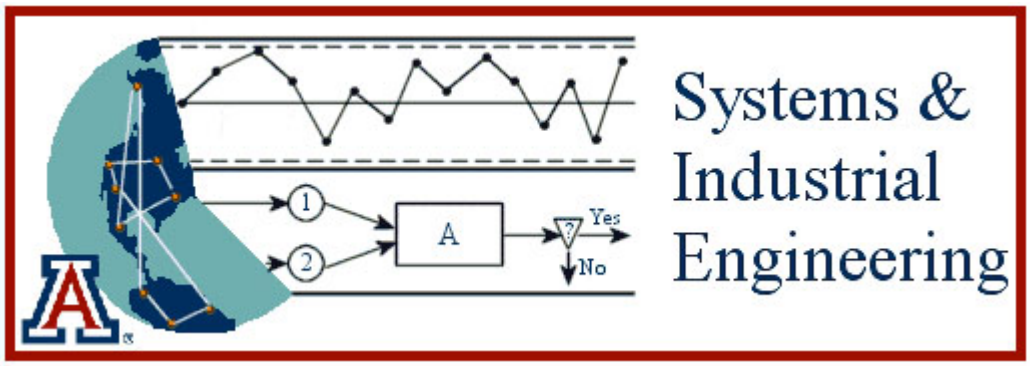

Graduate Student Handbook

2016 – 2017

(Revised 07/2016)

DEPARTMENT OF
SYSTEMS AND INDUSTRIAL ENGINEERING
UNIVERSITY OF ARIZONA

1. GENERAL INFORMATION

The University of Arizona is located in Tucson, Arizona, a picturesque community surrounded by mountains and home to almost one million residents. The Systems and Industrial Engineering (SIE) Department at the University of Arizona was established in 1961 as the nation's first department of systems engineering. Since then, the SIE Department has achieved international prestige for its contributions to the inter-disciplinary design of large-scale complex systems involving people, technology, and information. With the introduction of a modern industrial engineering curriculum in 1972 and a reliability and quality engineering degree in 1987, the department offers a truly diverse and successful graduate program. Career opportunities for graduates of the Systems and Industrial Engineering programs are outstanding. Over the years, graduates from these programs have found employment in the nation's leading corporations, research institutes, and universities.

The SIE Department offers opportunities for study leading to the Master of Science (MS), Master of Engineering (MEng), and the Doctor of Philosophy (PhD) degrees. For the MS degree, a student may specialize in Systems Engineering (SYE), Industrial Engineering (INE), or Engineering Management (EMG). At the doctoral level, the department offers a PhD in Systems and Industrial Engineering. The PhD degree requires a high level of achievement in scholarly and independent research culminating in a written dissertation. In addition, the department offers Professional Certificates in Systems Engineering and in Engineering Management.

This handbook informs graduate students of the requirements for completing various graduate degree programs within the SIE Department. You can visit the Graduate College website for current policies and info, http://grad.arizona.edu/new-and-current-students . This handbook is further intended to provide prospective applicants with information to enable them to assess the opportunities for graduate studies in this department and to assist students in preparing their programs of study.

1.1 Application Guidelines

For regular admissions, applicants should have a Bachelor's degree in engineering, mathematics, or physics. Students with Bachelor's degrees in other disciplines may also apply to the graduate program and receive regular admission after successfully completing required remedial coursework.

Application for admission is made by submitting an Application for Admission form to the Graduate College' Online Application. On that form, MS applicants should indicate Systems, Industrial, or Engineering Management in the major area. MEng students should indicate Engineering as the major, and PhD students should indicate Systems and Industrial Engineering as the major. Prospective students must submit academic transcripts, a letter of intent describing their reasons for wanting to join our graduate program, and three letters of reference. In addition, all PhD applicants must submit GRE scores while those MS applicants who seek for a departmental teaching or research assistantship must submit them. Online students are not eligible for assistantships. Those students who enter the MS program without GRE scores must submit them if they want to be considered for a departmental teaching or research assistantship afterwards. International students must also submit TOEFL scores.

Inquiries about the graduate programs in this department can be sent electronically or by regular post. Emails should be addressed to gradapp@sie.arizona.edu.

For more detailed information on applying to the Master's program, see section 2.1. For more information on applying to the Doctoral program, see section 4.1. Information is also on-line through the SIE Department and Graduate College web sites (see section 1.3).

1.2 Academic Advising

Upon arriving at the University of Arizona, students should contact the Department Head or the Chair of the Graduate Studies Committee to receive initial academic advising. At that time, students are assigned a tentative academic advisor according to their interests. PhD students and MS students who want to actively pursue research need to identify a research advisor. Students are encouraged to contact all faculty members in

their area of interest for this purpose and choose their research advisor with these interests in mind. Once a student and a faculty member agree to work together on research, the student informs the department's Student Academic Specialist and the tentative academic advisor of this change. In some cases, particularly when a student has special skills, the student may choose to accept a research assistantship from one professor while continuing to pursue a thesis or dissertation topic under the guidance of another advisor. In such cases, the student must make her/his intent clear to both faculty members and the Graduate Student Advisor. Online students should contact the Graduate Student Advisor, graduateadvisor@sie.arizona.edu

1.3 Other Resources

This handbook is available on-line at http://sie.engr.arizona.edu/graduates/files/grad_handbook_10-11.pdf. Other on-line resources include the following:

- University of Arizona
  http://www.arizona.edu/
- SIE Department
  http://www.sie.arizona.edu
- Graduate College
  http://grad.arizona.edu/
- Graduate Student Academic Services
  http://www.grad.arizona.edu
- Graduate College Forms
  https://grad.arizona.edu/gcforms/academic-services-forms
- Application
  https://apply.grad.arizona.edu/users/login
- UAccess Student
  http://UAccess.arizona.edu
- International Student Center
  https://global.arizona.edu/international-students

2. MASTER OF SCIENCE PROGRAM

This program is designed to prepare individuals for high-level professional work in systems, industrial, or reliability and quality engineering. Students must follow all procedures outlined in the handbook for Master's/Specialist Candidates published by the Graduate College. The handbook is available on-line as well as on paper from the Student Academic Specialist or the Graduate College (see section 1.3).

2.1 Undergraduate Preparation and Admission Requirements

To undertake graduate work in SIE, students are expected to have undergraduate training in mathematics, physics, computing, and mathematical modeling. Specifically, all incoming students are expected to meet the following fundamental requirements:

1. At least four semesters of mathematics, beginning with a two-semester sequence in calculus (e.g., Math 125a, 125b, 223, and 254 or SIE 270)
2. At least three semesters of calculus-based physics and general engineering science (e.g., Physics 141, and 241)
3. At least one semester of computing (e.g., an introductory course using a high-level language such as Java, C++, C#, Visual Basic, or C, with significant computational work)

Most undergraduate programs in science and engineering provide the required background. Students deficient in one or more of these areas may be admitted into the MS program on Provisional Status. Advancement to Regular Graduate Status will not be considered until all deficiencies have been completed (see section 2.2).

In addition to the fundamental requirements, all students who enter the MS program must also demonstrate satisfactory understanding of the following SIE course requirements:
SIE 305 Introduction to Probability and Statistics
and at least two of these three courses:
SIE 321 Probabilistic Models in Operations Research
SIE 340 Deterministic Models in Operations Research
SIE 350 Modeling and Analysis of Systems Dynamics

Where appropriate, graduate-level courses may be taken to remove SIE undergraduate course deficiencies.

Admission is based on evaluation of the applicant's letter of intent, undergraduate transcript, GRE scores (for students who seek for a departmental teaching or research assistantship), TOEFL score (for international students), letters of recommendation, and professional experience. Applicants are expected to have an undergraduate GPA of 3.00 on the last 60 units of course work, and GRE scores of 500 verbal (or 575 TOEFL), 700 quantitative, and 650/4.5 analytical.

2.2 Graduate Status

2.2.1 Regular Graduate Status

Students with adequate undergraduate preparation (see section 2.1) who meet the minimum admissions requirements are normally admitted with Regular Graduate Status. All graduate students must be granted Regular Status before the semester in which they plan to graduate. Without Regular Status, a student cannot receive an advanced degree from the SIE Department.

2.2.2 Non-Degree Status

Students holding a Bachelor's degree, or its equivalent, from a college or university that grants degrees recognized by the University of Arizona may attend graduate-level courses without being admitted to a graduate degree program. Such students may enroll in graduate-level course work as their qualifications and performance permit. However, no more than 12 units earned while in this status may later be applied toward an advanced degree awarded by the university.

Those students who are on Non-degree Status and who later decide to pursue a graduate degree must submit a Graduate Degree Program Application for Admission and the $75 admission fee to the Graduate College, as well as the additional documentation required by the SIE Department.

2.3 Degree Requirements

Some of the requirements for an MS degree may be classified as general requirements, common to all programs in the SIE Department. Each area of specialization (ie., SYE, INE, and EMG) has specific requirements. All requirements and standards are the same for online and main campus majors:

1. Students must earn at least 30 units of graduate credit (courses numbered 5xx, 6xx, 9xx). Credit for SIE 695A, SIE 900, SIE 920, and SIE 930 may not be counted toward the MS degree. No course may be counted toward the requirements for more than two degrees (earned at UA or elsewhere). For example, an SIE 5xx course can be counted toward the MS in SYE and PhD in SIE; but it cannot be counted toward a third degree (e.g. MS in another program).
2. The majority of all course work must be taken within the SIE Department. Per your faculty advisor's approval, 2 courses may be taken outside of SIE. At most, 3 units of SIE 599 (Independent Study) may be applied toward the MS degree, subject to prior approval by the Graduate Studies Committee. The committee considers such factors as there being no course in the university that would serve the same purpose, as well as the expectation that a tangible product (such as a final report) will be available for evaluation by the committee. Students must complete the independent study course form and submit to the SIE Graduate Studies Committee prior to registering for SIE 599. Additionally the topic of study must regard an area of academic study and should not be directly related to the student's research topic.
3. Each student enrolled in an MS degree program is expected to gain in-depth knowledge within a particular area of study and complementary knowledge from a related area. To meet this expectation, the student's Plan of Study must contain a primary and a secondary area of concentration, each consisting of courses that are related to a common theme. The primary and secondary areas must include at least 9 units and at least 6 units, respectively, of SIE graduate-level courses. Up to 3 units of thesis or project work may be used to satisfy the concentration requirements. In general, SIE courses whose three-digit course numbers share a common middle digit are related to a common theme. However, an area of concentration need not satisfy this general rule to be approved by the Graduate Studies Committee. In cases where the primary and secondary areas of concentration might not be readily apparent, the student can facilitate the Graduate Studies Committee's review of the Plan of Study by providing a brief statement explaining the nature of the intended areas of concentration.

4. All MS students must choose one of the options listed in section 2.4. Students wishing to pursue the Doctoral degree are encouraged to choose the thesis or exam option.

The University of Arizona requires that all requirements for an MS degree must be completed within six years.

Specific requirements for the respective degrees are as follows:

Systems Engineering (SYE) majors must include SIE 550, 554A, and either 520 or 530 in their Plan of Study.
Industrial Engineering (INE) majors must include SIE 530 and either SIE 540 or 545 in their Plan of Study. INE majors must also complete one course from the SIE 56x or 58x series.
Engineering Management (EMG) majors must include SIE 567, SIE 515, SIE 522, SIE 557, and SIE 514 in their Plan of Study.

The remaining elective credits will be selected with the approval of an advisor and the Graduate Study Committee. If you have taken the undergraduate version of any courses for your BS degree, you can NOT take them again for credit on your MS degree.

Performance Requirements

a) An M.S. student shall submit his/her Plan of Study after 12 course hours of study taken while enrolled in the SIE department. Students failing to meet this requirement will be so notified, and will be required to complete the Plan of Study immediately. A student who has not completed his/her Plan of Study by this time may be dismissed from the program.
b) All M.S. students must have taken all core courses for their degree within their first four semesters of study.
c) An M.S. student shall submit a progress report to his/her advisor by the end of each academic year (last day of final exams in the Spring semester). A progress report form will be provided to students by the SIE Student Academic Specialist in April of each year for this purpose. Based on this input, the Graduate Studies Committee determines whether or not the student is making satisfactory academic progress. If the Graduate Studies Committee determines that the student is not making satisfactory progress, they state a set of requirements and corresponding deadlines for the student to achieve to remain in the program. Students not meeting these additional requirements may be recommended to the Department Head and Graduate College for dismissal from the program.

2.4 MS Degree Options

All MS degree candidates must pass a final examination before the degree is awarded. This requirement may be met by one of the following options:

a. Thesis Option – This option requires 24 units of regular course work, followed by 6 units of thesis research (SIE 910). The thesis option is designed for students who wish to work with a faculty member on a specific research topic. Thesis work is an excellent complement to course work and constitutes a valuable opportunity to develop an appreciation for research. Only outstanding students are permitted to select the thesis option.

The thesis is prepared under the guidance of the major professor and is reviewed by members of the examining committee prior to the oral presentation. The examining committee consists of the major professor and at least two other members of the faculty selected on the basis of the student's course work and field of interest. Other members of the department may also examine the thesis if they wish to do so.

A final, CD copy of each thesis must be provided to the Student Academic Specialist for placement in the departmental library.

b. Report Option – This option requires 27 units of regular course work, followed by 3 units of project work (SIE 909) leading to a written report. The project report option is designed for students who wish to work on an applied research project. The topic should have practical significance and require application of graduate-level course material. The report typically involves the application of new methodologies to an actual industrial problem. If the faculty advisor agrees and the project is suitable, up to three students may work together on the same project and produce a joint report.

The final examination for this option is the same as that required for the thesis option.

c. Course Work Option – This option requires 33 units of course work approved by the Graduate Studies Committee. At least 3 of these units must be taken at the 600-level in the SIE Department with a grade of A or B. The Graduate Studies Committee's evaluation of the student's performance in this 600-level course constitutes the final examination for the MS degree.

d. Examination Option – This option requires 30 units of course work, approved by the Graduate Studies Committee. The student must also pass the Doctoral Qualifying Exam.

2.5 Preparing the MS Plan of Study

The MS Plan of Study is the student's contract with the university concerning specific course requirements the student must satisfy to become eligible for the MS degree. As soon as they arrive on campus, students see the Department Head or the Chair of the Graduate Studies Committee for referral to a tentative advisor.

Students prepare a Plan of Study as soon as possible (no later than immediately after the completion of 12 hours of course work), obtain the advisor's signature, and return the form to the Student Academic Specialist. The Student Academic Specialist submits the form to the SIE Graduate Studies Committee for review and signatures. In reviewing the proposal, the committee considers the following:

- Does the program meet the course work requirements specified in section 2.3?
- Upon completion of the MS program, will the student have an acceptable background in the academic areas that the SIE Department considers to be of primary importance?

Areas of primary importance in the SIE Department are as follows:

Computer Software Engineering (SIE 531, 547, 57x, 631)
Engineering Statistics (SIE 53x)
Intelligent Control (SIE 570, 589)
Manufacturing Systems (58x, 68x)
Optimization (SIE 54x, 64x)
Probabilistic Models and Techniques (SIE 52x, 62x, except SIE 528)
Production Systems (SIE 56x, 66x)
Engineering Management (SIE 567, 557, 514, 515, 522)
Systems Theory (SIE 55x, 65x)

If the Plan of Study is approved at the department level, the Graduate Student Advisor sends it to the Graduate Student Academic Services Office before the required Graduate College deadlines. If it is not approved at the college level, the Plan of Study is returned to the student for changes and re-submission.

For information on specific courses that may not be included in the Plan of Study, students should consult with their advisor, the Graduate Student Advisor, or the Chair of the Graduate Studies Committee. Typically credit is not allowed for courses offered by other departments that duplicate SIE course offerings.

2.6 Typical Plans of Study for the MS Degree

In this section, three typical Plans of Study are provided:

- Plan A is intended for students with a Bachelor's degree in either Systems or Industrial Engineering or for other especially well-qualified students.
- Plan B is more slowly paced than Plan A and is intended for students with undergraduate degrees in engineering, mathematics, physics, or computer science. It assumes that the student has completed four semesters of calculus-level mathematics, two semesters of calculus-level physics, and computer programming.

PLAN A

MS in Systems Engineering

Fall	Spring
SIE 530*……..….3CH	SIE 550*…… .3CH
SIE 554A*..……...3CH	SIE 520 or SIE 6xx..…….... 3CH
SIE 5xx…….. .3CH	SIE 5xx…….. .3CH
SIE 5xx..…… .3CH	SIE 6xx.……3CH

Summer – Thesis Research (6CH) or Third semester of 9CH

MS in Industrial Engineering

Fall	Spring
SIE 530*…….3CH	SIE 540** or SIE 546……3CH
SIE 545** or SIE 544……3CH	SIE 56x or SIE 58x...……3CH
SIE 56x or SIE 58x..…… 3CH	SIE 5xx……..…… 3CH
SIE 5xx…….…… 3CH	SIE 6xx……..…… 3CH

Summer – Thesis Research (6CH) or Third semester of 9CH

MS in Engineering Management

Fall	Spring
SIE 567*..…….. .3CH	SIE 515*…… .3CH
SIE 522*..…….. .3CH	SIE 514*…… .3CH
SIE 557*…..…….. .3CH	SIE 5xx .....……..…… .3CH
SIE 5xx..…… .3CH	SIE 6xx.……3CH

Summer – Thesis Research (6CH) or Third semester of 9CH

*Required for the degree

**SIE 540 or SIE 545 is required for the MS in Industrial Engineering.

If you have taken the undergraduate version of any courses for your BS degree, you can NOT take them again for credit on your MS degree.

PLAN B

First Year

Fall	Spring

SIE 305……..……3CH	SIE 321 ……..…..……3CH
SIE 340…… 3CH	SIE 5xx ……3CH
SIE 5xx…….. 3CH	SIE 5xx ……3CH

Second Year

Please be aware that any 300 or 400 level courses CANNOT be used toward your degree, these would just be used to satisfy pre-requisites.

The second year of Plan B is similar to the first year of Plan A, with one exception: one of the 5xx courses in each semester may be replaced by thesis research. Hence, there is no summer or third semester required in this plan, as there is in Plan A.

3. MASTER OF ENGINEERING PROGRAM

The SIE Department participates in the Master of Engineering (MEng) degree program. In general, the MEng program is intended to serve the advanced educational needs of practicing engineers. Entrance requirements are similar to those of the MS program in SIE. Degree requirements include 30 units of study, with 3 units in engineering management/business and engineering math. At most, 6 of these 30 units may be in the form of a practice-oriented project. For more information, see

http://sie.engr.arizona.edu/master-engineering

4. PHD PROGRAM

The Doctoral program is designed for those individuals wishing to pursue research at an advanced level. Only those who have already demonstrated an ability to pursue independent and scholarly work should consider applying for this program.

Students must follow all procedures outlined in the handbook for Doctoral Candidates published by the Graduate College. The handbook is available on-line as well as on paper from the Student Academic Specialist and the Graduate College (see section 1.3).

4.1 Entrance Requirements

To be considered for admission to the Doctoral program, the candidate must have attained a Bachelor's in Systems Engineering, Industrial Engineering, or a related field. Other factors that will be considered are as follows:

- GPA in previous undergraduate work of at least 3.25 and graduate work of at least 3.50
- Letters of recommendation
- GRE scores of at least 153 (500) verbal, 159 (750) quantitative, and 700 / 5.0 analytical are expected. In addition, international students should submit TOEFL scores (at least 575) and TSE scores (at least 50). IELTS of 7 (No subject under 6).
- A match between faculty and student interests

4.2 Preparing the PhD Plan of Study

As soon as they arrive on campus, students see the Department Head or the Chair of the Graduate Studies Committee for referral to a tentative advisor. Before the student registers to take the DQE, he/she must file a Plan of Study. The plan is reviewed by the Graduate Studies Committee and forwarded to the Department Head, before being transmitted to the Graduate College by the Student Academic Specialist. Forms for this purpose are available on-line, from the Student Academic Specialist, or at the Graduate College. If the Plan of Study is approved at the department level, the Graduate Student Advisor sends it to the Graduate College Degree Check unit before the required Graduate College deadlines. If it is not approved at the college level, the form is returned to the student for changes and re-submission.

The Plan of Study is the student's contract with the university concerning specific course requirements that the student must satisfy before becoming eligible for the PhD degree. This includes a minimum of 54 units of course work, at least 36 of which must be SIE-type courses approved by the faculty advisor and the Graduate Studies Committee, plus at least 18 units of dissertation research. In addition, at least 21 units of the course work must be taken from the SIE Department. At most 3 units of independent investigation may also be included, provided the study covers a topic not available through normal courses, a tangible course project is submitted to the Graduate Studies Committee, and prior approval is obtained from the Graduate Studies Committee. SIE 900 Research units may not be counted toward a PhD Degree. **Students must take at least two and no more than three units of SIE 695a. This class will be graded Pass/Fail. To fulfill this requirement, the student must attend the department seminars during each semester enrolled. Prior to completing the seminar requirement, the student must also give a research presentation to the class.**

Subject to the approval of the Graduate Studies Committee, course work applied toward a Master's degree may be applied toward the PhD as well. Research credit that was applied toward a Master's degree cannot be applied toward the PhD degree.

4.3 Minor Area and Foreign Language Requirement

All PhD students must choose at least one minor subject area. The purpose of choosing a minor is to add breadth to their training. Minors are normally taken outside the department, but students may petition the Graduate Studies Committee for minor courses within the department. A split minor between two departments is also possible. All selections are subject to the approval of the Graduate Studies Committee. The minor in SIE requires 12 units, split minors require 6 units from each area. Each department sets their minor requirements, some less units and some more. You must acquire a Minor Advisor before taking your minor coursework

The SIE Department does not have a formal foreign language requirement.

4.4 Examinations and Performance Requirements

On the way to a PhD degree, students must pass three exams: the Doctoral Qualifying Exam, the comprehensive exam (both a written and an oral component), and the final oral defense exam. The purpose and format of these exams are given below, and further details are available in the handbook for Doctoral Candidates published by the Graduate College (see section 1.3).

4.4.1 Doctoral Qualifying Examination (DQE)

This examination is the principal comprehensive means whereby the faculty can assess the readiness of a student to undertake advanced graduate work beyond the Master of Science level. This exam encompasses the following fundamental areas:

- Probabilistic Models (covered in SIE 520)
- Engineering Statistics (covered in SIE 530)

- Optimization (covered in SIE 545)
- Linear Systems Theory (covered in SIE 550)

Equivalent courses at other institutions should provide sufficient background in these areas. In addition to the subject areas covered in these courses, the examination tests whether students have an integrated understanding of these topics and the ability to extend their knowledge.

Students must have a GPA of at least 3.50 in these courses (or their equivalent, as approved by the Graduate Studies Committee) to register for the DQE.

The exam is administered at the start of any semester in which at least four eligible students request it, but at least once a year (if requested). Each student is allowed two attempts to pass the DQE. It is emphasized that a pass or fail decision is based not only on performance in the DQE but also on grades in SIE courses and recommendations of the faculty. Anyone who fails the qualifier twice is required to withdraw from the PhD program. Further details are published prior to the exam, and this information may be obtained from the Student Academic Specialist.

Students are evaluated on their overall performance on all exam questions. The DQE area committees recommend whether a student receives the grade of "high pass," "pass," or "fail" in each DQE area, for approval by the faculty at the DQE evaluation meeting. Anyone who fails the entire DQE but receives a grade of "high pass" on specific sections of the exam does not need to retake those sections on the second attempt.

4.4.2 Comprehensive Examination

The purpose of the comprehensive examination is to determine whether the candidate has sufficient background for research in the field of the planned dissertation. Successful completion of the examination leads to formal admission to PhD candidacy.

The examination includes written portions covering the major and minor fields. Shortly after successful completion of the written portions, an oral examination is conducted by a committee appointed by the Dean of the Graduate College in consultation with the departments concerned.

The written portion of the exam covers material in the candidate's area of specialization and, when appropriate, on the student's projected dissertation subject. The oral portion of the exam is conducted by the committee members from the major and minor areas. It may include a presentation based on the proposed dissertation research. When the candidate asks a faculty member to be a member of her/his preliminary examination committee, a description of the proposed dissertation should be provided.

The oral comprehensive examination is held when sufficient course work has been completed, but it cannot be scheduled until the written portion has been successfully completed. The Graduate College does not record a student's failure on the written portion of the exam. However, failure of the oral examination constitutes a failure of the preliminary examination and is so recorded. Administration of the oral comprehensive examination is governed by the Graduate College, and students should refer to the guidelines for Doctoral Candidates for regulations pertaining to this exam. Procedures for scheduling this exam are also detailed in that handbook (see section 1.3).

A student who has passed the oral comprehensive examination is recommended to the Graduate College for acceptance as a PhD candidate.

4.4.3 Final Oral Defense

When the doctoral candidate has met the required standards of scholarship and has documented the research in a dissertation, the candidate publicly defends the dissertation and answers any general questions related to her/his study. The exact time and place of the final examination must be announced publicly at least two weeks in advance. The examination is conducted by a faculty committee appointed by the Dean of the Graduate College in consultation with the major and minor departments. The presentation portion of the

examination is open to the public. The Graduate College requires timely notice to schedule the final exam, and students should refer to the handbook for Doctoral Candidates for exact dates (see section 1.3).

Performance Requirements

a) Before signing up to take the Doctoral Qualifying Exam (DQE), a Ph.D. student must submit his/her Plan of Study. (The timeline for taking the DQE is established in point b below.)
b) Ph.D. students must take the DQE the first time that it is offered after he/she has completed two semesters of study in the Ph.D. program. A student failing to take the DQE by this time may be dismissed from the program.
c) A Ph.D. student retaking the DQE must do so the next time that it is offered.
d) A Ph.D. student must take the oral preliminary examination within 24 months of the *first attempt* at the DQE.
e) Each Ph.D. student must submit a progress report to his/her advisor by the end of each academic year (last day of final exams in the Spring semester). A progress report form will be provided to students by the SIE Student Academic Specialist in April of each year for this purpose. Based on this input, the Graduate Studies Committee (GSC) determines whether or not the student is making satisfactory academic progress. If the GSC determines that the student is not making satisfactory progress, they state a set of requirements and corresponding deadlines for the student to achieve to remain in the program. Students not meeting these additional requirements may be recommended to the Department Head and Graduate College for dismissal from the program.

4.5 Residence, Completion Time, and Dissertation Submission Requirements

To meet the minimum residence requirement, students must complete two regular semesters of full-time academic work in residence at the University of Arizona. In general, any semester during which a student is registered for at least 9 units of graduate course work or research is counted toward meeting the residence requirements. However, some special circumstances (such as an assistantship) may change the required number of units. More details are given in the Graduate Catalog (see section 1.3).

All requirements for the PhD degree, including the MS (if applicable), must be completed within a period of 5 years after passing the Comprehensive Exam, however all coursework must be within 10 years of your graduation date.

A final, hard-bound copy of the dissertation must be provided to the Student Academic Specialist for placement in the departmental library.

5. THESES AND DISSERTATIONS

The SIE faculty has approved the following policy on the inclusion of papers in MS theses and PhD dissertations. The SIE Department allows the inclusion of previously published and submitted work in the appendix of a graduate thesis or dissertation, with the following restrictions:
The student must be a highly contributing author on all papers.
Papers that have been submitted for publication to technical journals are appropriate for inclusion in the appendix (this includes accepted and published papers). The content becomes an integral part of the thesis/dissertation and becomes relevant for review and approval of the examining committee. The examining committee retains the responsibility for assessing the technical merit of the research and the original contribution of the candidate. The significance of the candidate's contribution should be assured by the first rule and by the committee's judgment as to the merit of the work and the candidate's performance in the oral defense.
The majority of the examining committee members must not be co-authors with the student on the papers included in the appendix.

A final, CD copy of each thesis and dissertation must be provided to the Graduate Academic Advisor for placement in the departmental library.

6. CERTIFICATE PROGRAMS

6.1 Systems Engineering

The SIE Department offers a Professional Graduate Certificate in Systems Engineering. This can be taken on campus as well as online. The program offers valuable resources for any engineer responsible for the oversight, creation, or operation of a complex system. It provides essential education for systems engineers, design engineers, lead engineers, total-life-cycle engineers, senior software systems engineers, and project managers seeking to increase their professional knowledge and advance their careers. Through this program, students learn how to ensure that a system satisfies its requirements throughout the entire system life cycle.

All course work for this certificate can be earned Online as well as on campus. Degree requirements include four courses (12 units of study), of which three are required and one is an elective:

Required courses	Elective (choose one)
SIE 550 (3 units)	SIE 530 (3 units)
SIE 554A (3 units)	SIE 564 (3 units)
SIE 531 (3 units)	SIE 540 (3 units)
	SIE 654 (3 units)

If you have taken the undergraduate version of any courses for your BS degree, you can NOT take them again for credit on your MS degree.

Prerequisites for this program are as follows:

- A bachelor's degree in mathematics, physics, or engineering
- Two years of professional experience beyond the undergraduate level

Students **must** apply to the certificate program before registering for classes. Once they are admitted to the program, other required UA admission forms and complete registration information are furnished. Details are available on www.sie.arizona.edu

6.2 Engineering Management

The SIE Department offers the Professional Certificate in Engineering Management (which can lead to an MS degree). The program is intended for technical professionals who desire the knowledge and skills to effectively manage resources in technology-based organizations. Students develop an understanding of decision making theory and methodology, financial modeling and analysis and project management strategies. They learn to utilize modern software packages to efficiently and effectively manage human and material resources. Through this program, students enhance their opportunities to advance in their careers. All course work for this certificate is available via on campus or online.

The courses are official UA on-campus classes, recorded on web. Degree requirements include four courses (12 units of study), of which three are required and one is an elective:

Required courses	Elective (choose one)
SIE 567 (3 units)	SIE 506 (3 units)
SIE 557 (3 units)	SIE 515 (3 units)

SIE 522 (3 units)

SIE 531 (3 units)
SIE 540 (3 units)
SIE 564 (3 units)

The elective credits MUST be selected with the approval of an advisor and the Graduate Study Committee. If you have taken the undergraduate version of any courses for your BS degree, you can NOT take them again for credit on your MS degree.

Students are required to have a minimum of a BS in math, physics, chemistry, or engineering. The required minimum GPA is 3.0. One university-level introductory course in probability and statistics is recommended. SIE 500 provides a review of this and related material.

Students **must** apply to the certificate program before registering for classes. Once they are admitted to the program, other required UA admission forms and complete registration information are furnished. Details are available on our website, www.sie.arizona.edu.

7. MINOR IN SIE

Graduate students in a PhD program in any department of the university may choose a minor in Systems and Industrial Engineering. Students intending to minor in SIE should contact the Chair of the SIE Graduate Studies Committee at the earliest possible date. Courses taken to satisfy the requirements for a PhD minor in SIE are subject to the approval of the SIE Graduate Studies Committee.

The PhD minor in SIE consists of 12 units of regular SIE course work. A minor that is split between SIE and another department requires 6 units of regular SIE course work. **Students are required to maintain a 3.0 or higher in the SIE course work.** In consultation with the major advisor, the student forms a "minor" committee consisting of one SIE faculty member. These individuals assist the student and the major advisor in developing and coordinating the student's minor program of study consistent with her/his educational and career goals. The format of the written portion of the preliminary examination is at the discretion of the minor advisor. Participation on the oral portion of the preliminary examination and the final defense is at the discretion of the minor advisor.

8. FINANCIAL ASSISTANCE

8.1 Graduate Teaching and Research Assistantships

Financial assistance is available from the SIE Department in limited amounts, in the form of Graduate Teaching Assistantships (GTAs) and Graduate Research Assistantships (GRAs). Online students are NOT eligible for Graduate Teaching or Research Assistantships.

GTAs are allocated on a competitive basis, with priority given to entering students who exhibit outstanding potential and to continuing students who are making satisfactory progress toward their advanced degree objectives. Factors that the faculty consider as guidelines for satisfactory progress include maintaining an adequate GPA, the prompt and successful completion of the DQE, and passing the Preliminary Examination within two semesters of passing the DQE. GTAs are normally provided for a maximum of three semesters for a student in an MS degree program, or for a total of six semesters for a student pursuing a PhD. In accordance with university policy, students from countries in which English is not the primary language of instruction are required to pass the Test of Spoken English (TSE) with a score of at least 50 in order to receive a GTA.

In addition to the GTAs, a limited number of Graduate Research Assistantships (GRAs) are available for students who are exceptionally well-prepared to aid faculty research activities. Funding decisions on GRAs rest

directly with those faculty members who have grant money available. Interested students should discuss the availability and requirements for GRA funding with the appropriate faculty members.

Although graduate assistantships are reserved for the most qualified students and for the purpose of providing financial support to meet specified needs, they are not a service-free fellowship or scholarship. The assistantship is contingent on the student employee meeting certain responsibilities in order to draw pay from the University of Arizona**. In addition, graduate students in the College of Engineering who are supported through a GTA that is less than half-time or a GRA are expected to enroll in at least 12 units each semester. GTAs who have half-time appointments must enroll in at least 9 units each semester. All GRA's must enroll in at least 12 units each semester.** In addition to the stipend, all GRAs and GTAs automatically receive out-of-state tuition waivers, if applicable.

Because the Graduate College has no way of checking on the performance of a graduate assistant's duties, the SIE Department reports any unsatisfactory academic performance to the Graduate College. The department also reports to the Graduate College any situation in which a graduate assistant leaves the campus, stops attending classes, or fails in any way to perform assigned duties. This does not apply, of course, to any case in which the graduate assistant misses a few days of service because of illness or other justifiable cause, if satisfactory arrangements have been made within the department to ensure the completion of assigned duties.

8.2 Graduate Registration and Tuition Scholarships

Each semester the SIE Department receives a limited number of registration and tuition scholarships. These are not available to online students. The registration scholarship waives registration fees only (it does not include the Recreation Center Fee or the Financial Aid Trust Fee). To be eligible, a student must be enrolled in a graduate degree program for 12 or more graduate units, be in good academic standing, and have a GPA of 3.50. The tuition scholarship waives non-resident tuition only. To be eligible, a student must be a non-resident of Arizona, be enrolled in a graduate degree program for 12 or more graduate units, be in good academic standing, and have a GPA of 3.50.

Students may apply for the scholarships through the Student Academic Specialist. An application must be submitted every academic year; this scholarship does not roll over automatically. Preference is normally given to advanced PhD students.

8.3 Graduate Fellowships

A limited number of fellowships are available for excellent students. These awards may be limited to U.S. citizens or those who can substantiate an intent to reside in the United States.

9. RECENT PHD DISSERTATION TITLES

Massahi Khaleghi, Amirreza. *A Hardware-In-The-Loop Dynamic Data Driven Adaptive Multi-Scale Simulation (DDDAMS) System for Crowd Surveillance via Unmanned Vehicles*. 2015

Meng, Chao, *Simulation-based Decision Support for Grafted Seedling Supply Chain Performance Improvement. 2015*

Kim, Sojung. *Dynamic Learning and Human Interactions under the Extended Belief-Desire-Intention Framework for Transportation Systems. 2015*

Feng, Yiheng. *Intelligent Traffic Control in A Connected Vehicle Environment. 2015*

Golari, Mehdi. *Multistage Stochastic Programming and its Applications in Energy Systems Modeling and Optimization. 2015*

Wibben, Daniel. *Development, Analysis, and Testing of Robust Nonlinear Guidance Algorithms for Space Applications. 2015*

Nageshwaraniyergopalakrishnan,Sai Srinivas. *Simulation-Based Robust Revenue Maximization of Coal Mines Using Respor Methodology. 2014.*

Xu, Dong. *An Integrated Simulation, Learning and Game-theoretic Framework for Supply Chain Competition.* 2014

Zhang, Ye. *Advanced Data Analysis and Test Planning for Highly Reliable Products*. 2014.

Zhang, Dan. *Design of Statistically and Engery Efficient Accelerated Life Tests.* 2014.

Lan, Fujun. *Application of Optimization Techniques to Water Supply System Planning.* 2014

Xie, Wei. *Reliability and Service Logistics Management for a New Product.* 2013

Zhang, Weini. *Water Network Design and Management via Stochastic Programming.* 2013.

Zhao, Jiayun. *Simulation-Based Decision Support System for Integrated Analysis of High-Penetration PV and PHEV with Demand-Side Management.* 2013

Tan, Jingzi. *A Network Design Framework for Siting electric Vehicle Charging Stations in an Urban Network with Demand Uncertainty.* 2013

Xi, Hui. *A DDDAS-based Multi-Scale Framework for Pedestrian Behavior Modeling and Interactions with Drivers.* 2013

Wang, Zhenrui. *Statistical Analysis of Operational Data for Manufacturing System Performance Improvement.* 2013

Pierre-Louis, Peguy, *Algorithmic Developments in Monte Carlo Sampling-Based Methods for Stochastic Programming. 2012.*

Feng, Zhuo. *Behavioral Studies of Online Human Flesh Search Communities: A Social Network Analysis Approach. 2012.*

Zhang, Qingpeng, *The Analysis of Cyber Movement Organizations: A Case Study with Crowd-Powered Search. 2012*

Chen, Binyuan. *Finite Disjunctive Programming Methods for General Mixed Integer Linear Programs. 2011.*

Celik, Nurcin. *Integrated Decision Making for Planning & Control of Distributed Manufacturing Enterprises Using Dynamic-Data-Driven Adaptive Multi-Stage Simulations (DDDAMS).* 2010

Chan, ChiPak. *Large Scale Evacuation of Carless People During Short and Long-Notice Emergency.* 2010

He, Qing. *Robust-Intelligent Traffic Signal Control Within a Vehicle-to-Infrastructure and Vehicle-to-Vehicle Communication Environment.* 2010.

Lai, Guanpi. *A Framework for Application Specific Knowledge Engines.* 2010.

Lee, Seung Ho. *Integrated Human Behavior Modeling Under Extended Belief-Desire-Intention Framework.* 2009.

Keller, Brian. *Models and Methods for Multiple Resource Constrained Job Scheduling Under Uncertainty*. 2009

10. FACULTY MEMBERS 2015-16

MICHAEL J. ARNOLD, Professor of Practice

B.S. Chemical Engineering, University of Arizona, May 1972

M.S. Chemical Engineering, University of Arizona, May 1977

Founder & CEO 1978 – 2001 Modular Mining Systems

AREAS OF INTEREST

Corporate Management, Business Finance, New Venture Strategies, Strategic Planning, International Business.

SELECTED PUBLICATIONS

M. J. Arnold & G. H. Geiger, "A New Framework for Engineering Economics", 27th Annual American Society for Engineering Management (ASEM) National Conference, Huntsville, AL, paper #106 pp 1-4, October 2006.

M. J. Arnold, "Engineer to Entrepreneur: Making the Career Enhancing Transition", IEEE Today's Engineer, September, 2002

M. J. Arnold, "Computer Dispatching Advances Mining Technology", American Mining Congress International Mining Show Compendium, April 26, 1988. Reprinted: American Mining Congress "Washington Concentrates", (24) pp. 12-13, June, 1988

M. J. Arnold and J. W. White, "Computer DISPATCHing Improves Open Pit Mining Efficiency", Invited paper for American Mining Congress International Mining Show; Las Vegas, Nevada, October 1986.

DONALD BRUYERE, Adjunct Professor

Ph. D. - University of Arizona, Tucson – Radar Signal Processing (Optics Minor)
M.B.A. - California State University of Northridge
M.S.E.C.E. - University of California at Santa Barbara
B.S.E.E. - University of Washington, Seattle
A.A.S – S.U.N.Y. Canton A.T.C.

AREAS OF INTEREST - Image sensing and analysis

SELECTED PATENTS

"Directional Gradient Magnitude Second Moment Variance Detection Radar" - Nov 9, '10, (7,830,300 B2)
"Antenna Pointing Bias Estimation Using Radar Imaging" – Aug. 16, '11, (7,999,726 B2)
"Radar Imaging System Using Gradient Magnitude 2nd Moment Spatial Variance Detection", Nov. 8, '11, (8,054,217 B2)
"Interferometric Inverse Synthetic Aperture Radar & Method", Apr 24, 2014, (USWO2014062288 A1/EP13752789.1-1812)

SELECTED PUBLICATIONS

"Adaptive Detection and Diversity Order in Multistatic Radar", IEEE TAES, Oct '08
"Optimum and Decentralized Detection for Multistatic Airborne Radar", IEEE TAES, Vol. 43, No. 2, Apr '07
"SINR Improvements In Multi-Sensor STAP", IEEE Conf on Antennas, Radar, and Wave Prop., July '05
"Sizing Throughput Requirements on Real-Time Systems", feature article, Embedded Systems Programming, Sept '99

NENG FAN, Assistant Professor

Ph.D., Industrial and Systems Engineering, University of Florida, 2011.
M.S., Industrial and Systems Engineering, University of Florida, 2009.
M.S., Applied Mathematics, Nankai University, China, 2007.
B.S., Computational Mathematics, Wuhan University, China, 2004.

AREAS OF INTEREST

Integer programming and Combinatorial Optimization, Stochastic Programming and Robust Optimization, Energy Systems Modeling and Optimization, Data Mining and Healthcare Management

SELECTED PUBLICATIONS

N. Fan, S. Mujahid, J. Zhang, P. Georgiev, P. Papajorgji, I. Radziukyniene, B. Neugaard, P.M. Pardalos, Nurse scheduling problem: an integer programming model with a practical application in a VA hospital, In: P.M. Pardalos et al. (eds.) *Systems Analysis Tools for Better Health Care Delivery*, Vol. 74, pp 65-98, 2013.

H. Liu, N. Fan, P.M. Pardalos, Generalized Lagrange function and generalized weak saddle points for a class of multiobjective fractional optimal control problems, *Journal of Optimization Theory and Applications*, Vol. 154(2), pp 370-381, 2012.

N. Fan, J.-P. Watson, Solving the connected dominating set problem and power dominating set problem by integer programming, *Lecture Notes in Computer Science,* Vol. 7402, pp 371–383, 2012.

N. Fan, Q.P. Zheng, P.M. Pardalos, Robust optimization of graph partitioning involving interval uncertainty, *Theoretical Computer Science*, Vol. 447, pp 53-61, 2012.
R. Chen, A. Cohn, N. Fan, A. Pinar, N–k–e survivable power system design, *Proc. of 12th Intl. Conf. Probabilistic Methods Applied to Power Systems* (PMAPS 2012), Istanbul, Turkey, June 10-14, 2012.

N. Fan, R. Chen, J.-P. Watson, N–1–1 contingency-constrained optimal power flow by interdiction methods, *Proceedings of IEEE PES General Meeting 2012*, San Diego, CA, July 22-26, 2012.

N. Fan, D. Izraelevitz, F. Pan, P.M. Pardalos, J. Wang, A mixed integer programming approach for optimal power grid intentional islanding, *Energy Systems*, Vol. 3(1), pp 77-93, 2012.

N. Fan, P.M. Pardalos, Multi-way clustering and biclustering by the Ratio cut and Normalized cut in graphs, *Journal of Combinatorial Optimization*, Vol. 23(2), pp 224-251, 2012.

N. Fan, P.M. Pardalos, A rearrangement of adjacency matrix based approach for solving the crossing minimization problem, *Journal of Combinatorial Optimization*, Vol. 22(4), pp 747-762, 2011.

N. Fan, H. Xu, F. Pan, P.M. Pardalos, Economic analysis of the N–k power grid contingency selection and evaluation by graph algorithms and interdiction methods, *Energy Systems*, Vol. 2(3-4), pp 313–324, 2011.

N. Fan, P.M. Pardalos, Linear and quadratic programming approaches for the general graph partitioning problem, *Journal of Global Optimization*, Vol. 48(1), pp 57-71, 2010.

ROBERTO FURFARO, Assistant Professor

Professor Furfaro holds a joint appointment in the Aerospace and Mechanical Engineering Department

MS, M.S., Aerospace Engineering, University of Rome "La Sapienza"

PhD, Aerospace Engineering, University of Arizona

AREAS OF INTEREST

Intelligent Systems for Space Exploration, Space Systems Engineering, Guidance Navigation and Control of Space Systems, Radiative Transfer Numerical Modeling, Inverse Problems in Remote Sensing.

SELECTED PUBLICATIONS

"Asteroid Precision Landing Via Multiple Sliding Surfaces Guidance Techniques, Furfaro, R., Cersosimo, D., O., and Wibben, D., 2013, Journal of Guidance, Control, and Dynamics (2013): 1-18

Analytic Discrete Ordinate Method for Radiative Transfer in Dense Vegetation Canopies, Picca, P., Furfaro, R., 2013, Journal of Quantitative Spectroscopy and Radiative Transfer, 118(2013)60–69 .

Autonomous Real-Time Landing Site Selection for Venus and Titan using Evolutionary Fuzzy Cognitive Maps, Applied Soft Computing, Furfaro, R., Fink W., Kargel, J. S., 2012, (2012) 3825–3839.

"Identification of Cryovolcanism on Titan Using Fuzzy Cognitive Maps", Furfaro, R., Kargel, J., S., Lunine, J., I., Fink, W., Bishop, M. P., 2010,Planetary and Space Science, Volume 5, Issue 5, Pages 761–779.

"The search for life beyond Earth through fuzzy expert systems", Furfaro, R., Dohm, J.M., Fink, W., Kargel, J., Schulze-Makuch, D., Fairén, A.G., Palmero-Rodriguez, A., Bake, V.R., Ferré, P.T., Hare, T.M., Tarbell, M.A., Miyamoto, H., and Komatsu, G., 2008, Planetary and Space Science, Volume 56, Issues 3-4, 448-472.

JEFFREY B. GOLDBERG, Dean, College of Engineering

BS, Operations Research & Industrial Engineering, Cornell University

ME, Operations Research & Industrial Engineering, Cornell University
PhD, Industrial & Operations Engineering, University of Michigan

AREAS OF INTEREST

Applied optimization modeling and solution. Examples include determining optimal or near-optimal base locations for emergency vehicles and general location models. I am also interested in engineering education issues including effective classroom instruction, strategies for distance learning, and increasing gender and racial diversity in engineering programs.

SELECTED PUBLICATIONS

"Methods for Solving Nonlinear Equations Used in Evaluating Emergency Vehicle Busy Probabilities" (with F. Szidarovszky), *Operations Research* 39: 903-916 (1991).

"Web-Based Alternatives for Learning Engineering Science," (with K. Lansey) Computers in Education Journal, Volume 14, No. 4, 2004, pp 2-11.

"Algorithms for Solving the Conditional Covering Problem on Paths," (with B. Lunday and J.C.Smith) Naval Research Logistics, Volume 52, No. 4, 2005, pp. 293-301.

"The Design and Analysis of Lean Production Systems", John Wiley and Sons Inc., 2002. Selected as the Joint Publishers Book of the Year Award by the Institute for Industrial Engineering, May 2003.(with R. Askin)

11 Case Studies in "Introduction to Mathematical Programming, Applications and Algorithms", 3rd Edition, by Wayne Winston, Duxbury - Thomson Learning, 2002.

"Estimating the Number of Professional Poker Players" (with N. Dalla) *Card Player*, 10(3): 54, 98-99 (1997).

LARRY HEAD, Professor

B.S., Systems Engineering, The University of Arizona 1983
M.S., Systems Engineering, The University of Arizona 1985
Ph.D., Systems & Industrial Engineering, The University of Arizona 1989

AREAS OF INTEREST

Traffic and Transportation Systems Engineering, Traffic Signal Control, Microscopic Traffic Simulation, Traffic Flow Theory, Systems Engineering Methodology, Software Engineering, Communications, and Human Factors

SELECTED PUBLICATIONS

Mirchandani, P.B. and Head, K.L., "RHODES: A Real-Time Traffic Signal Control System: Architecture, Algorithms and Analysis", Transportation Research. Part C: Emerging Technologies Vol. 9 No: 6, 2001.

Abbas, M; Bullock, D; Head, K. L., "Real-Time Offset Transitioning Algorithm for Coordinating Traffic Signals", Transportation Research Record, No. 1748, 2001, pp. 26-39.

Sen, S. and K. L. Head, "Controlled Optimization of Phases (COP) at an Intersection," Transportation Science, Vol. 1, No. 31, February 1997, pp. 5-17..

Head, K. L. "An Event-Based Short-Term Traffic Flow Prediction Model," Transportation Research Record, No. 1510, 1995, pp. 45-52.

Head, K. L., P. Mirchandani and D. Sheppard, "A Hierarchical Framework for Real-Time Traffic Control," Transportation Research Record , No. 1360, 1992, pp. 82-88.

PAVLO KROKHMAL, Professor

M.S., Applied Mathematics and Mechanics, Kyiv National Taras Shevchenko University (Kyiv, Ukraine), 1996
Ph.D., Mechanics of Solids and Applied Mathematics, Kyiv National Taras Shevchenko University (Kyiv, Ukraine), 1999
Ph.D., Operations Research, University of Florida, 2003

AREAS OF INTEREST
Stochastic optimization, decision making under uncertainty, risk analysis, financial engineering, renewable energy, cooperative control and decision making, multidisciplinary optimization

SELECTED PUBLICATIONS

Rysz, M., Vinel, A., Krokhmal, P., and E. L. Pasiliao (2015) A scenario decomposition algorithm for stochastic programming problems with a class of downside risk measures, INFORMS Journal on Computing, 27(2), 416-430.

Vinel, A. and P. Krokhmal (2015) Certainty equivalent measures of risk, Annals of Operations Research, DOI:10.1007/s10479-015-1801-0.

Chernikov, D., Krokhmal, P., Zhupanska, O. I., and C. L. Pasiliao (2015) A two-stage stochastic PDE-constrained optimization approach to vibration control of an electrically conductive composite plate subjected to mechanical and electromagnetic loads, Structural and Multidisciplinary Optimization, 52(2), 227-352.

Vinel, A. and P. Krokhmal (2014) Polyhedral approximations in p-order cone programming, Optimization Methods and Software, 29(6), 1210-1237.

Krokhmal, P., Zabarankin, M., and S. Uryasev (2011) Modeling and optimization of risk, Surveys in Operations Research and Management Science, 16(2), 49-66.

ROBERT G. LEPORE, Director Engineering Management

B.S. Engineering, University of California, Los Angeles June 1976

M.S. Electrical Engineering, University of California, Los Angeles June 1978

VP Engineering, Raytheon Missile Systems 2006 – 2012 Modular Mining Systems
Deputy VP Engineering, Raytheon Missile Systems 2005 - 2006
Chief Engineer Exo Atmospheric Kill Vehicle, Raytheon Missile Systems 2001- 2005
Manager Electro-Optical Center, Raytheon Missile Systems 1997- 2001

AREAS OF INTEREST

Systems Engineering, Electro-Optical Sensors, Signal Processing, Tracking Systems

SELECTED PATENTS

"Forced Correlation Mixed Mode Tracking System" 1990
"Directional Running Average Segmentation" 1993

WEI LIN, Associate Professor

BS, Computer Science, Brigham Young University
MS, Mathematics, Rensselaer Polytechnic Institute
PhD, Civil Engineering. University of California at Berkeley

AREAS OF INTEREST

Traffic flow theory, transportation network analysis and modeling, application of advanced technologies in transit operations, and application of computer simulation to transportation analysis, logistics systems.

Editorial Board: Intelligent Transportation Systems Journal, Transportmetrica.

SELECTED PUBLICATIONS

L. Li, W. H. Lin and H. Liu (2006) A Type-2 Fuzzy Logic Approach for Short-Term Traffic Forecasting, IN *IEE Proceedings Intelligent Transport Systems*, Vol. 153, Issue 1, pp. 33- 40.

Y. Cheng and W. H. Lin (2005) Comparison of Methods for Allocating Costs of Empty Railcar Movements in a Railcar Pooling System, *Transportation Research Record Journal of the Transportation Research Board*. No. 1916, pp. 88 - 95.

W. H. Lin and Chenghong Wang (2004) An Enhanced 0-1 Mixed Integer LP Formulation for Traffic Signal Control, In *IEEE Transaction on Intelligent Transportation Systems*, vol. 5, no. 4, pp. 238 - 245.

W. H. Lin and R. L. Bertini (2004) Modeling Schedule Recovery Processes in Transit Operations for Bus Arrival Time Prediction, *Journal of Advanced Transportation*, Vol. 38, No. 3, pp. 347-365.

W. H. Lin, J. Dahlgren, H. Huo (2004) Enhancement to Speed Estimation Using Single Loop Detectors. *Transportation Research Record Journal of Transportation Research Board*, No. 1870. National Research Council, Washington D.C., pp. 147 -152.

W. H. Lin, A. Kulkarni, P. Mirchandani (2004) Short-term Arterial Travel Time Prediction for Advanced Traveler Information Systems. *Journal of Intelligent Transportation Systems*, 8(3) Sept. 2004. pp.143-154.

W. H. Lin and H. K. Lo (2003) A Theoretical Probe of a German Experiment on Stationary Moving Traffic Jams. *Transportation Research*: Part B. Methodological.. Vol. 37, pp. 251-61.

W. H. Lin, Q. Y. Lu and J. Dalhgren (2002) A Dynamic Procedure for Short-Term Prediction of Traffic Conditions. IN: Transportation Research Record, *Journal of Transportation Research Board*, No. 1783, National Research Council, Washington D.C., pp. 149 - 157.

W. H. Lin and V. Padmanabhan (2002) Simple Procedure for Creating Digitized Bus Route Information for Intelligent Transportation Applications, Transportation Research Record, *Journal of Transportation Research Board*, No. 1791. National Research Council, Washington D.C., pp 78-84.

W. H. Lin (2002) Quantifying the Benefits to Buses with Signal Priority Treatment in Mixed Mode Operation.: Transportation Research Record, *Journal of Transportation Research Board*, No. 1811, National Research Council, Washington D.C., pp. 100-106.

W. H. Lin, and H. K. Lo (2000) Are the Objective and Solutions of the Dynamic User-Equilibrium Models Always Consistent? *Transportation Research A*, Vol. 34, pp. 137-44.

JIAN LIU, Associate Professor

Ph.D., Mechanical Engineering and Industrial and Operation Engineering, University of Michigan, 2008.
M.S., Statistics, University of Michigan, 2006.
M.S., Industrial Engineering, University of Michigan, 2005.
M.S., Precision Instruments & Mechanology, Tsinghua University, China, 2002.
B.S., Precision Instruments & Mechanology, Tsinghua University, China, 1999.

AREAS OF INTEREST
Quality Engineering and Applied Statistics, multivariate statistics, statistical process control (SPC), reliability engineering, design of experiments, in-process quality and productivity improvement, applied data mining.

SELECTED PUBLICATIONS

Liu, J., Li, J., and Shi, J., 2005, "Engineering Knowledge Driven Cause-Effect Modeling and Statistical Analysis for Multi-Operational Machining Process Diagnosis," *Transactions of NAMRI/SME,* Vol. 33, 65-72.
Liu, J., Shi, J., and Hu, S.J., 2008, "Engineering-Driven Factor Analysis for Variation Sources Identification in Multistage Manufacturing Processes," *ASME Transactions, Journal of Manufacturing Science and Engineering*, **130** (4), p. 0410091-04100910.
Liu, J., Shi, J., and Hu, S.J., 2009, "Quality Assured Setup Planning Based on the Stream Of Variation Model for Multi-Stage Machining Processes," *IIE Transactions, Quality and Reliability Engineering*, to appear.
Liu, J., Jin, J., and Shi, J., 2009, "State Space Modeling for 3_Dimentional Variation Propagation in Rigid-Body Multistage Assembly Processes," *IEEE Transactions on Automation Science and Engineering*, 7 (2), 274-290.
Liu, J., 2010, "Monitoring and Diagnosis for Multistage Manufacturing Processes: A Comparison Survey of Statistical-Process-Control vs. Stream-of-Variation Methodologies," Quality and Reliability International, to appear.

MICHAEL C. O'BRIEN, Lecturer

B.S. Systems Engineering, University of Arizona, May 1991
M.S. Industrial Engineering, University of Arizona, May 1996

Director of Supply Chain Management 2010 – 2015 Verizon Wireless
Manager Supply Chain Solutions 1996 – 2010
Sr. Engineer 1991 – 1993 EG&G Idaho (Idaho National Engineering Lab)

AREAS OF INTEREST
Practice of Operation's Research, Forward Logistics, Reverse Logistics, Supply Chain Strategy, Supply

Chain Automation, the practice of Industrial Operations Research.

SELECTED PUBLICATIONS

J. Bean, A Devpura, M O'Brien, S. Shirodkar, "Optimizing Supply-Chain Planning", Intel Technology Journal, Vol 9, Issue 3, August 3, 2005

YOUNG-JUN SON, Department Head and Professor

BS, Industrial Engineering, Pohang University of Science and Technology (POSTECH), Korea
MS, Industrial and Manufacturing Engineering, The Pennsylvania State University
PhD, Industrial and Manufacturing Engineering, The Pennsylvania State University

AREAS OF INTEREST

Application of distributed and hybrid simulation to the analysis and control of systems of systems (e.g. extended manufacturing enterprises, renewable energy network, homeland security, social network): (1) integration of multi-paradigm simulations (discrete event, system dynamics, agent-based modeling), (2) time and event synchronization among horizontal simulations, (3) information synchronization among vertical simulations, (4) impact analysis. Shop floor control architecture design: (1) Intelligent control architecture embedding simulation and adaptive scheduling methods, (2) hybrid control architecture considering performance and disturbances, (3) real-time decision-making in multi-hierarchies, (4) control model development from process plan models.

Editor-in-Chief of the International Journal of Services Operations and Informatics
Department Editor of Design and Manufacturing Focus Issue for IIE Transactions
Associate Editor, International Journal of Modeling and Simulation
Associate Editor, International Journal of Simulation and Process Modeling
IIE Fellow
IIE (Institute of Industrial Engineers) 2005 Outstanding Young Industrial Engineer Award
SME (Society of Manufacturing Engineers) 2004 M. Eugene Merchant Outstanding Young Manufacturing Engineer Award
IERC Conference Best Paper Awards (2005, 2008, 2009)
Best Paper of the Year Award in 2007 from International Journal of Industrial Engineering

SELECTED PUBLICATIONS

Young Jun Son, Richard A. Wysk, and Albert T. Jones, Simulation Based Shop Floor Control: Formal Model, Model Generation and Control Interface, *IIE Transactions on Design and Manufacturing*, 35 (1), January 2003, 29 - 48.

S. Lee, Y. Son, J. Jin, Integrated Human Decision Making and Planning Model under Extended Belief-Desire-Intention Framework, ACM Transactions on Modeling and Computer Simulation, 20(4), 2010, 23(1)-23(24).

Jayendran Venkateswaran and Young Jun Son, Hybrid System Dynamic -- Discrete Event Simulation based Architecture for Hierarchical Production Planning, *International Journal of Production Research*, 43 (20), 2005, 4397 - 4429.

A. Khaleghi, D. Xu, Z. Wang, M. Li, A. Lobos, J. Liu, Y. Son, A DDDAMS-based Planning and Control Framework for Surveillance and Crowd Control via UAVs and UGVs, Expert Systems with Applications, 40, 2013, 7168-7183.

J. Min, W. Beyeler, T. Brown, Y. Son, and A. Jones, Toward Modeling and Simulation of Critical National Infrastructure Interdependencies, *IIE Transactions*, 39 (1), 2007, 57 - 71.

S. Kucuksari, A. Khaleghi, M. Hamidi, Y. Zhang, F. Szidarovszky, G. Bayraksan, Y. Son, An Integrated GIS, Optimization and Simulation Framework for Optimal PV Size and Location in Campus Area Environments, Applied Energy, 113, 2014, 1601-1613.

RICARDO VALERDI, Associate Professor

B.S./B.A., Electrical Engineering, University of San Diego 1999
M.S., Systems Architecture and Engineering, University of Southern California 2002
Ph.D., Systems and Industrial Engineering, University of Southern California 2005
A.L.M., Psychology, Harvard University 2014

AREAS OF INTEREST

Cost Estimation, Parametric Modeling, Economic Analysis of Large-Scale Systems, Model-Based Systems Engineering, Systems Thinking, Organizational Performance Measurement, Enterprise Transformation, Research Methodology, Test and Evaluation, Behavioral Economics, Baseball Analytics

SELECTED PUBLICATIONS

Dorey, S. P., J. Oehmen and R. Valerdi, "Enhancing Cost Realism Through Risk-Driven Contracting: Designing Incentive Fees Based on Probabilistic Cost Estimates," *Acquisition Review Journal*, Vol. 19, No. 2, 2012, pp. 133-158.

Valerdi, R., "Heuristics for Systems Engineering Cost Estimation," *IEEE Systems Journal*, Vol. 5, No. 1, 2011, pp. 91-98.

Purchase, V., G. Parry, R. Valerdi, D. J. Nightingale and J. Mills, "Enterprise Transformation: Why Are We Interested, What Is It, And What Are The Challenges?," *Journal of Enterprise Transformation,* Vol. 1, No. 1, 2011, pp. 14-33.

Valerdi, R. and C. Blackburn, "Leveraging Measurement Systems to Drive Enterprise Transformation: Two Case Studies from the U.S. Aerospace Industry," *Information, Knowledge and Systems Management*, Vol. 9, No. 2, 2010, pp. 77-97.

Wang, G., R. Valerdi and J. Fortune, "Reuse in Systems Engineering," *IEEE Systems Journal*, Vol. 4, No. 3, 2010, pp. 376-384.

Rhodes, D., R. Valerdi and G. Roedler, "Systems Engineering Leading Indicators: Assessing Effectiveness of Programmatic and Technical Performance," Systems Engineering, Vol. 12, No. 1, 2009, pp. 21-35.

Boehm, B. W. and R. Valerdi, "Achievements and Challenges in Software Resource Estimation," *IEEE Software*, Vol. 25, No. 5, 2008, pp. 74-83.

Boehm, B. W., R. Valerdi and E. Honour, "The ROI of Systems Engineering: Some Quantitative Results for Software-Intensive Systems," Systems Engineering, Vol. 11, No. 3, 2008, pp. 221-234.

AFFILIATED FACULTY (Joint Appointments and Emeriti)

TERRY BAHILL, Professor Emeritus

B.S., Electrical Engineering, University of Arizona
M.S., Electrical Engineering, San Jose State University
Ph.D., Electrical Engineering & Computer Science, University of California, Berkeley
Fellow of the Institute of Electrical and Electronics Engineers (IEEE)
Fellow of the International Council on Systems Engineering (INCOSE)
Raytheon Fellow

AREAS OF INTEREST

Modeling Physiological Systems: experiments and modeling analysis of the human arm, head and eye movement systems, with applications to clinical medicine and the science of baseball.

Knowledge Engineering: computer techniques for verifying and validating decision support systems.

Systems Engineering: system design, systems theory, concurrent engineering, requirements development, functional and object-oriented modeling, sensitivity analyses, tradeoff studies, etc.

Editor, CRC Press Series in Systems Engineering.

Associate Editor, Systems Engineering The Journal of INCOSE.

SELECTED PUBLICATIONS

Keep Your Eye on the Ball: Curve Balls, Knuckleballs, and Fallacies of Baseball (with R. G. Watts). New York: W. H. Freeman and Co., 1990 and 2000.

Linear Systems Theory (with F. Szidarovszky). Boca Raton, FL: CRC Press Inc., 1992 and 1998.

Metrics and Case Studies for Evaluating Engineering Designs (with J.A. Moody, W. L. Chapman, and F.D. Van Voorhees). Upper Saddle River, NJ: Prentice-Hall Inc., 1997.

Engineering Modeling and Design (with W. L. Chapman and Wayne Wymore). Boca Raton, FL: CRC Press Inc., 1992.

Verifying and Validating Personal Computer-based Expert Systems. Englewood Cliffs, NJ: Prentice-Hall Inc., 1991.

Bioengineering: Biomedical, Medical, and Clinical Engineering. Englewood Cliffs, NJ: Prentice Hall Inc., 1981.

ROBERT L. BAKER, Associate Professor Emeritus

BS, Civil Engineering, University of Arizona
MS, Computer Science, Texas A & M University
PhD, Operations Research, Texas A & M University

AREAS OF INTEREST

Economic analysis, financial strategies, retirement strategies, estate protection, cash flow analysis, and comparison of economic alternatives.

MOSHE DROR, Professor (Joint with Department of Management Information Systems)

MSc, Mathematical Methods in Engineering, Columbia University
IE (Prof Engr), Columbia University
PhD, Management Science, University of Maryland

AREAS OF INTEREST

Combinatorial and information systems, applied combinatorial optimization in transportation logistics and manufacturing, agent-based systems and distributed solutions for information and operations management, cooperative game theory, and cost allocation in inventory

SELECTED PUBLICATIONS

"The Metric TSP and the Sum of its Marginal Values", I. J. of Computational Geometry & Applications 16(4), Dror, M., Y. Lee, J. Orlin, and V. Polishchuk, (2006). 333-343.

"Shipment Consolidation: Who Is Going to Pay for it and How Much", Management Science (in press). Dror, M. and B.C. Hartman, (2006).

"Improved Bounds for Split Delivery", Discrete Optimization 3(4), Bompadre, A., M. Dror, and J.B. Orlin, (2006). (in press, online since 7/24/06).

WOLFGANG FINK, Associate Professor and inaugural Edward & Maria Keonjian Endowed Chair **(Joint with Department of Electrical and Computer Engineering)**

B.S.: Physics, University of Göttingen, 1990
M.S.: Physics and Physical Chemistry, University of Göttingen, 1993
Ph.D: Theoretical Physics ("summa cum laude"), University of Tübingen, 1997

AREAS OF INTEREST
(1) Artificial Vision (Vision Prostheses), (2) Autonomous Robotic Space Exploration, (3) Biomedical Sensor/System Development, (4) Cognitive/Reasoning Systems, (5) Computer-Optimized Design.

DaVinci Fellow 2015
AIMBE Fellow 2012
IEEE Senior Member 2015
NSBE Faculty Advisor UA 2014 - present

14 issued patents to date in the areas of autonomous systems, biomedical devices, neural stimulation, MEMS fabrication, and multi-dimensional optimization.
Co-recipient of R&D 100 Award in 2009
Co-recipient of R&D 100 Editors' Choice Award in 2009
NASA Board Award 2009
NASA Patent Awards (1 in 2009, 5 in 2010)

SELECTED PUBLICATIONS

Fink W, Sadun A (2004) *3D Computer-automated Threshold Amsler Grid Test*, Journal for Biomedical Optics 2004 Jan;9(1):149-53

Fink W, Dohm JM, Tarbell MA, Hare TM, Baker VR (2005) *Next-Generation Robotic Planetary Reconnaissance Missions: A Paradigm Shift*; Planetary and Space Science, 53, 1419-1426

Fink W, Micol D (2006) *simEye: Computer-based Simulation Of Visual Perception Under Various Eye Defects Using Zernike Polynomials*, Journal for Biomedical Optics 2006 Sep-Oct;11(5):054011

Johnson WR, Wilson DW, Fink W, Humayun M, Bearman G (2007) *Snapshot hyperspectral imaging in ophthalmology*; Journal for Biomedical Optics 2007 Jan-Feb;12(1):014036

Weiland JD, Fink W, Humayun MS, Liu W, Li W, Sivaprakasam M, Tai YC, Tarbell MA (2008) System Design of a High Resolution Retinal Prosthesis; Conf Proc IEEE IEDM 2008; doi:10.1109/IEDM.2008.4796682

Fink W, You CX, Tarbell MA (2010) μAVS²: Microcomputer-based Artificial Vision Support System for Real-Time Image Processing for Camera-Driven Visual Prostheses; J. Biomed. Opt., Vol. 15, 016013 (2010); doi:10.1117/1.3292012

Fink W, Tarbell M (2014) Artificial Vision Support System (AVS²) for Improved Prosthetic Vision; Journal of Medical Engineering & Technology; 38(8):385-95; DOI: 10.3109/03091902.2014.957869

Schmid EW, Fink W, Wilke R (2014) Operational Challenges of Retinal Prostheses; Journal of Medical Engineering & Physics; 36: 1644-1655

WILLIAM R. FERRELL, Professor Emeritus

BA, English Literature (honors), Swarthmore College
SB, Mechanical Engineering (honors), MIT
SM, Mechanical Engineering, MIT
ME, Mechanical Engineering, MIT
PhD, Mechanical Engineering, MIT

AREAS OF INTEREST

Modeling and measuring human performance in information processing tasks such as probability assessment, decision making, diagnosis, and inspection; design of methods and systems to augment human performance as in expert systems and responsive computer interfaces.

Departmental Editor for Judgmental and Probabilistic Methods, *Journal of Forecasting*.

Editorial Board Member, *Journal of Behavioral Decision Making*.

SELECTED PUBLICATIONS

"Preliminary Test and Evaluation of Datahand: A Keyboard Alternative Designed to Prevent Musculoskeletal Disorders and to Improve Performance" (with L.W. Knight and J. Koeneman). *Advances in Industrial Ergonomics and Safety IV*. London: Taylor and Francis, 1992.

"Discrete Subjective Probabilities and Decision Analysis: Elicitation, Calibration, and Combination," *Subjective Probability* (G. Wright and P. Ayton, eds.). 411-451. New York: Plenum, 1994.

"Dynamic Modeling of Repetitive Strain Injury in Organizations" (with Jurgen Hagenlocher), *Advances in Industrial Ergonomics and Safety VII*. London: Taylor and Francis, 1995.

"The Hard-Easy Effect in Subjective Probability Calibration" (with L. Suantak and F. Bolger), *Organizational Behavior and Human Performance* 67: 201-221 (1996).

"Influence Allocation Processes in Group Decision Support Systems" (with P. Balthazard), *Group Decision*

and Negotiation, in press.

JOHN S. RAMBERG, Professor Emeritus

BS, Electrical Engineering (Industrial Engineering Option), University of Minnesota
MS, Operations Research, Cornell University
PhD, Engineering Statistics, Cornell University
Fellow, American Statistical Association, American Society for Quality Control, and Institute of Industrial Engineers.

AREAS OF INTEREST
Engineering statistics, with emphasis on six sigma quality implementation issues (engineering experiment design, quality engineering, and management simulation).

Editorial Board, Journal of Quality Technology.

SELECTED PUBLICATIONS

"Process Capability Indices: A Discussion", Journal of Quality Technology, January 2002.

“Six Sigma: Fad or Fundamental,” *Quality Digest*: 28-32 (May 2000).

"A Generalization of Spring's Reflected Normal Loss Function" (with F. Sun), *Canadian Journal of Statistics* (1996).

"Process Capability Indices: Fundamental Engineering and Statistical Issues" (with J.J. Pignatiello, Jr.), “Statistical Applications in Process Control and Experiment Design,” Dekker Publishing, 1995 (Craig Award and Shewell Prize).

DONALD G. SCHULTZ, Professor Emeritus

BS, Electrical Engineering, University of Santa Clara
MS, Engineering, University of California at Los Angeles
PhD, Electrical Engineering, Purdue University

AREAS OF INTEREST

The use of control theory and optimization for the solution of practical engineering problems. Applications include a variety of areas, such as the crushing of ore, the optimal control of insects in cotton, the prediction of engineering manpower requirements, and the on-line digital control of nuclear rocket engines.

The underlying factors common to all of these areas are the need for mathematical modeling and the desire to optimize a quantitative performance index.

SELECTED PUBLICATIONS

"Computers in Anesthesiology: A Look Ahead" (with W. F. Arnell), *Anesthesia Delivery Systems*, Philadelphia: E. A. Davis Company, 1984.

"Getting the Data: Reducing Confusion with the Computer*," Medical Instrumentation* 17(6) (Nov-Dec 1983).

"The Art and Science of Decision Making (Using Simulation and Gaming)" (with Vern R. Johnson), *The Journal of Technological Horizons in Education* 3(5) (May/June 1976).

"On-line Computer Control of Complex Nonlinear Systems" (with L. E. Kendrick), *IEEE Transactions on*

Industrial Electronics and Control Instrumentation IECI-23 (4) (November 1976).

SUVRAJEET SEN, Professor Emeritus

BE, Mechanical Engineering, Birla Institute of Technology and Science, Pilani, India
MS, Industrial Engineering and Engineering Management, University of Louisville
PhD, Industrial Engineering and Operations Research, Virginia Polytechnic Institute and State University

AREAS OF INTEREST

Optimization theory: Large scale and stochastic programming, nonlinear and disjunctive programming. Applied mathematical modeling: Production planning, telecommunications, power systems, and traffic networks.

Area Editor for Optimization, Operations Research
Associate Editor, INFORMS Journal in Computing
Associate Editor, Telecommunications Systems

SELECTED PUBLICATIONS

"Stochastic Decomposition: A Statistical Method for Large Scale Stochastic Linear Programming" (with J.L. Higle). Boston, MA: Kluwer Academic Publishers, 1996.

"Controlled Optimization of Phasers (COP) at Intersection" (with K.L. Head), *Transportation Science* 31: 5-17 (1997).

"An Introductory Tutorial on Stochastic Linear Programming: Modeling" (with J.L. Higle), accepted for publication in *Interfaces* (n.d.).

DAOQIN TONG, Associate Professor

BS, Civil Engineering, University of Shanghai for Science and Technology, China
MS, Civil Engineering, The Ohio State University
MAS, Statistics, The Ohio State University
PhD, Geography, The Ohio State University

AREAS OF INTEREST

Spatial optimization, location analysis and modeling, GIS, spatial statistics, transportation, food access

SELECTED PUBLICATIONS

Murray A.T. and D. Tong (2007) "Coverage optimization in continuous space facility siting", International Journal of Geographical Information Science 21:757-776

Tong D., C.J. Merry and B. Coifman (2009) "New perspectives on the use of GPS and GIS to support a highway performance study", Transactions in GIS 13(1): 69-85

Shillington L. and D. Tong (2011) "Maximizing wireless mesh network coverage", International Regional Science Review 34(4): 419-437

Lin W.H. and D. Tong (2011) "Vehicle re-identification with dynamic time windows for vehicle passage time estimation", IEEE Transactions on Intelligent Transportation Systems 12(4): 1057 - 1063

Tong D., F. Ren and J. Mack (2011) "Locating Farmers' Markets with an incorporation of spatio-temporal variation", Socio-Economic Planning Sciences 46: 149-156

Tong D. and R.L. Church (2012) "Aggregation in Continuous Space Coverage Modeling", International Journal of Geographical Information Science. 26(5): 795-816

Tong D. and A.T. Murray (2012) "Spatial optimization in geography", Annals of the Association of American Geographers. 102(6): 1290-1309

Lei T., D. Tong and R.L. Church (2014) "Designing robust coverage systems: A maximal covering model considering with geographically varying failure probabilities", Annals of the Association of American Geographers 104(5): 922-938

Liu Y., D. Tong and X. Chen (2015) "Measuring spatial autocorrelation of vectors", Geographical Analysis 47(3): 300-319