White Paper Proposal for UA Transformation

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School of Sustainability for Energy, Water, and Materials

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Units and programs reorganized/consolidated:

- Chemical and Environmental Engineering (ChEE)
- Materials Science and Engineering (MSE)
- Hydrology and Water Resources (HWR)
- Atmospheric Sciences (ATMO)
- Soil, Water and Environmental Science (SWES)
- Mining and Geological Engineering (MGE)
- Civil Engineering and Engineering Mechanics (CEEM)
- Systems and Industrial Engineering (SIE)
- Arizona State Museum (ASM)
Rationale:

Today, the world has discovered that sustainability has become essential to both economic prosperity and environmental preservation. Energy and water are especially in critical supply, and the threat of global climate change dictates that innovative approaches to solutions in a very short time. These solutions are needed for resource production, for manufacturing processes, and for infrastructure renewal. The solutions to these challenges will be complex and will require a systems-level approach: for example, water and energy supplies are increasingly interdependent, and developing an understanding of the interactions inherent in this “water-energy nexus” are a key to achieving sustainability for the foreseeable future. Manufacturing and mining technologies that consume much less water and energy must also be developed, and they should also require smaller capital investment and be more carefully coordinated with population centers in order to be competitive in the world economy. The understanding developed by engineers and environmental scientists about the interdependencies between eco-systems present in the natural environment and built infrastructures must also be greatly expanded. The road-to-sustainability and the mitigation of climate change require full attention to the generation, conservation, and efficient use of water and energy, as well as most other natural resources.

The University of Arizona has an important opportunity to create new interdisciplinary education and research efforts around the critical challenge of sustainability. The 2009-2013 Strategic Plan states: “The University of Arizona’s strengths in water, environmental science, energy and sustainable engineering practices must be mobilized to meet the challenges of growth.” In September 2007, President Shelton affirmed the University’s commitment to sustainability by establishing the Campus Sustainability Committee (chaired by Prof. Schrader with several members of this team participating in working group committees) which now coordinates research, curriculum, operations, planning, outreach, and building design across the entire campus [www.sustainability.arizona.edu]. The University of Arizona has clearly been a leader in several aspects of sustainability for more than a decade; it has also been recently recognized by the National Wildlife Federation as one of the top six universities with a comprehensive approach to sustainable campus operations.

Sustainable designs and practices can be achieved only with a greatly expanded “toolbox” with novel materials and process designs, with resilient systems and infrastructures, and with a better understanding of the fundamental physico-chemical processes required for sustainable practices. However, university structures for education and research have been defined largely by historic academic boundaries. In most engineering and science colleges, these boundaries are set by undergraduate degrees such as chemical engineering, physics, chemistry, etc. which foster “silo-thinking” within disciplines. In engineering colleges, the status quo is also fixed even more rigidly by accreditation procedures. During this century, however, the boundaries between traditional programs will continue to be blurred by the increasing complexity of the problems that need to be solved jointly by engineers and scientists. Traditional approaches that are confined to narrow disciplinary avenues will fall far short of appropriately preparing students for modern employment and research where communication, common goals, and shared resources are essential.

Structure:

Disciplines from across the university will be united within a School of Sustainability that is devoted to tackling the comprehensive problems associated with energy, water, and materials. The faculty will work to develop technology and integrated systems across different
processing or manufacturing fields, as well as to train the next generation of engineers and scientists to apply sustainable principles and practices. Efforts within this new school will focus on developing research programs and educating graduate students; training of advanced (third through fifth year) undergraduate students will also be an important feature of a proposed new “practice school”. Although the structure of the school will incorporate organizational principles that emphasize the graduate education functions of the university, professional undergraduate disciplines will be preserved. Therefore, this proposal does not seek to eliminate undergraduate degrees, but rather changes how the lines are drawn and how connections are achieved. By emphasizing graduate research, the organizational structure will remove the traditional boundaries between disciplines that exist primarily because of undergraduate educational objectives.

The School of Sustainability will develop focal areas and priorities that can be pursued by interdisciplinary PhD research teams that build crosscutting initiatives in new areas such as solar energy production and storage; energy-efficient desalination facilities for industries and municipalities; and sustainable “high tech” manufacturing communities which inherently use less water or energy and which also recycle materials. These research efforts would also reduce the risk associated with future threats or uncertainties for current supply chains for strategic resources. The focus groups would constitute a critical mass of capabilities and resources to make a significant impact within a relatively short (3-5 year) timeframe. The configuration and membership within the focus groups will be determined on the basis of the faculty member’s research capabilities and creativity/adaptability so that responses to new opportunities or advances may be rapid and incisive. The initiatives can be built upon interdisciplinary institutes and centers already established at the University of Arizona: the Arizona Research Institute for Solar Energy [AzRISE], the Center for Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA), the Campus Sustainability Committee program, the Engineering Research Center for Environmentally Benign Semiconductor Manufacturing, and Biosphere 2. The large initiatives will include individual faculty from other departments and colleges, such as Physics, Chemistry, Geosciences, Optical Sciences, Architecture (such as emerging materials technologies), Electrical Engineering, Mechanical Engineering, Law, Medicine, and Business (Eller Business School/McGuire Center for Entrepreneurship).

Partnerships will be established with industry and with national laboratories. For example, Sandia National Laboratory has already promised to participate in the School through joint (salary-shared) appointments of university faculty and Sandia professional staff in order to encourage collaborative research. Real-world, practical experience will be brought to all aspects of the educational program. The School of Sustainability will stimulate the necessary critical investment in engineering and scientific infrastructure at the University of Arizona which would enable partnerships with industry leading to economic expansion and renewed growth. A new building designed to be a “Laboratory for Sustainability” will embody the school’s concepts (funded by private donations and bond issue). This facility will emphasize energy conservation, production of solar energy, water recycling and reclamation, green construction materials, and integrated greenhouse/living environments. By the creating of this 21st century laboratory, we will recognize that Tucson has actually been a laboratory for human civilization for over 4,000 years, and the involvement of the Arizona State Museum will connect the school to the deeper culture issues of our arid-lands civilization.

The teaching aspects of the School of Sustainability envisions the development of a division for undergraduate education that has the primary responsibility of teaching the common engineering courses which are generally taught to all students within the first two years, but also including laboratories and design. This general engineering program will also be responsible for
the accreditation activities. Common senior-level “capstone” design projects would be created which clearly define and apply technical and environmental performance criteria within a practical project setting. The third and fourth year (and fifth year) teaching responsibilities will primarily fall within the graduate education branch of the School. Here, the graduate efforts will provide a wealth of interdisciplinary topics for students along with integrated research options. This structure motivates and enables the School to adopt and promote interdisciplinary combined BS/MS programs, such as through concepts similar to a practice school. The School of Sustainability, however, will continue to support accredited undergraduate degrees from its component disciplines.

**Raising the University’s Reputation:**

The combination of sustainability and technology is critical to the growth of the industrial base in Arizona because of the environmental sensitivity of our State and particularly because of the scarcity of water. Currently, there are other efforts that focus on either environmental preservation or sustainable technology, but the combination has not been addressed, giving us a competitive advantage in this area. The participation the above-named centers with their world-renowned activities and reputations will immediately make this organization unit among the top units in the country. The reorganization will also promote growth of these successful activities and will give students from a wider range of backgrounds access to their activities. Graduates will have better training and educational experiences. The School’s reputation will grow with the success of its centers and institutes, as well as the joint achievements of its faculty and the reputation of its graduates. The unique focus and objectives of the proposed School have evolved from the participation of research programs in engineering and science. Support of the concept of a School for Sustainability for Energy, Water and materials will be definitive indication of commitment by the University of Arizona to develop other large interdisciplinary research centers.

**Consultation Process:**

This proposal was formulated in consultation with faculty, students, and staff in the primary departments. In addition, general meetings with the faculty of the affected departments were held; multiple discussions were conducted with faculty members both in open and small-group settings. Discussions were held with graduate and undergraduate students from all departments.
Projected Cost Savings:

Judicious selection of programs for the newly formed School can make them globally superior and will reduce costs through better unification of business and financial offices. Clerical activities will be centralized such as shipping and receiving, document preparation (photocopying), record maintenance, and coordinated IT investment and access. Savings will be realized by combining some courses in the programs of the core disciplines. Examples include solution or process thermodynamics, process control, undergraduate laboratories, and capstone design. Also undergraduate and computer laboratories will be combined across disciplines and with other units. Savings will also accrue from the elimination of duplication in the general engineering education branch and from the increased productivity of the faculty in that program. Because research-active faculty will have greater success in attracting funds, the University may initiate a program to increase their salaries through soft money sources with methods that could return state dollars to the units. Common analytical facilities will be developed as part of the School’s long-term goals: savings in acquisition, maintenance, and operation are likely to ensue. New hires to fill empty lines may be combined across disciplines within the School to enable increased capabilities with fewer faculty members.

Faculty will work together in interdisciplinary research groups formed for the purpose of winning large research grants, increasing the level of external funding. Support for these groups will be more efficient and better focused to their needs. With greater success in attracting funds and resources, a program will be initiated to increase salaries through soft money sources returning State dollars to the School for investment in new initiatives.