Developing Engineering Systems Graduate Education in Portugal

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Motivation

- Economic and social development calls for **highly educated leaders**:
  - who understand the **technical nature** of society's most important systems;
  - who are able to use **combined approaches** from Engineering, Management and Social Sciences to model, design an manage these systems.
- Since the 1970's, leading universities in US and Europe have started to establish academic and research initiatives to address this challenge.

Motivation

- International outreach and collaboration initiatives, such as the MIT-Portugal Program, have contributed to raise awareness for the critical role of Engineering Systems (ES) in the advancement of engineering education.
- Companies and government institutions are also becoming increasingly aware of the need for ES practitioners.

Background

- One of the objectives of the MIT-Portugal Program is to develop ES as a new field of study in the Portuguese University.
- We have been visiting scholars at the Engineering Systems Division (ESD), MIT.
- Opportunity to be engaged in ES graduate education and research programs:
  - needs for ES graduate education;
  - portfolio of programs that may be implemented;
  - capabilities required to deliver them.

Approach

- The approach to provide ES graduate education is organized along the following three interrelated dimensions:
- ***teaching***,
- ***research*** and
- ***outreach***.

Teaching

- Curricula for graduate ES education should be the base for educating students in:

1. The ***fundamentals*** (concepts, properties and principles) of ES;
2. A set of quantitative and qualitative ***methodologies*** drawn from a variety of disciplines;
3. A ***domain*** or context of their choosing in which they may specialize.

Research

- Research on ES should build new insights that are relevant for students, scholars, industry and government leaders, by:

1. Developing new ***ES methodologies*** or introducing innovative combinations of existing methodologies from various disciplines;
2. Tackling ***socio-technical complex systems*** problems in a specific domain or context;
3. Developing a deeper ***understanding of ES concepts and approaches***.

Outreach

1. Developing ***partnerships*** between different universities:
   - with expertise in **engineering**, **management**, and **social science**,
   - demonstrating a commitment to *establishing ES as a new academic field in Portugal*.
2. Participating in international efforts for the *diffusion and acceleration of ES graduate education*.
   - CESUN could be a host for annual roundtables on ES education.

Current situation

- ES components are present at Portuguese universities
  - Network theory, systems dynamics, probability models, decision analysis, optimization, simulation, game theory, agent-based modeling, etc.
- Interdisciplinary capabilities:
  - pioneer work within traditional departments – urban planning, transportation systems, energy systems;
  - emerging joint initiatives between engineering and other disciplines – information sciences, technology entrepreneurship, services engineering and management, etc.

Current situation

- MIT-Portugal Program seeks to implement the ES vision in four focus areas: **bio-engineering**, **engineering design and advanced manufacturing**, **sustainable energy**, and **transportation**.
- Key concerns that may be present in Portuguese universities, for implementing ES initiatives:
  - sustainability;
  - placement of students and brand awareness;
  - integration in conventional departmental organizations;
  - suspicion towards applied, multidisciplinary work.

Future work

- Assess the circumstances for further development of ES initiatives in Portuguese universities.
  - Thorough identification of existing teaching and research capabilities.
  - Survey private and public institutions for education needs and support.
  - Analyze existing ES graduate education models to determine what we (don't) need to invent.
- Valuable set of guidelines on:
  - building blocks to consider,
  - advocates and resources to mobilize,
  - obstacles to overcome.