A VISION FOR A SCHOOL of

DECISION SCIENCES and ENGINEERING SYSTEMS

IN THE COLLEGE OF ENGINEERING AND APPLIED SCIENCES

A White Paper Developed for Discussion of University Transformations

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“If you want to travel from New York to San Francisco, you would hire a Civil Engineer to build an airport at each end; an Aerospace and Mechanical Engineer to build an airplane; a Material Scientist to develop the composite aircraft materials; a Mining Engineer to provide the core metals; and Electrical Engineer to build the control systems; a Computer Engineer to build the software systems to guide the plane; and an Industrial Engineer to tell you how many seats to put on the plane, how much to charge for each ticket, how to schedule the flight and operations crews, to plan the best flight route given air traffic considerations, and a Systems Engineering to coordinate the other disciplines, to write the requirements to define what the system is supposed to do, to define the overall system architecture, and to design the acceptance tests to ensure that the system will function as desired -- the modern engineering profession depends equally on all of these disciplines to build efficient and effective systems” -- SIE Faculty, U of AZ, 2008

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This proposal has been developed as a cooperative effort between faculty, graduate students, and staff from the Systems and Industrial Engineering Department. We have shared these ideas and thoughts with College of Engineering leadership, faculty, graduate students, and staff from other departments and colleges as possible. It is intended as a vehicle for discussion and development of transformation - as is required for the success of The University of Arizona.

The faculty of the Systems and Industrial Engineering Department perform research, teach curricula, and serve professional communities in a broad range of disciplines including Systems Engineering, Operations Research, Industrial Engineering, Quality and Reliability, Statistics, Manufacturing, Logistics, Transportation, and Homeland Security. These areas, both methodologies and applications, span many fields of engineering, mathematics, and science.

As the discussions at the University of Arizona progress towards a Transformation to a more effective, “world-class” university it is important to consider the role of our profession within the context of new schools, colleges, and departments that will be considered and may emerge through this innovative and creative process.

The 2002 National Academy Report "The Engineer of 2020" (which the College of Engineering’s former Dean, Professor Ernie Smerdon, participated as a panel member) states that Systems Engineering
important in the future. The trend has been the emergence of micro-disciplines (microelectronics, photonics, biomechanics, ..., nano, etc) and there is a great need for engineers that can manage large complex interactions among components to build useful systems. It also states that engineers need skills in understanding the global economy (e.g. ideas from Engineering Management) and customer driven manufacturing (ideas from manufacturing and Industrial Engineering). These ideas are core parts of an overall engineering discipline we call Decision Sciences and Engineering Systems.

This vision of engineering is consistent with the principles and practices that span several departments within the College of Engineering as well as in other Colleges. We serve the College of Engineering and the University of Arizona by preparing students as professionals in a broad range of fields. Using the language of the National Academies Report (see Figure above) our current Systems Engineering Program provides “Structured Methodologies to Integrate Components & Technologies in Large Complex, Networked Systems” through our tradition of systems engineering and development of tools and methodologies to support integrated use of models and systems to control and optimize system operations and performance. Our Industrial Engineering Program provides “Customization: Buyer-centric Manufacturing - New Manufacturing and Production Methods, Supply Chain & Logistics” through our focus on applications of Operations Research to the design and operation of manufacturing and service systems. Our Engineering Management program provides the critical link the business and management of technologies, or “Understand Business & Technology; Public Policy & Administration; Legal Issues of Technology Globalization”. Many other faculty in departments and colleges around campus share in these important activities including - Electrical and Computer Engineering (control, information, queueing networks, simulation), Aerospace and Mechanical Engineering (reliability, design optimization, control, games), Applied Mathematics (discrete, dynamic, stochastic systems), Management Information Systems (information and decision support systems), Civil engineering (transportation, simulation), Hydrology (decision under uncertainty, multi-objective optimization), Mining (simulation; mining operations research, automation), and Statistics (via the current GIDP).

At the core of activities are the foundations in Probability and Statistics, Operations Research (including Optimization, Stochastic Process, Risk, Reliability, and Quality) and Dynamic Systems (mechanical, electrical, biological, economic, etc.). These foundations are taught in various programs throughout campus. These foundational areas provide tools, methodologies, and support for many disciplines – both Engineering and Science – that are required across disciplines, colleges, and professions.

There is a surge in the number of Systems Engineering (or called Engineering Systems) programs across the county. MIT, USC, The Stevens Institute of Technology, Missouri Science and Technology, and Cornell are all growing programs in this area that the University of Arizona has almost 50 years of tradition.
A significant contribution of engineers with an understanding of the business and technology application of research is the transfer of technology from research to industry. Engineers that have a broad understanding of the technologies, as well as the business of technology, best support this critical, revenue-generating process. The University of Arizona must commit to the development of the knowledge required to succeed in technology transfer as well as to the practice of succeeding in technology transfer. The Engineering Management program directly addresses this requirement for success and provides a foundation for sustained and continued revenue growth for the university.

We propose that the College of Engineering should reorganize the college into the following six areas (with the details of the School of Decision Sciences and Engineering Systems included)*:

- Optical sciences
- Applied biology and bio-engineering
- Electrical and computer engineering (including hardware and software)
- Materials, Mechanical, and Aerospace (including mechanics, materials, structures)
- Sustainability, Environment Science and Engineering (including energy, water, and the environment)
- Decision Sciences and Engineering Systems
  - SIE (system design process; manufacturing and production; operations research; optimization; simulation; probability and statistics)
  - Engineering management (as it is plus financial engineering)
  - Applied mathematics (that relate discrete, dynamic, stochastic systems)
  - MIS (parts related to information and decision support systems)
  - Civil engineering (parts related to transportation and simulation)
  - AME (parts related to reliability, design optimization, control and games theory)
  - ECE (parts related to control systems, information, queueing networks, and simulation)
  - Hydrology (that related to decision under uncertainty and multi-objective optimization)
  - Mining (related to simulation; operations research, and automation)
  - Statistics (the GIDP program)

The departments that are listed in the School of Decision Sciences and Engineering Systems are not intended to be an aggregation of diverse faculty, but as a source of faculty with similar foundations for the new school that combines capabilities and disciplinary synergies.

A vision for Decision Sciences and Engineering Systems is consistent with a vision for integration of academic disciplines to better serve Arizona, the USA, and the World. The Engineers of 2020 will be leaders in our profession and the University of Arizona is well prepared, poised, and ready to serve to meet this need.

A Statement from the SIE Graduate Students

We support the proposed School of Decision Sciences and Engineering Systems, which could broaden research and course opportunities to us. Also, consolidating the existing departments into the proposed six schools would provide a great opportunity to reduce some redundant courses across the departments in the College of Engineering. While these new opportunities are exciting, we want to ensure that continuity, reputation, visibility of current academic degree programs and their legacies are maintained throughout the reorganization process and that the degree requirements we expected at the beginning of our studies remain. However, as faculty members work to refine curricula and optimize on synergies provided in this robust reorganization, we offer our help and energy as needed to assist in the reorganization process.

A Statement from the SIE Staff

* It is assumed that other efforts on campus will define the details of the other five (5) areas/schools.
We support the concept of a School of Decision Sciences and Engineering Systems as presented in this white paper. One concern is that students will continue to receive high quality and personal service and that our reputation will continue to attract excellent students. The rumors of the transformation process have already reached applicants in places as far away as China. We believe that the proposed model will enable current staff to continue to maintain strong relationships with our current and new students. We believe that there is a need to maintain staff and professional support at levels that will ensure retention of faculty and students at The University of Arizona. We recognize the need for changes in light of the current economic situation and appreciate that great care needs to be taken in making strategic changes in the transformation process.

Budget Implications

At this stage of the Transformation Process it is difficult to directly estimate the savings (or increase revenue) that might result from reorganization along the lines described in this proposal, but there are several opportunities for significant decreases in cost and increases in revenue that will directly translate into improved budgetary considerations. These include:

- Increased revenue from Technology Transfer (due to the development of excellence through knowledge and personnel).
- Increased sponsored research due to an organized collection of faculty working on synergistic problems that are recognized by NSF, DOD, DOE, DHS, and other significant research sponsors.
- Increased revenue from Distance Learning (to meet the need of the Engineering of 2020 - as realized and exemplified by programs such as at the Stevens Institute of Technology, USC, Missouri Science and Technology, MIT, etc.)
- Decreased cost due to elimination of courses currently duplicated across existing departments.
- Potential decreased cost due to carefully considered consolidation of support and administrative functions.