Research, Development & Education (R+D+E): Management and Innovation Required for the XXI Century

University of South Florida, Tampa - Florida
October 10 - 14, 2016
Welcoming to USF

By

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Dr. Luis Fernando Cruz. Director SCED-ISTEC@USF
$488.6 Million
A TOP 25 PUBLIC RESEARCH UNIVERSITY

USF SYSTEM FACTS 2016-2017
<table>
<thead>
<tr>
<th></th>
<th>USF System</th>
<th>USF Tampa</th>
<th>USF St. Petersburg</th>
<th>USF Sarasota-Manatee</th>
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<tbody>
<tr>
<td><strong>Undergraduate</strong></td>
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<td>23,641</td>
<td>2,740</td>
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<tr>
<td>male</td>
<td>704</td>
<td>704</td>
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<td>13</td>
<td>5</td>
<td>17</td>
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<tr>
<td>part-time</td>
<td>704</td>
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<td>116</td>
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<td><strong>Non-Degree seeking</strong></td>
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<td>1,976</td>
<td>121</td>
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<tr>
<td>female</td>
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<td>37</td>
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<td></td>
<td>1,272</td>
<td>1,085</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<tr>
<td>male</td>
<td>40,581</td>
<td>42,803</td>
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<td>32</td>
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<td>2</td>
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<td>33,944</td>
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<td>15,647</td>
<td>12,826</td>
<td>1,836</td>
<td>985</td>
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</table>
FIRST TIME IN COLLEGE (FTIC) ENROLLMENT

Enrollment Data as of Drop/Add Fall 2016
# New Student Profile (FTIC)

<table>
<thead>
<tr>
<th></th>
<th>USF System</th>
<th>USF Tampa</th>
<th>USF St. Petersburg</th>
<th>USF Sarasota-Manatee</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of new FTICs</td>
<td>2,948</td>
<td>2,465</td>
<td>396</td>
<td>87</td>
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<tr>
<td>average high school GPA</td>
<td>4.05</td>
<td>4.08</td>
<td>3.86</td>
<td>3.9</td>
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<tr>
<td>average SAT</td>
<td>1213</td>
<td>1226</td>
<td>1142</td>
<td>1133</td>
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<tr>
<td>mid-range SAT</td>
<td>1140-1280</td>
<td>1160-1290</td>
<td>1060-1220</td>
<td>1060-1190</td>
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<tr>
<td>average ACT</td>
<td>28</td>
<td>28</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>mid-range ACT</td>
<td>26-30</td>
<td>26-30</td>
<td>24-28</td>
<td>22-26</td>
</tr>
<tr>
<td>top 10% of high school class</td>
<td>31%</td>
<td>34%</td>
<td>18%</td>
<td>20%</td>
</tr>
<tr>
<td>Florida residents receiving Bright Futures scholarship</td>
<td>67%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>non-White</td>
<td>40%</td>
<td>41%</td>
<td>35%</td>
<td>22%</td>
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<tr>
<td>reside in on-campus housing (fall)</td>
<td>1,967 (66.7%)</td>
<td>1719 (69.7%)</td>
<td>248 (62.6%)</td>
<td>n/a</td>
</tr>
<tr>
<td>National Merit Scholars</td>
<td>15</td>
<td>15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>National Hispanic Scholars</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Florida residents</td>
<td>2,584</td>
<td>2,142</td>
<td>361</td>
<td>81</td>
</tr>
<tr>
<td>out-of-state students</td>
<td>364</td>
<td>323</td>
<td>35</td>
<td>6</td>
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<tr>
<td>Florida counties</td>
<td>48</td>
<td>45</td>
<td>34</td>
<td>8</td>
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<tr>
<td>states represented</td>
<td>37</td>
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<td>2</td>
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<tr>
<td>countries represented</td>
<td>68</td>
<td>64</td>
<td>10</td>
<td>5</td>
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<tr>
<td>Florida high schools</td>
<td>424</td>
<td>396</td>
<td>184</td>
<td>31</td>
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</table>
USF System Academics

- USF Tampa ranks among the top tier of colleges listed in the *U.S. News and World Report Best Colleges 2016*, ranking in the top 100 of best public national universities.

- According to the *Academic Ranking of World Universities* (ARWU) (2015), USF Tampa ranks among the top 300 of the best colleges and universities in the world.

- USF Tampa graduate level programs continue to be ranked among the best according to the 2017 *U.S. News and World Report Graduate School Rankings*. USF graduate programs in the top 50 include: Industrial and Organizational Psychology (#4), Public Health (#16), Audiology (#17), Criminology (#22), Library and Information Studies (#24), Rehabilitation Counseling (#24), Nursing (#40), Industrial/Manufacturing Engineering (#46), and Clinical Psychology (#50).

- USF Tampa is ranked among the best in 2016 *U.S. News and World Report’s Online Education Program rankings*. USF graduate programs ranked in the top 50 include: Information Technology (#14), Engineering (#20), Business (non-MBA) (#22), and Education (#36).

- USF Tampa was named one of the Top 100 Best Values in Public Colleges (#45) by *Kiplinger’s Personal Finance* for 2016.


- USF St. Petersburg’s undergraduate programs were ranked in the top 25 (#23) for all Public Southern Regional Universities by *U.S. News and World Report* (2016).
Presentation Objectives

- To **share knowledge** from Engineering Disciplines and tools designed to help us solve Complex Trans/Multi/Inter-disciplinary engineering challenges
- To **share** on-going efforts in **I+D+E** at the College of Engineering/Department of Electrical Engineering at USF
- To Emphasize the Importance of Creating Vehicles of Interaction Between Academia, Industry, Funding Agencies and Government and the impact of the ISTEC network

“Student Success is Everyone’s Responsibility....”
The Millennium Project

15 Global Challenges facing humanity

Sustainable development and climate change

1. Clean water
2. Population and resources
3. Democratization
4. Long-term perspectives
5. Global convergence of IT
6. Rich - poor gap
7. Health issues
8. Capacity to decide
9. Peace and conflict
10. Status of women
11. Transnational organized crime
12. Energy
13. Science and technology
14. Global ethics
15. Sustainable development and climate change

by The Millennium Project
www.millennium-project.org
What Are the Challenges that we face?

- Make solar energy economical
- Provide energy from fusion
- Develop carbon sequestration methods
- Manage the nitrogen cycle
- Provide access to clean water
- Restore and improve urban infrastructure
- Advance health informatics
- Engineer better medicines
- Reverse-engineer the brain
- Prevent nuclear terror
- Secure cyberspace
- Enhance virtual reality
- Advance personalized learning
- Engineer the tools of scientific discovery

Source: NATIONAL ACADEMY OF ENGINEERING
http://www.engineeringchallenges.org
Knowledge-enabled economies are able to constantly modernize their education systems in line with changes in: Societal needs & Economic policies.
Retos de la Investigación en la Región

- De manera creciente la sociedad reclama de la C&T aportes verificables que respondan a necesidades apremiantes de la sociedad
  - Hambre
  - Desnutrición
  - Pobreza extrema
  - Desempleo
  - Violencia y (PAZ)
  - Deterioro ambiental

- Los grandes desafíos sociales, económicos y ambientales del país, son un reto para la comunidad científica y tecnológica.
The following factors have placed great strains on American research universities.

- Declining funding
- Increasing competition from academic institutions worldwide,
- Intensifying compliance requirements from the federal government
- Loss of political and public confidence in the value of academic research

https://www.elsevier.com/connect/studytackleschallengesofusresearchuniversities
Study tackles challenges of US research universities

Facing increasing pressures and declining funding, institutions seek solutions for sustainability
Stovepipe Organization
Power to the Edge

“Power to the Edge involves the empowerment of individuals at the edge of an organization - where the organization interacts with its operating environment to have an impact or effect on that environment”
Research Challenges

Issues:
- Securing Resources
- Deadlines
- Funding Cycle
- Industrial Liaison
- Access to Information

Undergraduates (REU)
- Masters, Ph.Ds.
- Committee Composition
- Academic Policies
- Accreditation/Regulatory

Issues:
- Time Allocation
- # of Students
- Trans-disciplinary
- “Not To Reinvent The Wheel”
Research Centers/Groups

- Determine Research Areas
- Masters & Ph.Ds
- Networking

R&D with Societal Impact
“Economic Development”
Responsibility to Share Knowledge by Publishing in National and International Journals & Conferences
Form “Integral” Researchers

University

Must Promote
Best Practices and Advances in Program Management

Project Management for Research and Development

Guiding Innovation for Positive R&D Outcomes

Lory Mitchell Wingate
The Systems Engineering Role in Research & Development – (R&D&E&I)

• Can be the foundation upon which R&D success can be achieved

• R&D activities have an inherent ambiguity, a need for creative exploration, and often lack defined scope, milestones and outcomes.

• System of Systems (SoS) engineering processes also provide the insight necessary to make informed decisions about R&D progress along a trajectory, to take definitive action to stop or change course, and to document and use the results of experiments and testing to make timely course corrections.
Systems Engineering as a discipline:

✓ It provides structure and methods to define and organize projects
✓ To integrate activities and ensure that interfaces are correctly identified and addressed
✓ To ensures testing of components and systems are completed
✓ Manages risks and reviews
✓ Performs configuration management to ensure that design changes are tracked and implemented methodically so that the current configuration is always known.
The System Engineering “VEE”

Today, the VEE Development Model is part of systems engineering standards including EIA 632 and ISO 15288. It has become popular in a number of industries including automotive, banking, defense, and aerospace.
1. Identifying long-term goals and the assumptions behind them. Backwards mapping from the long-term goal by working out the preconditions or requirements necessary to achieve that goal—and explaining why.

2. Voicing your assumptions about what exists in the system without which your theory won’t work, and articulating your rationales for why outcomes are necessary preconditions to other outcomes.

3. Weighing and choosing the most strategic interventions to bring about your desired change.

4. Developing indicators to measure progress on your desired outcomes and assess the performance of your initiative.

5. Quality review should answer three basic questions: Is your theory 1) reasonable, 2) “doable” (or feasible), and 3) testable?

6. Writing a narrative to explain the summary logic of your initiative.
Requirements Allocation

KPPs

Define

MOEs

Estimate/Verify

MOE ↔ KPPs ↔ MOPs ↔ TPMs

Top-Down Traceability

Requirements/Doors DB

MOEs

KPPs

MOPs

TPMs

Development

Verification and Validation

Operational Requirements Documents, Initial Capabilities Document

Operational Concept Document

Functional Requirements Document

System of Systems Specification, System Requirements Specification

SW System Specification

Configuration Item Specification

Factory Acceptance Test

Operational Test

System Test

Performance
Driving Innovation with Project Management

• Innovation is inclusive of process, research, application, design, and many other activities, where R&D is typically identified with basic and applied research and product development.

The application of project management methodology can effectively enhance the performance of innovation projects.
How to prepare engineer students, faculty, researchers and university administrators to face such challenges?
Establish levels (statements, numbers, %, etc) of desired outcomes in order of relative importance.

Define the assessment methods to provide evidence of desired outcomes.

Identify the changes required in order to achieve the desired outcomes:
- In curriculum
- In teaching methods
- In learning environment
- In faculty
- In procedures
- In policies
- ...

Research existing knowledge of change theory to select most appropriate change strategy and perspective. Involve all action agents (students, faculty, stakeholders). Strive for a shared vision, reflective teachers and complexity leadership.
Electrical Engineering Modernization and Social Adaptation Using a Complex Systems Approach (EE MOSAICS)
The Florida Consortium of Metropolitan Research Universities is a joint effort of Florida International University, The University of Central Florida, and The University of South Florida.

Faculty Learning Communities (FLCs) in Chemistry, Biology, Mathematics, Physics, and Engineering.

FLCs will be charged to:

1. analyze data on student retention and graduation in their respective disciplines
2. investigate innovative programs and policies that may contribute to higher completion rates and student learning
Personalized Learning EcoSystem (PLES) @ USF:

“From Control Systems Theory/Solutions to System Deployment: Empowering Faculty & Students to Discover & Learn”

A Collaborative Proposal
NI – CoE/EE@USF – Quanser
Evidence-Based Approach

“Throughout the educational system, teaching has traditionally followed a one-size-fits-all approach to learning, with a single set of instructions provided identically to everybody in a given class, regardless of differences in aptitude or interest. Similar inflexibility has persisted in adult education programs that ignore differences in age, cultural background, occupation, and level of motivation” [1]

“To seriously consider implementing long term and conceptually deep changes in the science and mathematics curricula is an exciting prospect. Properly infused into the curriculum, the cross-disciplinary concepts and methodologies emerging from complex systems research have the potential to form the basis of a new and principled scientific literacy for our student to learn, one that is powerful and appropriate for dealing with the problems and demands of the 21 century” [2]

“Ongoing research in neuroscience is providing new insights into the intricacies of neural processes underlying learning, offering clues to further refine individualized instruction. Given the diversity of individual preferences, and the complexity of each human brain, developing teaching methods that optimize learning is a major challenge for the software engineers & educators of the future…” [1]

"Pedagogy" literally means "leading children.". "Andragogy" was a term coined to refer to the art/science of teaching adults. The four andragogical assumptions are that adults:

1) move from dependency to self-directedness;
2) draw upon their reservoir of experience for learning;
3) are ready to learn when they assume new roles; and
4) want to solve problems and apply new knowledge immediately. [3]

"Power to the Edge" is an information and organization management philosophy first articulated by the U.S. Department of Defense that refers to the ability of an organization to dynamically synchronize its actions and achieve agility. The term is most commonly used in relation to military organizations, but it can equally be used in a civilian context, i.e Education – By Empowering the “people” at the “Edge” that are carrying out the mission of the organization, i.e. “Faculty/Students….”[4]

1 http://www.engineeringchallenges.org/cms/8996/9127.aspx
2 Complex Systems and Education: Cognitive, Learning, and Pedagogical Perspectives by Michael Jacobson & Working Group 2 Collaborators
3 http://www.educatorstechnology.com/2013/05/awesome-chart-on-pedagogy-vs-andragogy.html
R+D+E from a Complex Systems Perspective

Fundamental Knowledge

Knowledge Based on Disciplines

Management & Organizational Theories

Values, Ethics & Principles

Research Methodologies & Strategies
“Innovation Opportunity via Social Responsibility”

1. **Identify “A NEED….”**
2. **Theory - Curriculum Integration**
3. **Design/Simulate - Real World I/O Integration**
4. **Prototype - Industry Integration**
5. **Deploy**

**Social Impact**
“AN INTEGRAL”: Engineer/Researcher/Educator

- Create technologies and infrastructure to address human, social and economic issues, and challenges
- Connect social needs with innovation and commercial applications – “Economic Development”.
- To form the engineer prepared to face the challenges of the 21st century
Too many startups (engineers) begin with an idea for a product that they think people want.

They then spend months, sometimes years, perfecting that product without ever showing the product to the prospective customer.

When they fail, it is often because they never spoke to prospective customers and determined whether or not the product was interesting.
United Nation’s definition of Sustainable Development

El desarrollo sustentable es el desarrollo que satisface las necesidades del presente sin comprometer la capacidad de las generaciones futuras para satisfacer sus propias necesidades
The Millennium Project

“Son tiempos de grandes oportunidades y optimismo puesto que la aplicación de las nuevas tecnologías emergentes no sólo tienen la capacidad de mejorar la calidad de vida, pero también permiten la creación y el florecimiento de nuevas comunidades y instituciones sociales mejor preparadas para afrontar las necesidades de nuestra sociedad"
Innovación ....

“En realidad la mayoría de innovaciones son creadas a través de REDES – grupos de personas trabajando en "concordancia"

Dr. Andrew B. Hargadon
Professor of Management
Director, Technology Management Programs
Faculty Director, UC Davis Center for Entrepreneurship