are busy from 7 am to 6 pm five days a week, and we will shortly begin offering night sections to try to meet studio demand. The pressure to teach ever more chemistry has continued unabated for the last 10 or more years, and we see no relief from this increasing student demand. This ironic lack of space means that we have to choose carefully which classes can be taught in a studio format and which will need to be kept in the traditional, separate lecture and laboratory sections.

Students and faculty having ready access to factual information represents a tremendous potential boon for the possibility of depth in education. When
education can move away from low-level rote memorization and delve into application and analysis of concepts, the quality of understanding in any field must increase. This will be a challenge for students, who often equate understanding with memorizing—and who legitimately question the value of memorizing when facts are so readily available. Real-world problem solving brought into the classroom will help address this challenge by invigorating both students and faculty. This can be best achieved by having a research-based curriculum, where the topics and problems are those brought into the classroom by a research-active faculty. When students are challenged by a task in which their work has a measurable impact on a research study, many of the challenges of modern education—such as distraction by digital devices, plagiarism and other forms of cheating, and ennui—simply cease to exist. The students are excited and engaged, and there is nothing they’d rather be doing. The digital devices are there to help with the problem solving. The work is novel and has no precedent to allow cheating. Their work has meaning.

The challenges for creating a research-based curriculum stem largely from funding. This type of learning requires much more individual attention in the classroom and requires the faculty to continually update and analyze the results of the classroom activities. If a faculty member has more than two preps under this model, the workload may become overwhelming. It is, in many ways, an impractical model for a large, public university. However, the value of such an education seems almost limitless and reflects the ultimate in “Learn By Doing,” and convincing funding sources (both public and private) of the value of this problem-based education seems a manageable task. It may even be possible that by solving real-world problems, valuable intellectual property could be generated, creating a path for self-sustainability for the university.

Opportunities

In Chemistry, our greatest assets are our faculty and our new building. We have been hiring tenure track people at an almost alarming rate over the last several years, and we now have a very vibrant, excited, young cohort of dedicated teacher-scholars. Our new building is the very model for modern education, with state-of-the-art facilities, comfortable spaces for students to study or relax, and intentionally designed student-faculty workspaces. We have already witnessed the effect of an energized faculty with an incredible environment, with the ‘show rate’ and quality of accepted students into Chemistry and Biochemistry the highest in recent history. We are also exceedingly fortunate to have a base of very generous donors who have helped augment our program in numerous ways, such as our large summer student research program. We anticipate these positive trends to continue and to grow, creating a positive spiral of excellence.

Tier 2: Projections to 2030

2a. Who will our students be in 2030 (e.g., demographics, pre-college preparation)? What are their expectations and interests likely to be?
Student Profile

Challenges

Science tends to be reasonably colorblind and welcoming to diverse backgrounds. There is little that is subjective in scientific success, and anyone with intelligence, skill, and drive can succeed. Thus a changing demographic has little impact on the Department of Chemistry and Biochemistry. Our faculty is already reasonably diverse, certainly representing the pool of PhD-level chemists. Our department is welcoming to all students, regardless of background. There can be a challenge with being a residential campus and a department requiring many long hours in lab. If a student has family obligations some distance away, and has limited resources, the balance between time in school and time helping family can lead to some serious conflicts.

We expect to serve increasing numbers of the first-generation students, particularly those from outside the area and need to figure out how to best support their learning. We witness uneven preparation among our students, and finding ways to address and predict success in our program remains a challenge. We currently offer supplemental instruction workshops for some of our freshman courses; however, these opportunities are not available to all students who need help. There is a need for flexible support system available to students who need it most (e.g. supplemental instruction groups forming based on skill level and open to motivated students from different sections).

The high cost of living and the hostile manufacturing environment in California present significant challenges for employment for our recent graduates, with many of them needing to leave the state to find suitable employment.

Opportunities

By admitting and addressing the challenges, opportunities will present themselves. For example, the poor in-state employment outlook for chemistry leads to a possibility to harness student interest in entrepreneurship. Such an interest, if fostered, can lead to new industries in our area and new employment opportunities for future students. Increasing support for first-generation students can lead to a cultural shift among these underserved people. Reaching out and supporting poor-performing high schools in the state can bring service and employment opportunities to our students interested in teaching, and can help to solve systemic inequities in our educational system.

2b. **What will the global and regional economy be like in 2030** (and how are these forces relevant to your field or discipline)?

Global and Regional Economy
Challenges

California is a high-tax, high-regulation state that is fundamentally hostile to basic manufacturing. We have watched most chemically-related manufacturing leave first the state and then the nation, with most chemical manufacturing now done in Asia. If this trend continues, the paucity of middle-income jobs will continue the division we see between have/have-nots or educated/uneducated, and this will directly impact the quality of life for future generations. The trend of medium-tech jobs vacating the state leaving behind high-tech research or non-tech service jobs has very far-reaching implications for all of California, and particularly for chemistry. Traditional jobs in chemistry are of the medium-tech type: specialty, commodity, and fine chemical manufacture, traditionally based on petroleum precursors. These industries have traditionally been solid employers of bachelor-degree level chemists, but these jobs are all but gone from California. What remains in the chemical industry are boutique and large research firms focusing on pharmaceutical drugs, but even these are looking outside of California to find more business-friendly locations. Graduating from a school with an excellent statewide reputation, but a minimal national presence, puts our students at a disadvantage in a competitive job market located primarily outside of California.

2c. What will we be preparing our graduates to do (in general, and in your discipline)? What kinds of careers will you be preparing your students for in 2030? (What will your graduates be doing at work?) How might this be different from what they do today as a result of the challenges and opportunities identified above?

Opportunities

The high-regulation environment of California has, among other things, resulted in the Safer Consumer Products Act, better known as the “Green Chemistry” law. This law directs the Department of Toxic Substances Control to work with manufacturers to identify harmful components of consumer products and to seek safer, more environmentally benign alternatives. This law represents the single largest opportunity for chemists in the state. The need for analysis of products and development of alternatives has the potential to fuel a new, green-chemistry industry within the state. It would behoove our department to train our faculty in the details of this law and to find ways to incorporate the implications into our curriculum and research activities.

The other major area of potential growth for chemists is in agriculture, particularly in wine chemistry. Obviously, wine is a major industry for our state, and modern winemaking requires optimization of flavor factors to create the greatest value from the grapes. Understanding the biochemistry of fermentation can lead to better control of the flavor profile in wine. Our department is eager to work with Wine and Viticulture to hire and support wine chemists and to grow and enhance the chemistry component of WVIT.
With much of chemical manufacturing now done in Asia, having students with global experience will give them a competitive edge against their peers. Increasing the number of students who have a study-abroad experience, particularly in Asia, should be a focus of our department in the future.

2d. What will our students need to learn to be successful (in general, and in your discipline)? What level(s) of education will they need (particularly in your discipline)? Discuss the implications and opportunities for Cal Poly’s academic programs, majors and its future students and graduates. Discuss the implications and opportunities for educating students to be successful members of global society. What competencies will our graduates need? What does this imply for the kind of holistic, interdisciplinary education experience that Cal Poly envisions, including its residential community?

Preparing Future Graduates

The one certain thing about a very uncertain future is that all people will need to be flexible and adaptable lifelong learners with significant technological savvy. Fundamental skills such as oral and written communication, the ability to work with others, and the emotional intelligence to face hardship and uncertainty with confidence, will continue to be important. In many ways, Cal Poly has traditionally focused on excellence in a major field without addressing the ‘softer’ skills that are also critical for success.

Many of these skills are outside the scope of the department and need to be addressed by a shift in university policy. We have had a model in which increasing student services are provided, all with the best of intentions, and students are allowed multiple chances to correct inappropriate behavior. A tougher love model could be both more effective and less expensive. Students come from coddling, are coddled in college, and then leave to face a reality where they aren’t special, they aren’t loved unconditionally, and they are judged entirely based on their performance. Enforcement of codes of behavior and standards of performance will only help students in their transition to adulthood. A few well-publicized examples of students being disqualified for underage drinking, serious consequences for cheating (such as “FC” to denote Fail for Cheating on their transcript, and disqualification for more than one offense), and other policies that promote and enforce ethical, responsible behavior will help. The modern notion of extended adolescence may be a reality, but it turns college into the new high school—and enables students who are immature to be feckless, bad influences on students who are here to study and secure their future. The latter need to be supported; the former, removed.

Beyond ethical and responsible behavior, students need a host of non-technical skills to succeed in the current and future worlds. These must be achieved without sacrificing depth of knowledge within our discipline. First and foremost, we can set and maintain high standards within our field, something our department already
does proudly. Among the softer skill set, we find a deficiency in our students’ writing ability and have often discussed creating a cohesive plan for writing proficiency beginning with their freshman year. We need to find ways to develop their leadership potential, to engage them in entrepreneurial endeavors, and to encourage their interdisciplinary activities. Our department is in an enviable position with respect to student/faculty ratio. Because of the very large service component of our teaching load, we have a large number of tenure track faculty. Opportunities abound to find students from other majors and bring them to chemistry for research opportunities, which would expose our students to other fields and bring some different perspectives to our department.

2e. **What are the implications for emerging fields and integrated learning that goes beyond traditional disciplines?**

Computational skills are becoming increasingly important in many scientific fields, including chemistry. Computational tools are becoming standard tools for research in many areas of biochemistry and biophysics, and our graduates will need to develop computational fluency and computational thinking skills. Integrating these skills in existing curriculum is one of our current goals. If there was institutional support (resources), we could also collaborate with colleagues from Computer Sciences on developing an interdisciplinary minor in bioinformatics and computational chemistry.

Interdisciplinary learning opportunities with business (developing entrepreneurial skills), wine and viticulture (wine chemistry), and chemical engineering are also attractive opportunities for the future given appropriate institutional support.
Academic Planning Program Narrative
Kinesiology Department

Introduction
Kinesiology as an academic discipline examines the application of natural, behavioral and social science to human movement. As such it informs our understanding of exercise, human performance and how movement is fundamental to human health, structure and function. Having emerged from departments of physical education, Kinesiology is the intersection of fields studying human movement from various perspectives and in a multitude of contexts. Between now and 2030 the domain of “Physical Activity” will be critical (Blair & Powell, 2014) to our understanding of human health and how to achieve positive health outcomes.

The Kinesiology department faculty, staff and students have engaged in the process of addressing the tier one and tier two academic planning questions. Based on the university wide discussions there is a broad realization that public health will be a critical consideration in 2030 and that the solution to society’s burgeoning problem of overweight and obesity lies not only with physicians and pharmaceuticals but critically also with exercise and health science. There is a strong sense among department constituents that the work we’ve been engaged in through STRIDE and our Department Vision to address societal needs through our programs, curriculum and research is appropriately focused.

Demand for undergraduate kinesiology degree programs is on the rise. The American Kinesiology Association (AKA) identified that the number of undergraduate kinesiology majors in the United States increased more than 50% from 2003 to 2008 (Wojciechowska, 2010). Thomas (2014) reported that it is common for programs to have in excess of 1000 kinesiology majors and he concluded that it will continue to grow for the foreseeable future. Approaching 2030 the graduates of Kinesiology programs will be critical players in improving health outcomes for an ailing global population. An analysis of the global economic impact of obesity by the McKinsey Global Institute (November, 2014) reported that about 30% of the world’s population was overweight or obese and that the proportion could rise to almost half of the world's population by 2030. Domestically this trend is equally alarming, as U.S. adult obesity rates continue to increase and racial, economic and geographical disparities continue to exist (Levi, Segal, St.Laurent & Rayburn, 2014). In the United States more than 68% of adults and 32% of children were overweight or obese in 2011 and if the current obesity trend persists, the combined annual direct costs and indirect losses could exceed $600 billion per year by 2030 (Levi et al, 2014).

What are the salient forces that will shape Cal Poly between now and 2030?
We see a number of powerful social forces acting to shape Cal Poly both now and into the future, including a shifting job market, concerns about high levels of student debt, increased disparity between society’s highest and lowest earners, and an increasing need for graduate degrees. We see the potential for profound change by 2030 and it will be critical for programs at Cal Poly to maintain a focus on what they are preparing their students to contribute to the
global economy. As job markets and graduate programs become increasingly competitive, there is an increased need to prepare students to be successful in the transition from Cal Poly to gainful employment in the work force or in graduate school.

Our society currently includes an alarming number of college graduates who are struggling to repay college loans. The project on student debt (http://projectonstudentdebt.org) claims that in 2013, seven in 10 (69%) graduating seniors owed an average of $28,400. Between now and 2030 the balance between the rising cost of tuition and the burden of student loans will be an important point of focus for many universities and Cal Poly will be no exception.

In terms of funding, within the context of the CSU, Cal Poly will be increasingly reliant on student fees and external funding as it seems highly unlikely that state revenues will increase significantly. In the coming years it will be important for Cal Poly and the CSU as a whole to erode the current mistrust and misunderstanding of higher education by the general public and the state legislature. We would be well served as an institution to engage in powerful messaging and public promotion of the role that higher education has to play in building sustainable and expanding economies.

Non-traditional educational mechanisms of education driven by information technology are likely to become more popular and have the potential to be a powerful force shaping Cal Poly in the years leading up to 2030. Faculty, staff and administrators will need to pay close attention to the continued growth in distance and on-line learning and the influence of initiatives such as Massive Online Open Courses (MOOCs) that increase student access to massive amounts of information. There will need to be a shift in the focus of our instruction to embrace the fact that students can access incredible amounts of information quickly, so that we ensure Cal Poly graduates are informed consumers of information; that they can distinguish credible sources from non-credible sources; and that they are able to quickly synthesize and apply the information that they are accessing.

Cal Poly will need to change and adapt as students become used to learning through on-line and non-traditional forums. This will shape the way Cal Poly invests in infra-structure, student services and instruction. The growth in access to information is driving change within and across disciplines. As a collection of applied sciences the knowledge base in kinesiology is growing rapidly, skills and practices in the application of knowledge in kinesiology are evolving. In the years approaching 2030 we will need to prepare students to be flexible, adaptable and to quickly and nimbly apply information gleaned from multiple sources.

The changing demographics of the state of California offers an opportunity to Cal Poly to address the lack of diversity on campus but an increase in cultural diversity will demand that the campus evolve to be more sensitive to cultural differences and supportive of student success in people from different backgrounds. This should be an important point of focus within the master plan. Meeting student needs and the demands of an evolving student body will also mean a need for more buildings including on-campus housing, a stronger IT infrastructure and more campus green space.
Between now and 2030, Cal Poly needs to expand its efforts to develop programs, services and infrastructure to promote well-being within the campus community. Promoting health and well-being aligns with the core mission of the university by facilitating healthy learning environments. The CSU and Cal Poly have adopted policies surrounding issues related to mental health, alcohol and other drug use, sexual misconduct, violence, suicide and unintentional injury. As we approach 2030, it is clearly evident that more needs to be done to support the health of students, staff and faculty. The American College Health Association provides guidelines for Standards of Practice for Health Promotion in Higher Education that need to form part of the overall campus master plan to ensure that between now and 2030 we “advance the health of students and contribute to the creation of healthy and socially just campus communities” (ACHA Guidelines, 2012).

**What will Kinesiology students look like in 2030?**
As we stated in the introduction of this narrative, demand for kinesiology programs continues to rise and our sense is that demand will continue to be strong. We trust that current and sustained efforts at increasing diversity at Cal Poly will yield a student body that is more representative of diversity in California by 2030, but we anticipate that the success of these efforts will be limited by the university’s ability to provide scholarships. Without significantly more support to our advancement efforts, the reality is that as long as we remain heavily impacted, there are bigger structural deficits within our budget (lack of equipment money and facility renovations) that will be more of a priority given the context of limited advancement potential.

With the increasing challenge of paying for an expensive college education with jobs that may not pay enough to comfortably pay back student loans, Cal Poly students in 2030 may well be jaded by the prospect of an unstable job market, less confident about their ability to get a full time job and perhaps more unsure of their career goals. We see some of this general uncertainty being off-set in kinesiology by what we perceive as an inevitable demand for our graduates given the widely anticipated need for health educators and exercise specialists to address society’s deteriorating health outcomes.

The current reality is that many graduates of undergraduate kinesiology programs are deserting the traditional careers of teaching, coaching and fitness instruction to enter the rapidly expanding allied health professions (Thomas, 2014; Wojciechowska, 2010). Thomas (2014) pointed to the fact that “the population that is 65 years of age and older is expected to double by 2030” (p.316) and concluded that current growth in allied health professions is likely to continue, increasing the demand for kinesiology graduates. Although we do not expect our graduates to be exclusively employed in allied health by 2030, we do expect that given the current trends many of them will have career aspirations in some aspect of allied health.

**Kinesiology graduates in the global economy of 2030**
While we find it difficult to predict what the global economy will look like in 2030, many would suggest that given our reliance on fossil fuels and the industrial-military complex, our current
global economy is not sustainable. Much of this volatility is beyond the scope of our expertise but one trend within the national and global economy that is pertinent to our graduates is the move towards universal healthcare (e.g. The Affordable Care Act). Health care spending will continue to increase and our graduates will need to be prepared to become part of the solution.

Another trend that will impact the global economy in 2030 is the growing number of people who will be 65 years and older. According to Thomas (2014), the population of people 65 and older should be twice what it is now by the year 2030. This demographic shift will result in increased demand for professional degrees in physical therapy (DPT), occupational therapy (DOT), physician’s assistant (PA), doctors of medicine (MD), etc. Undergraduate Kinesiology programs with a scientific and interdisciplinary foundation in human movement will be in increased demand as students will look to a B.S. in Kinesiology as the gateway to the aforementioned professional degree programs.

The Sub-Disciplines of Kinesiology in 2030

“Universities are complex institutions with...long standing traditions...and typically slow to change” (DePauw, 2014, p.295). Kinesiology has its academic and professional roots in the training of physical education teachers (Thomas, 2014) but the future is clearly in the expanding knowledge base of the sub-disciplines. The foundation of kinesiology is interdisciplinary by nature. Faculty members in kinesiology departments are increasingly collaborating with colleagues from their home disciplines, for example biomechanists are working with engineers, sport psychologists are collaborating with psychologists and so forth across the sub-disciplines of kinesiology.

Kinesiology is also experiencing an expansion in interdisciplinary collaboration as academics see the potential for interconnected inquiry. Instead of research topics being focused around one domain in kinesiology (e.g., biomechanics, exercise physiology or motor behavior), areas are brought together to focus on collaborative modes with themes like aging and physical activity, or physical activity promotion in youth. Even within the emerging research areas of health and sport, cross-collaborations can emerge, including studies of sport as an intervention for improving long-term lifestyles and health. Herein lies the need to protect and maintain departments of kinesiology that house this rich blend of applied sciences.

Teacher-Scholars in kinesiology are expected to increasingly focus on health-related outcomes and sports performance. Health-related research will include studying the role of physical activity and sedentary lifestyle in the treatment and prevention of chronic disease and conditions of ill health. Understanding physical activity in the context of individual (e.g., brain functioning, microbiome, psychology, physiology, genetic, developmental), environmental and societal (e.g., social and built environment, policy initiatives, dissemination trials) variables will become critical. Long-term funding initiatives of the National Institutes for Health [NIH] reflect these focal areas and echo the importance of future research in physical activity and health outcomes.
The field of kinesiology will also continue to lead efforts in studying sports performance and fitness. Many students enter the field of kinesiology because they are interested in sports. Sport is important in US culture and historically in the field. While health-related research may overlap with public health and allied health programs, the emphasis on sport research is a significant and unique strength of kinesiology. Increasingly, funding sources for sports related research will come from companies that provide funds to test products (e.g., clothing and equipment) and evaluate the efficacy of products and programs.

**Which graduate programs will our students be applying for in 2030?**

Graduates with a degree in Kinesiology will work in the fitness, health, and sport industries. They will continue to work in allied health sectors such as pharmaceutical sales, corporate, commercial, clinical, governmental, and educational settings. Beyond initial employment immediately following graduation, collectively we believe that kinesiology students will continue to pursue graduate degrees in the following areas:

- **Corporate and Commercial Settings** - During the 1980s there was a growth in graduates who sought careers in employee wellness/fitness centers. Those graduates who want to work in a corporate fitness, health or wellness setting may seek masters or doctoral degree programs in exercise physiology, sport and exercise science.
- **Clinical Settings** - The types of graduate programs vary based on the graduates’ career goals. If a graduate is interested in a health or fitness career in a clinical setting, they will no doubt seek admission to professional degree programs in physical therapy (DPT), occupational therapy (DOT), medicine (MD), physician’s assistant (PA) or athletic training (MS).
- **Governmental** - Those students who pursue a direction more closely aligned with public and environmental health may wish to pursue graduate degrees in public health (MPH) or some similar fields. Once they earn those degrees, they may secure employment as directors of governmental health agencies at the city, county, state or national level.
- **Educational Settings** – Thomas (2014) suggested that by 2030 there may still be up to 30% of graduates who want to start a career teaching physical education or coaching at the interscholastic and intercollegiate level. Add to this the potential for graduates to teach health, health education or health promotion and clearly there may a strong proportion of graduates pursuing graduate degrees related to education.

**Conclusion**

Given the increasing need to address societal issues such as obesity, chronic disease, and an aging population, we foresee an increasing demand for education and training in kinesiology and applied health-related sciences. Kinesiology is preparing to propose a B.S. Degree in Health Science that would prepare graduates for some of the fastest growing careers in Community and Public Health, Health Promotion and Disease Prevention. A Bachelor of Science degree in Health Science would provide Cal Poly students with the knowledge, skills and abilities to meet the increasing demand for a trained workforce to improve health outcomes, prevent disease, promote healthy communities and address the public health challenges of the 21st century.
We anticipate that by 2030 we will have successful programs in both Health Science and Kinesiology with an emphasis in Exercise Science; with degrees in both areas we will be ideally positioned to prepare our graduates to enter the work force or proceed into a wide variety of graduate programs. Once we have established a successful undergraduate program in Health Science, our Kinesiology degree will focus on Exercise Science and prepare graduates who are ready to meet the demand for exercise specialists in areas other than public health and health promotion.

Our graduate program currently has a broad focus within the field of kinesiology. While we currently have no undergraduate or graduate programs for students who want to become credentialed health or physical education teachers, as a department we do have interest in developing sustainable programs in these areas if resources become available. Given trends toward public-private partnerships at Cal Poly and the potential to offer professionally focused graduate degrees through a self-support model (e.g. Fire Protection Engineering), we are interested in the possibility of participating in partnerships to develop graduate degrees that might interest our graduates.

Given the trends outlined in this narrative and the clear demand for graduates of kinesiology programs that is likely to continue growing in the years approaching 2030, we see profound need to increase enrollment in kinesiology. Our department has a number of exciting initiatives underway through the Center for Solutions Through Research In Diet and Exercise (STRIDE) and our push towards a B.S. degree in Health Science. As a department we have a considerable amount of funded research that provides exciting opportunities for students and faculty. Our ongoing work will require a continued commitment of resources and as success breeds success we anticipate a strong potential for growth, which would require additional fiscal, human and material resources. Given the clearly outlined societal needs we have addressed in this narrative and the potential for us to build on our established success, we the Kinesiology Department faculty, see great potential for growth and investment, not only in our academic programs, but also in other aspects (e.g. facilities, personnel) of our department between now and 2030.
Resources & References


**Tier 1 – Higher Education Today**

a. What forces are shaping Liberal Studies today (which are likely to continue into the future and what new forces may come into play by 2030)?

**Balanced curriculum and experiences.** Liberal Studies students are mostly in our major because they are planning to be elementary school teachers. They acquire broad based knowledge in many disciplines and develop multiplicity of talents to help them teach all students. Graduates demonstrate a balance of knowledge of subject matter and ability to communicate effectively. They develop passion for learning, make connections between disciplines like literacy and science, and are particularly good with their abilities to relate to each other, members of our community and children. The balanced curriculum with experiences that reinforce core-learning outcomes (ULOs [http://ulo.calpoly.edu/](http://ulo.calpoly.edu/)) will continue to be a drive for our curriculum to help us develop students and future teachers that will strive for excellence through continuous improvement.

**Knowledge on the foundations of coursework.** With the current educational reforms and the National adoption of new standards (Common Core-Mathematics, Common Core- English Language Arts, Next Generation Science Standards and Next Generation Art Standards), the structures that are known to support how people learn and develop 21st century skills are central to teaching. Instruction facilitation with processes involved in their formation needs to be clear. What drives scientific thinking, mathematical thinking, the creative process, the engineering design, problem solving, are important for future teachers. Making discipline specific thinking visible, engaging student in active learning, help deliver relevant and meaningful instruction.

Ability of the instructor to demonstrate how the cross cutting concepts are connected by discipline; or be able to show the varying demands of the task, audience, purpose and discipline are related to the construction of the curriculum is fundamental. Constant re-conceptualization of teaching and learning to adapt to continue integration of emergent life and workplace skills needed. Incorporating instruction and learning research advances into the curriculum as well as social, political and economical factors that drive our educational decisions.

**Rich Pedagogical Content Knowledge Development & Skills.** Many of our courses are student-centered and this will continue to play a key role for development in the future. Courses where the teaching plan is transparent and
students are able to see its well-developed execution when they engage in learning is necessary for our majors. Students should be able to understand to the fundamental ideas of each discipline as it relates to elementary school teaching and learning. Acquiring more basic knowledge and procedural skills will not be sufficient for elementary school teacher preparation, hence courses that prepare LS majors to be better at problem solving, exploration, being curious, communicating, and reflectiveness are overarching goals.

**Personal and Professional development.** Collaborative skills are central to the learning and our students. Students working together in finding multiple solutions to a problem and presenting them should be prominent in our all of our curriculum. Use of appropriate technological tools will continue to be an area of emphasis, and is likely to increase in importance. Multiple ways to collaborate in class and beyond while they construct their learning will be prevalent. One challenge for interpersonal skills development for our students is that the majority of our courses are for LS majors which makes the student body mostly female with many good teacher qualities of self-reliance and organization. In the future, we hope to mix our students more with other majors so our students can also experience discipline based thinking from a wide variety of fields and to be able to use these experiences in their future career.

Multiple opportunities to reflect on their learning and individual creative work are important; for example, creative and technical writing, oral reports, research papers, lab reports, critical thinking exercises. Our students need to have many developed capacities and skills that will serve them for their professional career. The career goal will rely on themselves as the main guide for their students. A progression of needs as new generations come through our program needs to be reinforced throughout all the courses that our majors take. For example, engaging in some forms of communication, not commonly used by the millennial generation, could possibly be challenging, however development of target tasks can be done in a course or series of courses for personal and professional growth.

**Increased Technological Literacy and use in Learning.** They will continue to be more sophisticated in the future using more technology to construct understanding in a subject or how it relates to their background and other disciplines. The will use data to assess learning of all individuals and use developments in learning theories. The relevance in society will increase as we learn that their students’ development and interest will be more central in the early development of college fields and career opportunities.
In the Future: We need to focus on working on development of critical liberal education. This pedagogy emphasizes the interdisciplinary knowledge and inquiry skills of a traditional program in conjunction with intercultural competence, civic engagement and an ethical stance toward social justice. This will be a great opportunity for our students and may be important to students in other majors.

Tier 2 – Projections to 2030
a. Who will our students be in 2030 e.g., demographics, pre-college preparation? What are their expectations and interests likely to be?

We expect that the student population for Liberal Studies in 2030 will be increasingly diverse and more closely match the demographics of the state of California. It is also expected that LS majors will see an increase in the number of transfer students. With continued changes to the ethnic mix of the California population, we will have to be more attentive with respect to learning strategies, personnel relations, and, communication. Specific efforts by Cal Poly faculty and staff to recruit students from underrepresented populations is a related, critically important challenge.

Based on research in learning and education traditional lectures will decline in use, and learner-centered forms of instruction will increase in use, especially for courses for LS majors. Hence the expectation is that LS majors will be increasingly familiar with learner-centered instruction and integration of technology across courses.

They will come with well-developed cognitive skills from the educational reforms enacted in the 2010s.

Tier 2 – Projections to 2030
b. What will the global and regional economy be like in 2030 and how are these forces relevant to Liberal Studies?

Continued growth in the California population is expected. The Department of Finance estimates California population to grow to over 50 million by 2050. Hispanics become the majority of the population in 2014 and will be ~48% of the population by 2060. In 2030, there will be 9.6 million Hispanics, 7.2 million whites and 3.1 million Asians in the prime working ages of 25 to 64. The California population will be aging and there will be an increasing need for new teachers.

c. What will we be preparing our graduates to do (in general, and in Teaching Preparation) in 2030?
We will continue to help students engage in the “the doing” and “the critical thinking” for the field and address changes and growth as they move through our program.

Our students will be able to develop central communities links and be willing to serve and lead projects. Serve in a vital role to address societal problems and future developments.

They will be able to use technology in their communications and educational environment effectively.

Be able to use multiple modes of instruction to teach diverse students.

In general, we are preparing our graduates to:

- Achieve personal, academic, and professional growth;
- Gain superior abilities and transferable skills that satisfy future employers' needs;
- Gain capabilities and critical skills to address challenging issues and decisions throughout their lives;
- Understand the differences and similarities among people and world cultures;
- Develop the capacity to bring people together to solve problems in the workplace or in the community;
- Communicate effectively in a technological society;
- Be prepared for leadership roles in the 21st century
  - know how to inspire and motivate others
  - display ethic behavior, honesty and responsibility
  - be able to solve problems, analyze issues and communicate effectively.

**Tier 2 – Projections to 2030**

**d. What will our students need to learn to be successful (in general, and in Teacher Preparation) in 2030? What level(s) of education will they need in 2030?**

- Our students would need to learn how to adapt to the Environment Changes:
  - Increasing social attention to our environment and limited resources;
  - Support sustainability practices in their lives and community;
  - Understand complexity of systems and consequences of changes variables;
  - Technology advances that will change our resources as consumers and social conscience on energy uses.
- Our students need to use evolving technologies in their lives and professionally
  - Include emerging technologies to facilitate learning;
  - Incorporate increasingly more complex educational data and use in their everyday decisions.
● Our students should focus on capacities and practices like those in common core and NGSS will continue to take a prevalent role and additional clarity on how they are incorporated in their formation will be essential.
● Our students will be users and producers of educational research, cognitive, brain development advances, and evolving social interactions.
● Our students need practice and repetitions of learning with multiple audiences/experiences: tutoring, special education, language learners, teaching of a discipline or an intentional multidisciplinary curriculum.
● Our students need to be exposed to world cultures, possible all of our LS students will have a study abroad experience and compare different educational systems.
● Our students need to be engaged in more community partnerships where they interact with at-risk students and develop an intentional service attitude.

Tier 2 – Projections to 2030
e. What are the implications for emerging fields and integrated learning that goes beyond traditional disciplines?
● Multidisciplinary thinking will be key to all new professions and Liberal Studies could offer elective courses to other majors;
● Case-based, problem learning approaches fostering multi-discipline integration is one model of instruction that might help better prepare our students.
● Increased relevance of informal education and the Do-It-Yourself world in higher education may increase in relevance in the PK-12 culture as well as shift to more personalized learning deliveries.
The Mathematics Department conducted a survey of its constituents – tenure/tenure track faculty, lecturers, graduate students, and staff – during the week of November 3, 2014. The survey, which consisted of 10 questions related to the forces affecting the discipline (currently and in the future) and the make-up of our students, received 56 responses of a possible 73. The narrative that follows reflects the consensus viewpoints established by the survey respondents.

First, the questions:

1. What forces are affecting the discipline [mathematics] today?
2. What forces will be affecting the discipline in the future?
3. Describe our students in 2030.
4. What will our future students expectations be?
5. What global/regional factors will influence mathematics in 2030?
6. What will we be preparing our students for in 2030? [In terms of careers]
7. With regard to #6, how will we be doing this differently in 2030 compared with today?
8. What skills will our future students need for success?
9. What fields will emerge that will affect the mathematics major?
10. What level of education will our Class of 2030 graduates need?
1. What forces are affecting the discipline today?
2. What forces will be affecting the discipline in the future?

[Note: The types of responses for #1 and #2 were nearly identical and so have been grouped together]

- Technology
  Development of computational technology; computer science; advanced analytics; big data; artificial intelligence; unfiltered access to information

- Demands of the Job Market/Industry
  Technology needs in industry require more mathematics competence; need for STEM professionals; need for skills more immediately applicable in the job market; emphasis on job training (rather than broad education)

- Demand for Math Teachers
  The shortage of qualified math teachers increases demand for math service courses

- Student Preparation, Approaches to Teaching Mathematics, Assessing Student Learning
  Need for independent thinking skills; use of technology in the teaching of mathematics, availability of technology outside the classroom; student diversity; level of preparation for college, study habits developed in K-12 education, holding students accountable [this was by far the most prevalent response to #1]; mathematics textbooks promote “cookbook” approach to learning; Common Core; employment vs. grad school preparation; classroom techniques/delivery of material, MOOCs, IBL, flipped classrooms, etc.; demographic changes

- Funding
  Decreases in education funding; increase in student costs for education (and resulting student debt); potential changes to availability of research funding; increased enrollment increases burden on service courses

- Interdisciplinary Aspects
  Applications to theoretical physics and computer science; robotics and artificial intelligence; area of mathematics influenced by data manipulation and computational techniques; increasing prominence of data science; preparing students for certain areas of applied math like climate, finance, biology, etc.

3. Describe our students in 2030.

- Academic Background
  The pool of highly qualified students will increase in pure mathematics, as the general public recognizes the value of rigorous mathematical thinking; the variance in student abilities/preparedness will increase; shorter attention spans,
more exposure to calculus but less competence in algebra; less qualified students for other majors, but the same number of qualified students for math majors; will possess less [capacity for] independent thought; better prepared for college-level mathematics; more computer and technology savvy; hopeful that their pre-college preparation will be better due to increased access to online educational materials; more dependent on technology, better preparation for university-level mathematics due to “common core”; more AP credit; increasingly interconnected with peers in other disciplines; dependent on technology for many school-related activities; more adept with technology

- Demographics
  More culturally diverse, with a broad range of academic backgrounds; a growing number of students who need to take mathematics courses; size of the pool will increase; greater percentage of 1-st generation college students; more geographically diverse; more Hispanic students; based on campus’ isolation, they will still be wanting a “traditional” college experience

- Interests
  Increasing interest in applied math and teaching; more specific idea of their post-graduation job opportunities; interest in applied math as opposed to pure math

4. Student Expectations

- Teaching Styles/Delivery of Education
  Students will expect shorter presentations because their attention spans will have declined; to be inspired by expert teachers who show them how an experience professional attacks challenging problems; supportive, competent teachers; that all faculty have transitioned to active learning strategies in the classroom; fun, group-oriented, interactive instruction; superior illustrations, 3D illustrations and professionally created diagrams beyond what a professor can write on the board in a few minutes; more flipped-model courses, less lecturer-centric

- Technology
  Students will expect, and be more dependent upon, technology; to be able to use technology for everything, including learning mathematics; that technology is used in all courses; that they will be using computer tools/technology in their careers

- Sense of Entitlement
  They will expect that easy and ready answers are an entitlement; that if they work hard they will be guaranteed a good grade; that faculty will meet more of their individual needs rather than focus on serving them as a group

- Curriculum/Resources
  Students will expect to receive a rigorous training in pure mathematics and methods of proof; to willingly do independent work (research, independent study,
etc.); major-specific calculus courses with field-specific applications; specific job/career preparation; math course tailored to their degree; adequate resources in the university; access to classes – if they are are paying for college, they will expect to get the classes they need in a timely manner; more learn-by-doing experiences; interdisciplinary programs and career-related services; to learn skills that will get them a job and/or transfer to other areas; more opportunities to do internships and hand-on work (like many other disciplines at Cal Poly do); to be educated broadly enough to allow for multiple career paths; to be educated to deal with societal issues; that applications to STEM fields will be more at the forefront of their classroom experiences.

5. Global and Regional Factors that will Influence Mathematics in 2030.

- **Technology**
  Advancement of technology; changing technology will drive/motivate new fields in applied math; technology is fundamentally changing human beings – is it changing mathematics itself, or just how people view and do mathematics; advances in technology will result in fewer math courses meeting in a classroom and more work done online; computing capabilities; as computation continues to advance, mathematics will be used to model more complex phenomena.

- **Economics**
  Globalization makes jobs less permanent, so society needs an intellectually adaptable workforce; global conflict could lead to a decrease in prosperity and thus educational funding; the attempt by moneyed interests to diminish public education by replacing role-modeling with computer-assisted learning; worsening economic challenges may make the pursuit of college degrees significantly more difficult; CA may have a wider income divide than most areas, so our students may be split between very privileged students and low-income students; economics is going to become more important as the middle class fragments – we will likely see more students from that area; changing economy will demand highly generalizable problem-solving skills.

- **Educational Preparation/Curriculum/Quality of Education**
  Need to update curricula and teaching to address changing needs, education must prepare students to solve tomorrow’s problems; demand for students with strong quantitative backgrounds should increase; popularity of higher degrees in mathematics; US will retain status as world leader in university-level education, but not at secondary and primary levels – large numbers of international students will seek US education; globalization will require our students to be internationally competitive; increased demand for highly educated work force leads to increased demand for college degrees in the sciences; increase in volume of transfer of information means that quality of information should be closely monitored; proximity to Silicon Valley makes Cal Poly attractive to STEM majors; global challenges will provide opportunities for those who model complex systems; demand for mathematics will increase, but mostly for math minors – we’ll need to
offer more “mid-level” courses; the emergence of “big data problems and corresponding mathematical techniques may become more standard in the curriculum; new subjects will use mathematics more – needs for these disciplines will increase new mathematics courses/programs; CA will remain a higher education leader; increased demand for highly educated workforce leads to increased demand for post-bacc degrees; need to maintain high quality education for influx of new students; common core makes students frustrated; teaching too much material in shorter amounts of time

6. What will we be preparing our students for in 2030? What careers?

- Teaching
  Careers will continue to expand in teaching due to rising population and retirements; teaching at all levels

- Pure Mathematics
  Students will receive more training in pure mathematics so they can be placed in a job-specific post-college training course; advanced mathematics competency in order to thrive in a career in engineering, programming, etc.; problem solving is valuable in all areas of the economy; good understanding of deeper concepts; mathematicians

- Applications
  Industry, including NASA, NSA, defeating cyber terrorism; working with/analyzing data privacy, computational methods applied to various sciences; health/medical modeling, biostatistics, big data, computer science; data analytics; work in investment firms; actuary

- Advanced Degrees
  Academia – higher education and research fields; pursuing advanced study; most jobs will require at least a Master’s degree

- Technology
  New developments in math and technology will lead to exciting new material that undergraduates will not see in coursework

7. Regarding #6, how will we be doing this differently in 2030 compared with today?

- Technology
  The skills and knowledge needed to be successful need to be updated to adapt to the changing technology; more knowledge in technological tools will be necessary; the university as we know it may be on the way out – maybe it will all move online; computing platforms will continue to increase in performance, enabling the modeling and simulation of more complex systems
• Pure Mathematics
A greater focus on the core of mathematics (abstract algebra, analysis) which provides the tools for studying most other areas of mathematics

• It Won’t Be Changing
It won’t be changing, but people will think it should be; not much different – our curriculum is sufficiently broad for admission to grad school; it won’t be different, but the percentages may change; we will continue to teach calculus, linear algebra and differential equations, to prepare students for pursuing more specialized topics post-graduation

• Interdisciplinary
It may involve better communication between pure and applied mathematics; more academic connections with other departments (team-taught courses, projects etc.); our current approach is not interdisciplinary focused

• Applications
Tools of applied mathematics and relevant courses might appear earlier in the four-year program; greater emphasis on numerical methods and error approximation; more focus on tech-related fields; students will want more mathematics taught to their interests rather than a more general approach; more demand for application, “real-world” problems, algorithmic processes, less demand for theoretical results/understanding; math majors more comfortable with programming

8. What skills will our future students need for success?

• Pure Mathematics
Clear, logical thinking; problem solving; proof; critical thinking; proving the truth of statements, understanding the importance of definitions in mathematics, understanding the ideas behind mathematics, independent of their proofs; logic; basic knowledge of university mathematics

• Applications
Mathematical fluency for general applications; computing, statistics; knowledge about other fields, interest in solving global problems; programming, use of cutting edge computational tools

• Communication
Oral and written communication skills; interpersonal skills; networking, effective communication of technical/mathematical material/topics

• Interdisciplinary
Team collaboration; be able to work effectively in groups
• Technology
Computational technology; use of technology

• Other
Inspired to develop an intellectual life; coping with intellectual uncertainty; time management; adaptability; stress management; moral and ethical awareness

9. What fields will emerge that will affect the mathematics major?

Statistics, clean energy solutions, energy-efficient transportation, data science, biometrics, AI, big data, cyber security, robotics, computational complexity, quantum computing, biomathematics, mathematics of the environment, mathematics of aging, combating the evils of technology; natural resource management, medicine/genetics/ stochastic algorithms, network analysis, alternative energies, sustainability, space exploration, population growth

10. What level of education will our Class of 2030 graduates need?

Pure: BS (4), MS (6) PhD (4)

Applied: BS (4) MS (7) PhD (2)

Math Ed: BS (7) MS (4) PhD (1)

General: BS (5) MS (8) PhD (1)
Academic Enrollment Planning
Cal Poly-Department of Physics
Matthew Moelter (Chair)

(This document was prepared by Moelter, who attended (parts of) the forums and solicited input from physics faculty.)

Based on our examination of the physics discipline and some extrapolation we have compiled our expectations regarding physics in the four areas. There were several commonalities that arose and they will be highlighted as we go through the different questions. Specifically, we expect an increased emphasis on computation and data science, the continuing emergence of interdisciplinary areas, and changes in aspects of instruction, in particular the increased use of technologies. We feel our program is doing well now and looking ahead perhaps “The undergraduate physics major should be the liberal arts education of the twenty-first century!”

Careers: What jobs will physics graduates have in 2030? (How are these different than current students?)

** Note: By some respondents this was interpreted this more broadly to include “paths after graduation” rather than just “jobs”.

The paths available to our graduates in the future will exist likely include many of the same paths our graduates currently pursue, with an emphasis on even more technology and computation.

- There was agreement that physics graduates will be doing jobs with even more computational aspects than currently. Almost all fields will require analysis of data, and some cases lots of data, so the need for “data science” or “big data”.
- In recent years there has been a significant increase in applied and interdisciplinary (hyphenated) areas such as geo-physics, biophysics, medical physics, and the like. There are some less obvious areas that are becoming popular such as econophysics or finance. In some of these areas physics majors (with appropriate elective courses) are well suited for entry into these fields. In those instances requiring problem solving skills an a quantitative approach it can be easier to teach the physics student the geology or biology needed, rather than teach the biology or geology student the necessary physics.
- One job for which there is significant current demand that will continue to grow, is teaching high school physics. Whatever changes happen to our field, the demand for qualified physics teachers will continue to be high.
- As the do now, we expect a third or so of our majors will go to graduate schools, although more and more will pursue graduate study in fields other than physics

1 Goodstein, David “The Coming Revolution in Physics Education”
http://www.aps.org/publications/apsnews/200006/back-page.cfm
(medical school, law school, aeronautical engineering, biomedical engineering, etc.)

- In a more speculative vein there may be new jobs: “quantum computer” scientist, neuro-implant specialist, brain-hardware interface specialist, and similar.

Recent physics graduates have been well served by our program and have post-graduation patterns similar to the national trends as shown.

According to recent data from the American Institute of Physics, physics majors do well on the placement exams for both medical (MCAT) and law (LSAT) schools as shown:

![Status of Physics Bachelor's One Year After Degree, Classes 1995 through 2012](image)

![Average LSAT Scores by Selected Majors, 2012](image)

![Average MCAT Scores by Selected Majors, 2012](image)
Capabilities: What general and specific competencies will be needed by physics graduates in 2030?

The skills and competencies of the future will include many of the same as present, but even more so, and possibly new ones as well.

- Given the growing existence of big data, statistical and computational capabilities with an eye toward large datasets will be necessary, “data science”. There will perhaps a bigger need for algorithm development and testing.
- We anticipate even more collaborative efforts (teamwork) across departments, companies, and disciplines.
- The ability to communicate your findings or analyses, in analog and digital forms, will be essential.
- It seems likely advances will be made at the interface between biology, neurology, brain science, and physics. This will lead to fields that are nascent or absent today such as advanced computer skills, advanced biology, brain and neurology skills, techno-ethics, and robotics.

A solid grounding in physics principles, analytical-computational-experimental problem solving, the ability to work collaboratively and share your findings will continue to be the foundations of our program. These competencies are consistent with recent findings of the American Institute of Physics survey of recent physics bachelors. (See chart.)

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**Knowledge and Skills Regularly Used by Physics Bachelor’s Employed in the Private Sector, Classes of 2009 & 2010 Combined**

<table>
<thead>
<tr>
<th>Skill</th>
<th>Employment in Engineering</th>
<th>Employment in Computer Science or Information Technology</th>
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<tbody>
<tr>
<td>Solve Technical Problems</td>
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<td>Work on a Team</td>
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<td>Technical Writing</td>
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<td>Knowledge of Phys. or Ast.</td>
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<td>Perform Quality Control</td>
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<td>Use Specialized Equip.</td>
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<td>Design &amp; Development</td>
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<td>Programming</td>
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<tr>
<td>Manage Projects</td>
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<tr>
<td>Work with Customers</td>
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<tr>
<td>Advanced Math</td>
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<tr>
<td>Simulation or Modeling</td>
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<tr>
<td>Computer Admin.</td>
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<tr>
<td>Manage People</td>
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<tr>
<td>Manage Budgets</td>
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</table>

Percentages represent the physics bachelor’s who chose “daily”, “weekly”, or “monthly” on a four-point scale that also included “never or rarely”.

[http://www.aip.org/statistics](http://www.aip.org/statistics)
Instruction: How will teaching and learning physics be different in 2030?

- There will likely be a significant change in the mode of instruction in much of our introductory level offerings. Specifically, some combination of flipped, hybrid or online modes seems likely. There is concern that this change be pursued in a thoughtful and responsible fashion, to ensure the quality and effectiveness of this new approach, while keeping the student success at the forefront of our efforts.

- Currently many introductory courses are about information that is widely (and freely) available. Rather than the facts it will be the skills to create, analyze, and synthesize information, and solve problems that will the main focus of our instruction.

- In the majors and upper-division courses there will be even more “learn by doing” through small enrollment courses with significant guidance and mentoring from faculty. In particular, in laboratory courses there will see even more emphasis on data acquisition and analysis along with competent use of scientific instrumentation.

- It is possible that with an increased emphasis on skills and competencies there will be a change in how we assess them. Exams as traditionally administered and assessed are not necessarily accomplishing their intended purpose, determining competency and providing feedback. In many cases they lead to a culture of gaming the test or just studying for the exam. (There have recently been serious cheating problems in the military.\(^2\)) There may an increased emphasis on projects, oral presentations, and practical demonstrations of content knowledge and competence. While written exams, quizzes, and homework may still be used for taking periodic “temperature readings” of student learning, they will mostly be used for feedback purposes to help students calibrate themselves for the project, practical, or oral exam.

\(^2\) [http://www.npr.org/2014/03/12/289423404/ex-missile-crew-members-say-cheating-is-part-of-the-culture](http://www.npr.org/2014/03/12/289423404/ex-missile-crew-members-say-cheating-is-part-of-the-culture)  
Situation: What are some opportunities and challenges that will exist for Cal Poly physics in 2030?

Opportunities

- There is a strong sense that almost all technical (and even many nontechnical) areas will be more data focused. We can create new approaches that enhance the computational capabilities and experiences of our majors.
- Identify and create educational pathways (emphases, concentrations, minors, etc.) that will allow students to participate in interdisciplinary and applied areas as students and then succeed in graduate programs and as employees.
- Enhance the curriculum so that undergraduate physics education more closely reflects what “physicists do;” a) include more modern physics, b) be current in instrumentation and experimental techniques, c) provide opportunities and credit for longer-term research participation.
- For most every sector of society (socio-economic, technology, geopolitics, ethics, etc.) exposure to physics will likely become important for almost all undergraduates. For example, fields like biology, kinesiology, and chemistry may become more physics based. There will be a need to provide opportunities for these other students to engage in physics.

Challenges

- Maintain the relevance and quality of higher education in general, and the “learn by doing” approach in particular, as instructional modes and the employment landscape evolves.
- Establish partnerships with other programs, departments, and private or public agencies to provide a rich variety of educational and employment opportunities.
- Be sure that adjustments to the curriculum continue to serve the likely paths of our students: become a teacher of high school physics; attend graduate school in physics or other areas; find employment in science and technology.
- Make curricular and pedagogical changes that allow flexibility and provide authentic experiences for students.
Background: The narrative below was created through a collaborative process that took place at the School of Education in the fall of 2014. Jon Margerum-Leys and Julie Herron attended university-sponsored sessions around the Academic plan effort. School of Education program coordinators were asked to discuss the questions below as part of their program meetings. The School of Education Coordinating Council, comprising all tenure track faculty and staff and part-time faculty representatives, discussed the effort and the specific questions at a meeting on November 13, 2014. Some text below is directly from program coordinators. Alphabetically by program, they are: Dr. Bill Kellogg, Agriculture Education; Ms. Julee Bauer, Bilingual Authorization; Dr. Jodi Jaques, Counseling and Guidance; Dr. James Gentilucci, Educational Leadership and Administration; Dr. Shirley Magnusson, Multiple Subject; Ms. Nancy Stauch, Single Subject; Dr. Mike Ruef, Special Education.

Tier 1 and 2 Questions to Be Addressed in Narrative

Tier 1 – Higher Education Today

a. What forces are shaping Cal Poly (and your discipline) today (which are likely to continue into the future and what new forces may come into play by 2030)?

As a professional school, we both influence and are influenced by the P-12 profession and higher education. Our prospective students are found in these environments or aspire to enter them; our program designs are dictated in part by regulatory structures in the profession; and the market for our graduates is nearly entirely in these two communities. We expect this existing professional orientation and the broad outlines of the environment thus created to continue into the foreseeable future.

That said, we anticipate changes in the education landscape, some of which are beginning now. For example, the role of the school site leader is changing from middle manager to visionary leader. The old paradigm of "administrative manager" is no longer effective in today's schools. Instructional leadership and transformational leadership are the emergent paradigms. The era of the top-down "boss" on school campuses is quickly coming to an end. This means emergent leaders must know how to delegate, share power, and leverage the strengths of staff members. Our Educational Leadership and Administration program is already oriented in this direction and will continue to evolve.

Across the nation and particularly in California, we are seeing the beginning of what we anticipate will be a significant teacher shortage. It is already the case that in several
fields (Special Education and STEM particularly) students have their choice among positions. Education leaders in our region and beyond tell us that these shortages are likely to continue for some time.

The move to Common Core and Next Generation Science Standards currently have an impact on our School as well. We see this as largely positive; the call for critical thinking and for increased understanding of science that is part and parcel of the standards parallel both the vision of the School of Education and the Learn by Doing and Comprehensive Polytechnic foci of Vision 2022.

**Tier 2 – Projections to 2030**

a. **Who will our students be in 2030 (e.g., demographics, pre-college preparation)? What are their expectations and interests likely to be?**

Demographic shifts in California have been occurring for some time; we expect that California will be “majority minority” in the very near future and that by 2030 we will be even more culturally diverse than we are today. It is vital that public education professionals reflect both the reality and aspirations of California’s people. Currently, the School of Education’s students, like those at many Schools of Education across the nation, are majority white, female, suburban, non-veteran, and young. To meet the needs of California, we must recruit, prepare, retain, and place a more diverse student population. Retention is key among these; we must be sure that we have in place structures to support diverse students and ensure their successful completion of our programs.

We expect the current emphasis on differentiation in P-12 instruction to continue and that students who come to Cal Poly in 2030 will therefore expect differentiated instruction at the university level. Fortunately, this fits well in a Learn by Doing environment.

If we are successful in our efforts to attract a more diverse set of students, that diversity may also manifest in the ages of our students. Particularly as an all-graduate unit, we serve an older set of students than Cal Poly overall and we expect that in 2030 some portion of our students will be 30s and 40s. It is important that campus services take into account students who fall outside the traditional 18-25 band.

Related to demographics, the importance of communicating in a language in addition to English is likely to increase. We expect students in 2030 to have an interest in speaking, reading, and writing in a second language; this is also in line with the needs of P-12 schools for professional educators who are linguistically and culturally diverse.

**Tier 2 – Projections to 2030**

b. **What will the global and regional economy be like in 2030**

As mentioned above, we expect the heightened need for education professionals to continue for some time. What that will mean in 2030 is somewhat unclear.
More generally, we expect global climate change to have an impact on the regional and global economy. Severe weather events are likely to be much more common in 2030 and changes in sea level are extremely likely to have an impact on the local coastal economy. From a School of Education standpoint, we expect to play a role in preparing others to deal with changing conditions.

**Tier 2 – Projections to 2030**

c. What will we be preparing our graduates to do (in general, and in your discipline) in 2030?

First and foremost, the School of Education expects that we will be preparing our graduates to reach each and every student. In higher education, which is served by our Counseling and Guidance program, we expect that greater inclusion will have an impact on community colleges and that graduates of the Counseling and Guidance program will need to be prepared to reach a higher education with a broader range of skills and abilities.

At the P-12 level, we expect to be preparing our teacher candidates to enter a system in which tenure is de-emphasized and in which teacher evaluation is more systematized and rigorous.

**Tier 2 – Projections to 2030**

d. What will our students need to learn to be successful (in general, and in your discipline) in 2030? What level(s) of education will they need (particularly in your discipline) in 2030?

Generally, one of the most important things students will need to learn is to be effective in fluid work groupings. Both across their careers and within individual jobs, students can expect to work on a variety of projects with a variety of sizes and compositions of work groups. Learn by Doing will continue to be vital and being even more purposeful about setting up a range of experiences will be important to student success.

In our conversations in our disciplines, we identified a number of components: Use of technology, information literacy, and academic content. Being able to effective employ technology in educational settings is likely to continue to be important. Our students will need to not only learn about particular tools, but will also need to learn how to learn about new tools as they come on the scene. Related is the importance of information literacy. Within information literacy, an issue that is of particular importance is the ability to evaluate information for validity and relevance. An increased need for teachers to have academic content knowledge is also likely.

For all of these reasons, we expect that by 2030 education professionals will require more preparation than is currently the case. Credential programs, for example, may extend to two years and may involve increased experiences in the field and with the co-teach model. Co-teaching involves more than one content expert working with a group
of learners. Often, this is accomplished with an experienced mentor teacher and a student teacher. Related, it’s possible that students will need a longer induction period or a paid post-credential internship. Alternatively, we may seek more-experienced students on the incoming side of the equation.

**Tier 2 – Projections to 2030**

e. **What are the implications for emerging fields and integrated learning that goes beyond traditional disciplines?**

Education professionals have always had multiple domains of knowledge for which they are responsible. School leaders require knowledge of law and regulations, instructional leadership, team building, and budgetary oversight; counselors require knowledge of higher education structures, student life, and academic programs; P-12 and special educators require content area and pedagogical knowledge. The preparation of education professionals is, by nature, integrated across these and many other areas. We expect this to remain the case.
Introduction

Before addressing the questions posed to us about anticipating the future, I’d like to set the stage for those predictions with some observations about the present and recent past. I start with some observations about Cal Poly’s Statistics Department:

1. Statistics is a vibrant scientific discipline in its own right, but its primary mission is to support research conducted in application areas. Accordingly, our department invests most of its teaching resources into service/support courses. We offer seven different introductory courses for various types of majors, with most undergraduate programs at Cal Poly requiring at least one statistics course. (Using Cal Poly’s course inventory management system revealed that 51 different undergraduate programs refer to an introductory statistics course.) During the 2013-14 academic year, we taught 128 sections of courses for students majoring in other disciplines, compared to 33 sections of courses aimed primarily at students majoring or minoring in Statistics, so 79.5% of our sections were service/support courses.

2. Student demand for statistics courses at Cal Poly has grown considerably in recent years, in both services/support courses and in courses for students majoring or minoring in statistics. Table 1 below indicates that the number of student credit units (SCUs) taught by the Statistics Department have increased by more than 22% over just the past three years. Table 2 presents SCUs in recent Fall quarters, showing even stronger growth of more than 30% in the past four Fall quarters.

Table 1: Student Credit Units (SCUs) taught by Statistics in academic year (final census):

<table>
<thead>
<tr>
<th>Year</th>
<th>SCUs</th>
<th>% change from previous year</th>
<th>% change from 2010-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-11</td>
<td>18,449</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011-12</td>
<td>20,553</td>
<td>11.40</td>
<td>11.40</td>
</tr>
<tr>
<td>2012-13</td>
<td>20,852</td>
<td>1.45</td>
<td>13.03</td>
</tr>
<tr>
<td>2013-14</td>
<td>22,537</td>
<td>8.08</td>
<td>22.16</td>
</tr>
</tbody>
</table>

Table 2: Student Credit Units (SCUs) taught by Statistics in Fall (final census):

<table>
<thead>
<tr>
<th>Year</th>
<th>SCUs</th>
<th>% change from previous year</th>
<th>% change from 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>6497</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>7285</td>
<td>12.13</td>
<td>12.13</td>
</tr>
<tr>
<td>2012</td>
<td>7560</td>
<td>3.77</td>
<td>16.36</td>
</tr>
<tr>
<td>2013</td>
<td>8021</td>
<td>6.10</td>
<td>23.46</td>
</tr>
<tr>
<td>2014</td>
<td>8504</td>
<td>6.02</td>
<td><strong>30.89</strong></td>
</tr>
</tbody>
</table>
Table 3 refers specifically to enrollments in two intermediate-level courses, beyond the introductory level, taken almost exclusively by students who are majoring or minoring in Statistics: STAT 324 (Applied Regression Analysis) and STAT 330 (Statistical Computing with SAS). Combined enrollment in these courses has increased by more than 80% over the past four years, suggesting that the growing popularity of statistics extends to majors and minors and not simply service/support courses.

<table>
<thead>
<tr>
<th>Year</th>
<th>STAT 324 enrollment</th>
<th>% change from 2010-11</th>
<th>STAT 330 enrollment</th>
<th>% change from 2010-11</th>
<th>STAT 324, 330 combined</th>
<th>% change from 2010-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-11</td>
<td>51</td>
<td>41</td>
<td>92</td>
<td>25.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011-12</td>
<td>69</td>
<td>35.29</td>
<td>46</td>
<td>12.20</td>
<td>115</td>
<td>25.00</td>
</tr>
<tr>
<td>2012-13</td>
<td>103</td>
<td>101.96</td>
<td>78</td>
<td>90.24</td>
<td>181</td>
<td>96.74</td>
</tr>
<tr>
<td>2013-14</td>
<td>85</td>
<td>66.67</td>
<td>84</td>
<td>104.88</td>
<td>169</td>
<td>83.70</td>
</tr>
</tbody>
</table>

This growth in the number of students pursuing undergraduate degrees in statistics is also happening on a national level. A recent *Wall Street Journal* article (“Data Crunchers Now the Cool Kids on Campus, by Carl Bialik; March 1, 2013) documented this tendency. (In fact, the author’s blog post on this topic featured extensive quotes from Roxy Peck, Professor Emerita of Statistics at Cal Poly. Links to references are provided at the end of this report.)

3. Cal Poly is quite unusual among non-research-oriented universities for having a stand-alone Statistics Department and an undergraduate major in statistics. For example, only 2 other institutions in the CSU system (East Bay, San Diego State) have a Statistics Department that is separate from the Mathematics Department, and only 5 other campuses offer an undergraduate major program in statistics. In fact, our department is larger (in terms of number of faculty and undergraduate majors) than many statistics departments at research universities with well-respected Ph.D. programs in statistics.

In these preparatory remarks I also want to mention several external forces that have shaped our program substantially in the recent past:

1. The Advanced Placement (AP) program in Statistics has made hundreds of thousands of high school students aware of the field of statistics and given them substantial exposure to applications of statistics before starting college. The first AP Statistics exam was taken in 1997 by approximately 7,700 students. By the tenth administration of the exam in 2006, that number had grown more than ten-fold to about 88,000 students. In the eight years since then, the number of exam-takers has doubled to about 185,000 in 2014. Moreover, many more students take the AP Statistics course than take the exam. This rapid growth of the AP Statistics program appears to be a strong contributor to increasing numbers of students majoring in statistics at Cal Poly and other institutions. (By the way, Cal Poly faculty have been leaders in the AP Statistics program since shortly after its inception and have established connections with teachers of AP Statistics around the country.)

2. The technology explosion of the past few decades has revolutionized how the practice of statistics is conducted and also how the discipline of statistics is taught. Consequently,
software tools are essential for doing statistics and for learning statistics at all levels. Moreover, as with most other technologies, these tools are quickly becoming more powerful, less expensive, and adaptable to smaller devices.

3. The “big data” phenomenon and the emerging field of “data science” have received an extraordinary amount of attention in the news lately, as well as in business, industry, government, and education. A Google search conducted on November 17, 2014 produced 884 million results for “big data” and 289 million results for “data science.” (Both of these searches took less than half a second to run, which is of course a testament to the power of how efficiently Google applies data science to harness big data!)

Wikipedia defines “big data” as “an all-encompassing term for any collection of data sets so large and complex that it becomes difficult to process them using traditional data processing algorithms, and “data science” is defined as “extraction of knowledge from data” and as “the practice of deriving valuable insights from data.” The field of statistics is central to the data science and big data enterprises. In fact, some statisticians argue that statistics is the science of gaining insight from data and therefore there’s no distinction between statistics and data science. Others contend that the field of data science sits at the intersection of computer science, statistics, mathematics, and domain-specific knowledge. These quibbles and controversies aside, it seems indisputable that big data and data science are rapidly changing what statisticians need to learn and be able to do with data, as well as quickly increasing the demand for well-educated professionals with these skills.

With this preamble completed, I will now proceed to the assigned task of speculating about the future. But I do so with a very humble and perhaps even fearful attitude, as I am mindful of two wise sayings:

- Provost Enz Finken began the recent workshop in Avila Beach by cautioning us that Daniel Boorstin has said that “the greatest obstacle to discovery is not ignorance; it is the illusion of knowledge.”
- Attributed to many sources, including an unknown Danish humorist (and also, perhaps inevitably, Yogi Berra), is an admonition that is especially pertinent to statisticians: “Prediction is hard, especially about the future.”

(1) How factors affecting higher education will affect your field

We’re not sure that the major factors affecting higher education will necessarily affect the field of statistics in substantively different ways from other fields. The growing popularity of online courses and MOOCs has the potential to affect our course offerings, if more and more students come to campus already having studied statistics. But we think a larger issue in this regard is the potential impact of the Common Core State Standards, which we discuss in the next section. Similarly, we expect that we’ll have to adapt to learning styles and abilities of the millennial culture and subsequent generations, but we don’t expect the impact there to be much different or more profound on statistics than on other subjects.

One trend in higher education that concerns us is the movement toward increasing class sizes, which we see as running counter to Cal Poly’s emphasis on “learn by doing” that allows faculty
to provide more personalized learning experiences and feedback to students. We strongly prefer that Cal Poly maintain reasonably small class sizes along with the attendant emphasis on student-faculty interaction. We think this is especially important in our discipline of statistics because of the importance and difficulty of helping students to develop their skills with technology, communication, and interpretation of results.

We’re very intrigued by the shift in role of college faculty away from traditional lecturers toward learning facilitators. Several of our faculty members have obtained substantial grant funding and have established national reputations for curricular and pedagogical innovation. We expect to comment extensively on this issue when we prepare our report about tier 3 questions of curriculum, pedagogy, and enrollment in February.

(2) Who your students will be

As with colleagues in other fields, we look forward to Cal Poly attracting a more diverse student body, and more diverse faculty/staff/administration members, over the next 15 years.

We also expect to see that students of the future will be even more entrenched as digital natives rather than digital immigrants, to borrow terms coined by Marc Prensky in his well-known essay “Digital Natives, Digital Immigrants.” Prensky argued in 2001 that “today’s students are no longer the people our educational system was designed to teach.” We recognize, with some trepidation, that students are already less comfortable with reading and listening than students of the past, and we expect this trend to continue. On the more positive side, we anticipate that students will become more and more comfortable with using technology and with searching for information from multiple sources.

We are also struck by the recognition that California will see fewer 18-year-olds in the coming years as compared to the recent past. We like to think that our program in statistics might already be well-positioned for the increased competition of California universities for fewer students, because we are one of a few CSU campuses with a full-fledged statistics department and undergraduate program.

We believe that implementation of the Common Core State Standards (CCSS) has the potential to affect what and how statistics is taught at the undergraduate level fairly dramatically. I mentioned in my overview comments that the development of the AP Statistics program has impacted our program substantially, and the CCSS could have an even more profound effect. CCSS calls for the teaching (and learning) of substantially more content related to probability, statistics, and data analysis throughout grades 6 – 12. In particular, some of the standards call for all high school students (not merely those who opt to study AP Statistics) to learn enough about statistical inference to be able to:

- Use data from a sample survey to estimate a population mean or proportion
- Develop a margin of error through the use of simulation models for random sampling
- Use data from a randomized experiment to compare two treatments
- Use simulations to decide if differences between parameters are significant
We currently devote considerable time and attention to helping students learn these concepts and skills in our introductory statistics courses at Cal Poly. If high schools succeed in leading students to achieve these learning goals, that success will provide us with a great opportunity to rethink our learning goals in introductory courses to build on the statistical knowledge that students bring with them to Cal Poly. Even if high schools achieve only moderate success, we will still find ourselves in the fortunate position of working with students who have encountered more statistical ideas before they enter Cal Poly than students of the past and today.

(3) How the global context will affect your field

As noted above, the biggest global factors affecting the field of statistics are the phenomena of big data and the rise of data science. Data can be found and gathered everywhere and constantly in today’s technology-rich society. Our discipline is about gaining insights from data, and our teaching is about enabling students to do just that. We expect that even more professions will have a need for people who can find information in data, so we expect even more employment prospects for our graduates and even more demand for our offering service/support courses to students in other fields.

A 2011 report by the McKinsey Global Institute concluded that “the amount of data in our world has been exploding, and analyzing large data sets – so-called big data – will become a key basis of competition, underpinning new waves of productivity growth, innovation, and consumer surplus.” This report went on to predict: “There will be a shortage of talent necessary for organizations to take advantage of big data. By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts with the know-how to use the analysis of big data to make effective decisions.”

(4) What your future graduates will be doing

We expect that our future graduates will be involved with managing and analyzing datasets of all sizes for all sorts of businesses and industries. They will work closely and collaboratively with managers, decision-makers, and researchers in a wide variety of application areas. Many of them will engage in substantial programming tasks using statistical software and other packages.

We also hope and expect that many of our future graduates will be helping to pioneer the use of data to make decisions in industries where that has not typically been the norm. We also anticipate that many of these future graduates will be working in non-traditional environments, such as tele-commuting and other ways of working collaboratively across distances.

With the increased emphasis on teaching statistics in high schools as well as at the postsecondary level, we also foresee that more and more of our future graduates will pursue careers in teaching.

(5) What your students will need to learn (what competencies they need to have)

To address this question of what our future students of statistics will need to learn, I first turn to a new set of guidelines for undergraduate programs that has very recently been endorsed (the press
release is dated November 19, 2014) by the American Statistical Association (ASA). Cal Poly’s Beth Chance has been one of ten committee members who have spent much of the past two years developing these guidelines in consultation with stakeholders in business, industry and government as well as academia. Our department generally supports the recommendations of this group, which are that students majoring in statistics “need to master an integrated combination of skills that are built upon statistical theory, statistical application, data manipulation, computation, mathematics, and communication.”

These ASA guidelines identify four key points that future statistics graduates especially need to learn:

- Extensive computing skills, due to the increased importance of data science
- Many experiences with real applications involving genuine, complex data
- Exposure to and practice with a variety of predictive and explanatory statistical models
- Ability to communicate statistical methods in understandable ways to multiple audiences

Some additional competencies that we believe will be important for our future graduates to develop include the ability to recognize how to apply statistical ideas and methods to answer questions and solve problems in fields that have not traditionally relied on data-based decision-making. We also need to help future students to realize that not all data come in the traditional and convenient form of rectangular arrays. Students will also need to interact with databases and perhaps create databases for themselves. Visualization is another aspect of statistics that is growing in importance, so students will need to learn to produce informative visual displays, draw sound conclusions from visual information, and perhaps develop software tools that create new types of visualizations. We also believe that developing students’ teamwork and time management skills will become increasingly important in future years. Also becoming more and more important is for students to think and learn about ethical issues involved with the practice of statistics.

(6) How your department might engage with emerging fields and interdisciplinary opportunities

The most promising opportunity is for our statisticians to work closely with computer scientists to prepare Cal Poly students for careers in data science. We are about to embark on just such a collaboration, as we have worked for the past year to develop a new program called a cross-disciplinary studies minor in data science. This program, which will begin in Fall 2015, is a very innovative, rigorous, and project-based one that should prove to be quite distinctive and beneficial to students.

Moreover, this program could provide a springboard for more collaborations in this area, with computer scientists and others. A closely related field is business analytics. We understand that the College of Business intends to propose developing a self-support Master’s program in this area, and we statisticians would be glad to work together with the business faculty on such a program.

Many more opportunities under the heading of “data” will present themselves in the decades to come. Another specific example is the emerging field of data journalism, which is being
popularized by Nate Silver and others. In fact, Cal Poly’s Journalism Department has recently proposed a new course in Data Journalism to begin in fall of 2015. This is another area in which statisticians have much to contribute.

Another group with which we may well increase our levels of collaboration involves science educators. Several faculty members in our department specialize in statistics education and work closely with faculty members in mathematics education. We see many opportunities to collaborate further and more closely with mathematics educators and also with faculty in other science fields who concentrate on scholarly work related to education. We would also like to work more closely with colleagues in the School of Education and in cognitive science and learning theory.

I should also mention that we in the Statistics Department have many common interests and a good, long-standing working relationship with our colleagues in the Mathematics Department. We foresee much potential to expand our collaborations into new areas related to big data and other related fields that may emerge in the coming decades.

As I mentioned at the outset of this report, the field of statistics is by its nature an interdisciplinary one. In a recent list of the top 100 most-cited research articles of all time compiled by Nature magazine (October 30, 2014), statistics was one of six areas called out for special notice, as 12 of the 100 articles focused primarily on statistical issues. Statisticians at Cal Poly have a very strong track record of collaborating with colleagues in departments and office across campus. One way in which we do this is through our statistical consulting service, which offers free consultations to students and faculty researchers in many fields. A partial list of departments, centers, and offices that this service has helped in the past few years includes:

- Biology, Center for Marine Coastal Sciences, kinesiology, STRIDE, physics, chemistry, mathematics
- Aerospace, biomedical, materials, civil, environmental, mechanical, electrical, and computer engineering
- Food, dairy, soil, crop, animal sciences; nutrition; wine and viticulture
- Dairy Products Technology Center, natural resources management, environmental sciences, forestry
- Business, economics, marketing, finance, information technology
- Recreation, park, and tourism administration; city and regional planning
- Sociology, psychology, political science, journalism; art and design
- Kennedy Library, Wellness Center, advising, institutional research, student life

We would like to expand our consulting service, and we would also like to be included even more often on funded projects that can benefit from statistical advice about designing studies and analyzing data. In fact, perhaps it would make sense to develop a center on campus through which all data-oriented courses, programs, and research could be coordinated. Such a coordinated effort might help to alleviate some of the obstacles to cross-disciplinary innovation that universities often struggle to overcome.
Conclusion

Thanks for this opportunity to think about and plan for what we think will be exciting educational opportunities in the field of statistics in the coming decades. We like to think that our discipline is an exciting and important one, and recent trends justify our optimism that statisticians will have much to contribute to making the world a better place in the years ahead. We also like to think that we at Cal Poly are very fortunate to enjoy working with outstanding colleagues and students who will change the future for the better. We look forward to the remainder of this planning process and especially to the next several years of helping Cal Poly students, particularly those interested in studying statistics, to become valuable contributors to society.

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