Healthcare Systems Engineering Programs

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Associate Dean for Research, College of Engineering

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Monica Puertas, MS, IMSE at USF
Ron Rardin, PhD, IE at University of Arkansas

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Healthcare Systems Programs

- Most offered through
  - Public Health,
  - Schools of Medicine,
  - Health Administration, or
  - Health Care Management Departments

- Engineering certificates
  - Graduates: 2
  - All professionals: 3
  - Undergrads and 1st year grad-students: 1

- Health school certificates
  - Graduate: 19
  - All professionals: 3
Health Systems Engineering Alliance (HSEA)

- An association of academic programs that includes research focused on engineered solutions to improve disease prevention and healthcare delivery.
- Includes 39 members from US and Canada
- “HSEA focuses on the application of its engineering-based tools to integrate resources, refine operations, and aid clinical decisions with the goal of making healthcare delivery systems and processes consistent, high quality, and cost-effective over the entire course of patient care, including prevention.”

1https://catalyzecare.org/groups/hsea
<table>
<thead>
<tr>
<th>No.</th>
<th>University/Program</th>
<th>Degree(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>University of Southern California</td>
<td>Master of Health Systems Management Engineering</td>
<td>Los Angeles, CA</td>
</tr>
<tr>
<td>2.</td>
<td>Texas Tech University</td>
<td>MS Healthcare Engineering, Healthcare Engineering Option in the Master of Engineering Degree</td>
<td>Lubbock, TX</td>
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<tr>
<td>3.</td>
<td>Georgia Institute of Technology</td>
<td>MS in Health Systems</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td>4.</td>
<td>Stanford University</td>
<td>MS Degree in Health Services Research</td>
<td>Stanford, CA</td>
</tr>
<tr>
<td>5.</td>
<td>University of Missouri</td>
<td>Dual MS in Industrial Engineering (MSIE) &amp; Master of Health Administration (MHA)</td>
<td>Columbia, MO</td>
</tr>
<tr>
<td>6.</td>
<td>Lehigh University</td>
<td>MS Healthcare Systems Engineering</td>
<td>Bethlehem, PA</td>
</tr>
<tr>
<td>8.</td>
<td>University of Arkansas</td>
<td>MSIE - emphasis on Healthcare Systems Engineering</td>
<td>Fayetteville, AR</td>
</tr>
<tr>
<td>10.</td>
<td>Northeastern University</td>
<td>Healthcare Industrial Engineering Minor (undergraduate)</td>
<td>Boston, MA</td>
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<tr>
<td>11.</td>
<td>North Carolina State University</td>
<td>Health Systems Engineering Certificate</td>
<td>Raleigh, NC</td>
</tr>
<tr>
<td>12.</td>
<td>University of Wisconsin - Madison</td>
<td>MSIE, Health Systems specialization, PhD, Health Systems specialization</td>
<td>Madison, WI</td>
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<tr>
<td>13.</td>
<td>Massachusetts Institute of Technology</td>
<td>MS Degree in Engineering Systems: Health Care Systems Track</td>
<td>Boston, MA</td>
</tr>
</tbody>
</table>

*Healthcare systems engineering programs based on information available online as of 08/30/2013*
# Example Areas of Emphasis

## Quantitative Methods
- Risk Modeling/Assessment
- Queuing Theory
- Design of Experiments
- Decision Theory
- Computer Simulation
- Multivariate Statistical Analysis

## Process Improvement
- Six-Sigma Quality Resources
- Health Care Operations Improvement
- Performance Analysis
- Quality Management for Engineers

## Healthcare Management
- Coding and Healthcare Law
- Clinical Practice Management
- Financial Engineering
- Economic Concepts Applied to Health
- Financial Management of Health Services

## Information Systems
- Software Project Management
- Biomedical Informatics
- Enterprise Wide Information Systems

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Typical Requirements

• Graduate Programs (mostly MS)
  – BS in engineering, mathematics, sciences, or related fields
  – 30-45 credit hours (for a PhD is higher)
  – Overall undergraduate GPA of 3.0 or better
  – Satisfactory scores on the Graduate Record Examination (GRE)
Graduate Programs’ Audience

Professionals with:

• Strong quantitative skills
• Degrees in engineering, sciences, or applied social science
• Interest in operations management and health care applications
• Interest in additional technical and management responsibilities within healthcare organizations

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Variation-Intersection @ USF between Engineering and Medicine

Aims (Peter and José):

- “Bidirectional bilingualism”

- Scholarly concentration - @ USF- College of Medicine
  – Spillover: some medicine students in IE certificates or masters

- Status: Proposal on an MS in HSE (bringing IE, Medicine and Public Health students “together”)
## HSE Education: Enhancers vs. Inhibitors

<table>
<thead>
<tr>
<th>Enhancers</th>
<th>Inhibitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Market/Industrial support &amp; sponsors</td>
<td>• Lack of market support/sponsors</td>
</tr>
<tr>
<td>• Funded research opportunities</td>
<td>• Lack of funded research</td>
</tr>
<tr>
<td>• Job opportunities</td>
<td>• Lack of jobs</td>
</tr>
<tr>
<td>• “Multiple champions”</td>
<td>• “One person show”</td>
</tr>
<tr>
<td>• Collaborative/unselfish - share incentives and success</td>
<td>• Cultural/power/territorial clashes</td>
</tr>
<tr>
<td>• Creative/flexible in curricular development</td>
<td>• Inflexible in curricular development</td>
</tr>
<tr>
<td>• Willingness to venture and embrace change</td>
<td>• Resistance to change, Status quo</td>
</tr>
<tr>
<td>• “Smooth” bureaucratic processes</td>
<td>• Bureaucratic processes</td>
</tr>
<tr>
<td>• Dual delivery mode: online and on campus</td>
<td>• Just on campus?</td>
</tr>
</tbody>
</table>
Healthcare Systems Engineering Job Profile*

Required Experience

- 1-5 years for project managers or quality engineers
- +7 years for senior positions

Job titles

- Process Improvement Analyst or Health Center Process Improvement Specialist; process engineer, Manager for Strategy & Operations; Health Care Providers Performance Improvement; Healthcare Industrial Engineer; Continuous Quality Clinical Documentation Improvement specialist; Business Process analyst; Lean Six Sigma Black Belt Analyst
- Data Analyst or Healthcare Analytics Manager; Data management; Quality Data Analyst; Healthcare/Big Data/Image Processing; Principal Research Engineer
- Quality engineer or Senior Quality Assurance Engineer, Sr. Quality Engineer - Regulatory/Quality Healthcare Diagnostics/Medical Instrumentation; Director, Division of Quality; medical device quality engineer; Design Quality Engineer; Product Engineer; Reliability Engineer
- Healthcare Clinical Operations Consultant or Clinical Engineer; Manager clinical quality analysis
- Health Economics and Decision Support Consultant

*Based on a job search on the IIE career center and the LinkedIn job search (as of 08/30/2013).
Thanks!
SUPLEMENTARY SLIDES/INFORMATION
<table>
<thead>
<tr>
<th>University</th>
<th>Department</th>
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<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona State University</td>
<td>School of Computing, Informatics and Decision Sciences Engineering</td>
<td>SUNY Buffalo</td>
<td>Industrial and Systems Engineering</td>
</tr>
<tr>
<td>Dalhousie University</td>
<td>Industrial Engineering</td>
<td>Texas A&amp;M University</td>
<td>Industrial and Systems Engineering</td>
</tr>
<tr>
<td>George Mason University</td>
<td>Systems Engineering and Operations Research</td>
<td>University of Arkansas</td>
<td>Industrial Engineering</td>
</tr>
<tr>
<td>Georgia Institute of Technology</td>
<td>Industrial and Systems Engineering</td>
<td>University of Calgary</td>
<td>Operations Mgmt, Haskyne School of Business</td>
</tr>
<tr>
<td>HEC Montreal</td>
<td>Industrial Engineering and Management</td>
<td>University of Central Florida</td>
<td>Industrial Engineering and Management Systems</td>
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<tr>
<td>Kansas State University</td>
<td>Industrial and Manufacturing Systems Engineering</td>
<td>University of Louisville</td>
<td>Industrial Engineering</td>
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<tr>
<td>Lehigh University</td>
<td>Industrial and Systems Engineering</td>
<td>University of Michigan</td>
<td>Industrial and Operations Engineering</td>
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<tr>
<td>Mississippi State University</td>
<td>Industrial and Systems Engineering</td>
<td>University of Minnesota</td>
<td>Industrial and Systems Engineering</td>
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<tr>
<td>Missouri University of Science</td>
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<td>University of Missouri</td>
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<tr>
<td>and Technology</td>
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<td>Montana State University</td>
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<td>University of South Florida</td>
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<tr>
<td>New Mexico State University</td>
<td>Industrial Engineering</td>
<td>University of Tennessee</td>
<td>Industrial and Information Engineering</td>
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<tr>
<td>North Carolina A&amp;T</td>
<td>Industrial and Systems Engineering</td>
<td>University of Texas at Arlington</td>
<td>Industrial and Manufacturing Systems Engineering</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>Industrial and Systems Engineering</td>
<td>University of Texas at El Paso</td>
<td>Industrial, Manufacturing and Systems Engineering</td>
</tr>
<tr>
<td>Northwestern University</td>
<td>Industrial Engineering and Management Sciences</td>
<td>University of Toronto</td>
<td>Mechanical and Industrial Engineering</td>
</tr>
<tr>
<td>Ohio State University</td>
<td>Integrated Systems Engineering</td>
<td>Virginia Tech University</td>
<td>Industrial and Systems Engineering</td>
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<tr>
<td>Ohio University</td>
<td>Industrial and Systems Engineering</td>
<td>Wayne State University</td>
<td>Industrial and Systems Engineering</td>
</tr>
<tr>
<td>Oregon State University</td>
<td>Mechanical, Industrial and Manufacturing Engineering</td>
<td>Western Michigan University</td>
<td>Industrial and Entrepreneurial Engineering</td>
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<tr>
<td>Purdue University</td>
<td>Industrial Engineering &amp; Regenstrief Center</td>
<td>Worcester Polytechnic Institute</td>
<td>Operations and Industrial Engineering</td>
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<tr>
<td>Rochester Institute of Technology</td>
<td>Industrial and Systems Engineering</td>
<td>Youngstown State University</td>
<td>Industrial and Systems Engineering</td>
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<tr>
<td>San Jose State University</td>
<td>Industrial and Systems Engineering</td>
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</tr>
</tbody>
</table>

HSEA Members
Job search characteristics

- Search was conducted on LinkedIn (http://www.linkedin.com/job/home) and IIE (http://www.iienet2.org/)

- Keywords: healthcare engineer

- 37 job listings found
Job market needs

• “Responsible for analyzing large amounts of clinical and financial data and turning key findings into strategic recommendations to improve outcomes and drive cost of care efficiencies.” Fairview Health Services

• “This person will play a role in driving the agenda for evaluating and prioritizing improvement opportunities through the use of statistical analysis, modeling, and industrial engineering.” Medical University of South Carolina

• “Proven ability to design and lead complex data management and analysis projects; familiarity with clinical information, including diagnostic coding and clinical databases; and in-depth knowledge of statistical analysis and programs, research methods, epidemiologic study design, quality performance measurement, and quality improvement are all essential.” NYU Langone Medical Center
HCSE Job Profile

Desired knowledge and skills*

- Direct interaction experience with environments within the healthcare industry; familiarity with clinical information, medical terminology, including diagnostic coding and clinical databases
- Process mapping and root cause analysis
- Healthcare data analytics, research methodology, statistical analysis and sampling methods, Machine Learning, Informational Retrieval, and Image Processing
- Complex database management
- Reliability and Risk Management FTA, FMECA, DFMEA
- Certification on quality improvement, Lean, Six Sigma, GMP and/or ISO regulated environment, FMEA, DOE, quality tools
- Software knowledge/proficiency in Word, Excel, PowerPoint, Minitab, Visio, Project, Java, Python, .NET.

*Based on a job search on the IIE career center and the LinkedIn job search (as of 30/08/2013).
Employers

• Fairview Health Services
• Medical University of South Carolina
• American Academy of Pediatrics
• Fairview Health Services
• Holy Redeemer
• NYU Langone Medical Center
• American Academy of Otolaryngology
• TrueBridge Resources
• Bloom Health
• Resources Global Professionals
• Optum Payer Market
• Humana
• Bureau of Naval Medicine and Surgery
• Allience HealthCare Services
• Smith & Nephew
• Siemens Healthcare Diagnostics Inc.
• API Healthcare
• MedSolutions
• Huron Consulting Group
• Siemens Healthcare Diagnostics Inc.
• NextGen Healthcare Information Systems
• CyberCoders
• Siemens Healthcare Diagnostics Inc.
• Siemens Healthcare Diagnostics Inc.
• Stoakley-Dudley Consultants, Ltd
• Johnson & Johnson
• STERIS Corporation
• Siemens Medical Solutions USA, Inc.
• Cyberonics
• Covidien
• Alere Analytics
• Geisinger Health System
• Planned Parenthood of the Pacific Southwest, Inc.
• The CSI Companies
• Kaiser Permanente
• Deloitte
USF Morsani College of Medicine
Health Systems Engineering Program

• A formal four year program that runs concurrently with the four years of medical school.

• Students apply for participation and are approved based on review of applications and interviews. There are typically 7-8 students per year.
USF Morsani College of Medicine
Health Systems Engineering Program

• Year 1. Human Error and Patient Safety. Weekly one hour group meetings/discussions
• Summer 1. Research. Students prepare research proposals, weekly meetings on Advanced Excel and Minitab, individual mentoring.
• Year 2. Systems Modeling and Optimization. Weekly 1-hour meetings to review reading assignment and assigned homework problems.
• Year 3. Analytics and Data Mining. Weekly meetings to review assigned reading and assigned homework problems.
• Year 4. Quality, LEAN, Six Sigma.
• Years 3 and 4. Conduct, perform, write manuscript for individual scholarly project in Health Systems Engineering.

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Probability and Statistics
• Summer 1- Probability and Statistics workshop- eight 1-hour sessions reviewing probability, statistics, common methods, plus Excel, Minitab, RExcel
• Year 4- Applied Probability and Statistics for Clinicians – 2 hour small group workshop on using concepts of probability, conditional probability, and statistical inference in clinical medicine. Sources of error and bias.

Patient Safety
• Year 4- Human Error and Patient Safety- students register for a typical 4 week “block”, but attend a one semester, 3 credit hour graduate course together with graduate students from engineering, nursing, public health, and USF residency/fellowship program
• Year 4- Patient Safety Education Program- all students required to attend one-day workshop on teaching/using patient safety principles in clinical medicine

September 20, 2013
Top Locations for Healthcare Engineer Jobs

Search was conducted on LinkedIn (http://www.linkedin.com/job/q-healthcare-engineer-jobs) as of 09/17/13

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Top locations for “Health-care” Engineer Jobs

<table>
<thead>
<tr>
<th>Location</th>
<th>Jobs</th>
</tr>
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<tbody>
<tr>
<td>San Francisco</td>
<td>83</td>
</tr>
<tr>
<td>New York</td>
<td>61</td>
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<tr>
<td>Boston</td>
<td>51</td>
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<tr>
<td>Chicago</td>
<td>45</td>
</tr>
<tr>
<td>Denver</td>
<td>30</td>
</tr>
<tr>
<td>Houston</td>
<td>24</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>19</td>
</tr>
<tr>
<td>Cleveland</td>
<td>19</td>
</tr>
<tr>
<td>Akron</td>
<td>20</td>
</tr>
<tr>
<td>Kansas City</td>
<td>23</td>
</tr>
</tbody>
</table>

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Top locations for “Healthcare” Engineer Jobs

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<tr>
<th>Location</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>174</td>
</tr>
<tr>
<td>New York</td>
<td>121</td>
</tr>
<tr>
<td>Boston</td>
<td>123</td>
</tr>
<tr>
<td>Chicago</td>
<td>107</td>
</tr>
<tr>
<td>Richmond</td>
<td>64</td>
</tr>
<tr>
<td>Dallas/Fort</td>
<td>58</td>
</tr>
<tr>
<td>Washington D.C.</td>
<td>54</td>
</tr>
<tr>
<td>Houston</td>
<td>49</td>
</tr>
</tbody>
</table>
Business School Alliance for Healthcare Management (BAHM)

• “Formed in 2010, BAHM is a collaborative non-profit organization comprised of business schools committed to the belief that management education, applied to the challenges of healthcare delivery and healthcare innovation, plays a special role in creating new and important solutions”

  2

• Arizona State University W. P. Carey School of Business
• Boston University School of Management
• Duke University Fuqua School of Business
• Harvard Business School
• Northwestern University Kellogg School of Management
• University of California – Berkeley
• University of Colorado – Denver
• University of Minnesota Carlson School of Management
• University of Pennsylvania Wharton School of Business
• Vanderbilt University Owen School of Business
• Yale School of Management

2 (http://www.bahm-alliance.org/about.php)