Background and Problem Issues
Engineering is recognized as a key to long-term sustainability in the State of Arizona economically and environmentally. Engineers are drivers of transferring innovations to practice and to producing real goods. Major state employers in electronics, defense, infrastructure construction, and manufacturing rely on the Arizona universities to provide the highly skilled workforce to remain competitive. The demand for College of Engineering (ENGR) graduates in some fields far exceeds our capacity to educate engineers and projections for engineering growth are among the highest in all fields to meet our present needs and to remain internationally competitive.

ENGR has a long history of success at the UA – the land grant institution of the State of Arizona. Currently we are at 8 departments, 17 undergraduate programs, 135 faculty of which perhaps 100 are research active relative to funding, 2400 undergrads, and 650 graduate students. We run about $26-$27M in contract research and $10M in gifts each year. We have the traditional accredited programs such as electrical, mechanical, civil, and chemical. We have specialty accredited programs in mining, aerospace, optical, materials, system, industrial, computer, and engineering management. Finally we have non-accredited boutique programs such as Hydrology, a Bachelor of Arts in Engineering, Engr. Math, and Engr. Physics. Our branding has infinite possibilities, and this manifests itself in a number of small departments, a large number of degree programs – (many with less than 100 students,) and a faculty working in a large number of technical and applications areas. Table 1 contains faculty count, undergraduate student count, and research dollar data for each department.

In terms of impact of the College of Engineering on campus, our incoming Fall 2008 students are the best as a group with average SAT scores 125+ points above the university average and average GPA’s more than 0.2 above the campus average. These students are committed to the University to study engineering. **Maintaining that quality on campus is important to our overall university ranking.** Our 1-year retention in ENGR has been over 75% for the past 2 years (as opposed to 65-67% during the previous
decade) and our 1-year retention at the UA for the Fall 07 class was 89.5%. The quality of ENGR lifts
the UA in rankings. ENGR is 52nd nationally among all schools while the UA ranks 96th. Similarly
among public institutions ENGR is 26th while the UA is ranked 45th.

ENGR research expenditures are more than 12% of the UA main campus funding with 9% of the
faculty. If the three research institute/departments (optics/astronomy/LPL) are not considered, ENGR
accounts for 17% of the on-campus research funding. Several international recognized NSF funded
centers are housed within ENGR. Further, expenditures are support a large number of students
corresponding a large amount to the general ERE pool. Several new large projects totaling over $25M have
been secured in the last month and will increase these expenditures over the next several years.
Opportunities for technology development and patents leading to technology transfer returns are high, but
this focus has not been nurtured in ENGR or the UA. Teaching loads of regular faculty are well within
the norms of the University.

ENGR is a microcosm of the UA in terms for quality and numbers of programs. ENGR has 8 state
supported departments with 135 faculty with approximately 17 faculty per department, while the
University has 75 units and just over 1500 faculty. The need for change in this structure is clear:

- We are under pressure from an ever-decreasing state budget. We need to generate more overhead
  return and philanthropy gifts as these are our only source of relatively unrestricted revenues.
- Our structure of small departments ensures that few departments are highly rated – we have 4
  programs in the top 30% (US News) of their rankings (Elec. Engr., Comp. Engr., Civil Engr. and
  Systems/Industrial Engr.). Our perceived strongest program – Hydrology – is in an area that is
  not ranked by US News. Our Mining program – biggest improvement over the past 5 years –
  suffers the same fate. We are not getting full benefit at the department level for these successes.
  All analysis on national rankings suggests that rank is highly correlated to size (with the
  exception of places like UC-Berkeley).
- We have a wide variance in teaching loads and research output as evidenced by our student
  counts and 2007 research expenditures when compared to faculty size.
- Our salaries lag behind our peer institutions significantly across all ranks and deciles. This is a
  significant issue in faculty morale. Our highest paid faculty – those in the upper decile of their
  peer group - lag the farthest.

It is clear the something needs to be done. The following set of ideas is a kernel of a proposal.
Clearly, every detail has not been completed, but the general structure will be clear.

**ENGR Reorganization Strategy**

As expressed in several forums, the transformation process should be conducted in an analytical
manner. Therefore, to begin, the goals of an ENGR transformation are defined as:

**Re-organization Goals**

- Achieve world class status
- Improve short term efficiencies
  - in support services
  - through better use of faculty time
- Increase long term revenue streams by promoting
  - technology development and transfer
  - grant activity and productivity
- Preserve identity and integrity of established programs to maintain philanthropy and ties to
  alumni and employers

Success in achieving these goals can be assessed by the following metrics and indicators that are
intended to be correlated with the 7 program quality measures outlined by the SPBAC and tied to the UA
Strategic Plan 2009-2013. (http://provost.arizona.edu/files/RecGuide.pdf)

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1 MNE SfAZ (20M), EFRI (2M), Wind Tunnel (2M), ECE optimization studies (2M)
World Class indicators/metrics
  o Percentage of ENGR that are highly ranked programs (e.g., in top 20 or 25)
  o Research dollars per active researcher (relative to peers)
  o Demand for graduates relative to market and rankings of graduates relative to other institutions
    (as rated by large engineering firms and recruiting)
  o Citation rates per active researcher (relative to peers)

Metrics (in terms of university expected cost/benefit)
  o Short term cost reductions by consolidation (via DH increments or staff)
  o Long-term cost reduction/revenue increase
    ▪ research productivity and expenditures
    ▪ better allocation of faculty time between teaching/research
  o Patents secured
  o Increase in philanthropy
  o Teaching loads as measured by SCH per faculty discounting for TA/adjunct taught courses

Numerous strategies can be employed to achieve these goals. All strategies should address means to:
  o Develop critical mass of researchers in focus fields
  o Promote cross-disciplinary projects
  o Provide development time to active researchers
  o Promote entrepreneurship and reward technology development leading to marketable products

Clearly, since goals are long-term these metrics cannot be assessed at present. However, all strategies should be examined on how they anticipate that the strategies will affect the metrics noted above and complement the UA Strategic Plan.

Proposed New Structure

Unit Reorganization

1. The College of Engineering merges with the College of Optical Sciences and this creates a College of Engineering and Optical Sciences. We have already done this in our US News data reporting.
2. The College of Engineering and Optical Sciences will have 5 departments (names to be determined) with the following component groups:
   a. Optical Sciences and Engineering (OSE)
   b. Aerospace and Mechanical Engineering (AME) with the Biomedical Engineering (BME) Program
   c. Electrical and Computing Eng. (ECE) with Systems and Industrial Eng. (SIE)
   d. Chemical and Environmental Eng (CHEE) with Material Science Eng. (MSE)
   e. Civil Eng. and Eng. Mechanics (CEEM), Mining Engineering (MNE), and Hydrology and Water Resources (HWR) plus Environmental Engineering faculty

This structure will retain degree offerings as presently defined. Additional advising structures will be required. Further, it will provide critical mass in complementary areas. This will likely result in three top 20 nationally ranked programs (ECE, OSE, and CivMinHyd- CMH) and retain the individual program identities.

Other combinations are possible (for example, MSE with AME, HWR with CHEE), but the basic premise is fewer larger departments with critical mass that can achieve recognizable status. It is possible that we try to combine with CS or MIS in ECE/SIE. However, Eller is not interested in losing a department and CS students and research dollars do not help the national ranking of our engineering program. Other possible additions to CMH are a portion of the planning faculty. The BME program may be more appropriate as a stand-alone department or joint program.
3. The College will run only accredited undergraduate degree programs. This will result in the elimination of the BA program, Engineering Math, Engineering Physics, and the undergraduate Hydrology program. Today, that would affect 80 students. Although these programs have low cost, this would focus our program in a relatively painless way. Further, we propose that that SE and IE be combined into a single degree program; much in the way that ECE is combining Electrical Engr. and Computer Engr. The Engineering management program can be run out of the College or the ECE/SIE department.

4. The College of Engineering and Optical Sciences will work toward reducing largely duplicate course offerings in areas such as probability and statistics, thermodynamics, fluid mechanics, strength of materials, numerical methods, advanced math and linear algebra.

5. The College of Engineering and Optical Sciences will work toward a common laboratory space to better coordinate duplicate equipment and services.

6. Additional faculty resources should be distributed based on research funding potential as well as balancing faculty workload. On the teaching end, there is a clear imbalance where AME has a large load. If AME stands alone in the new College, then this imbalance will remain.

Financial reorganization

While items 1-6 form the basis of this reorganization, the following financial elements are a sub-concept of this proposal and important but not necessary to the success of items 1-6.

7. The College of Engineering and Optical Sciences will get the Research Overhead Return deal that is currently in place in the College of Optical Sciences.

8. The faculty salary model used in the College of Optical Sciences should be the model used in the merged college. This is the way to generate funding for more people. On average, this is a structure where 70% of faculty salary is paid from state funds and 30% is paid from soft funds. To move toward this goal, we propose to increase all faculty salaries in the college by 25% immediately; however we will only fund 75% of this new total amount. This results in a net savings of 6.25% or approximately $875,000 per year. For some faculty, an approach of just cutting salary by 6.25% is better, but the key is to realize salary recovery from everyone. We would like to realize at least 50% of the savings to support faculty growth in the College. We propose to reduce the state support from 75% to 70% over the next 2 years. A structure for new faculty must be worked out (example - pay 100% first 3 years, and then down to 90%, 80%, 70%) to keep us competitive in the market. Note that the size of the raise and the initial funding percentage are decisions to be formalized. The 25% and 75% funding are only examples. I do think that we have to give people raises.

9. The faculty workload for anyone on the 70% state model is 4 courses per year plus research writing. Course can be “bought out” by transferring either direct or indirect dollars to the respective department. If a faculty member wanted to teach more, then a higher % of salary can be state funded. The target for 100% state funding should be 6 courses per year with research writing. The target for 100% state funded with no research writing (a 100% teacher) should be 8 courses/sections per year. These latter two categories are only possible if sufficient state funds/temp funds exist at the department level. The specific numbers are decisions to be made, as one could see, that the standard load might be different than 4 courses per year.

10. Work to improve the College/University policies that impede commercialization of IP.

Benefits

We distinguish benefits for the two concepts – Unit Reorganization and Financial Reorganization relative to achieving the defined goals.

Unit Reorganization Benefits

- **Achieve world class status** - The strength of this proposal is that it focuses our resources in the traditional areas that garner national attention. We create critical mass and improve synergies
between parallel groups. For example, system engineering includes several control and dynamic system faculty that will complement ECE faculty. Similarly, returning Environmental Eng. to its traditional home in civil engineering will enhance ongoing collaborations between groups and elevate the status of the overall department. The MNE program will complement and expand the geotechnical group in CE. HWR, a traditional CE sub-discipline, will also greatly benefit the reputation of CE in rankings.

- **Preserve identity and integrity of established programs to maintain philanthropy and ties to alumni and employers** - In addition to providing a more coherent College structure and world-class departments, each subgroup will maintain separate degrees programs. This approach will maintain their identity and potential ranking as separate programs (MNE, HWR, and Env. Engr.). Philanthropy and alumni ties are critical to the economic viability of these programs and a significant portion of the present unit resources. Furthermore, although this structure is not as transparent as individual departments, it will provide recognition and identity of the units.

- **Improve short term efficiencies**
  - Department Staff Savings – by combining some of the functions at the department level, we can either save staff dollars or finally have sufficient staff to run the operation. Combined units will have minor reductions in needs for support services. ENGR has had significant reductions in the past and our staffing is likely near optimal for the current faculty numbers. A separate staff proposal includes concepts for these types of reductions.
  - Dean Office Savings – currently there are 2 offices (one in ENGR and one in OP SCI) and now there would be one. Both colleges have 2 associate deans and these could be reduced in the joint effort. Typical savings here might be $20,000 - $30,000 per dean in supplemental compensation for administration.
  - Department Head Savings – similar to dean savings, the salary supplement for 4 or 5 department heads could be saved.
  - IT support – We have IT infrastructure that has sufficient capacity for the entire college in multiple locations. Even if staff is kept the same, we will save significantly on soft dollar costs for hardware and system management. By using more UITS services, we can probably save more through better use of faculty time.
  - The savings from combining courses is minimal but adds to the overall idea of streamlining and getting back to basics. With larger faculty number, re-deployment of faculty to gain efficiencies in terms of modifying teaching loads is possible and leads to increased research productivity.

- **Increase long term revenue streams by promoting**
  - technology development and transfer
  - grant activity and productivity

Synergies created by re-organization and noted faculty re-directions will provide enhanced opportunities for increased research activity. Current interdisciplinary work between new departments and colleges will not be affected, but new reporting mechanisms will be necessary at the university level. Further, a new emphasis will be placed within the College on technology transfer. This revenue stream has been largely untapped and ENGR will be a prime technology developer. While taking steps to improve technology transfer and licensing revenue cannot solve the University’s current financial problem, now is the time with the reorganization to make a commitment to technology transfer and entrepreneurial activity that can significantly improve the University in the long term.
Financial Reorganization Benefits

- The move towards soft money will make our faculty more of a “partner” in the research enterprise. We realize that some people will stop supporting graduate students and concentrate on salary recovery, but this is a necessary risk. Financially, there are potentially significant savings with respect to faculty salaries. Using a 70-30 salary model, these freed state dollars can be reinvested in the College to get more faculty members or support personnel investments that lead to additional opportunities.

- Improving the commercialization of IP enable the growth of a major revenue stream. Table 2 below indicates that universities with our size research program generate substantially more revenue from commercialization. The University of Minnesota and the UA have similar research expenditures; Minnesota has an annual return of $56 million and the UA $ 1.7 million. ASU with one-fourth the research expenditures as the UA has twice the annual licensing revenue.

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Note: ASU Research Expenditures are $131,814,265 and their Licensing Agreement Revenues are $3,349,612

* This number has remained nearly constant for 6 years.