# Educating I-Shaped Computer Science Students to Become T-Shaped System Engineers

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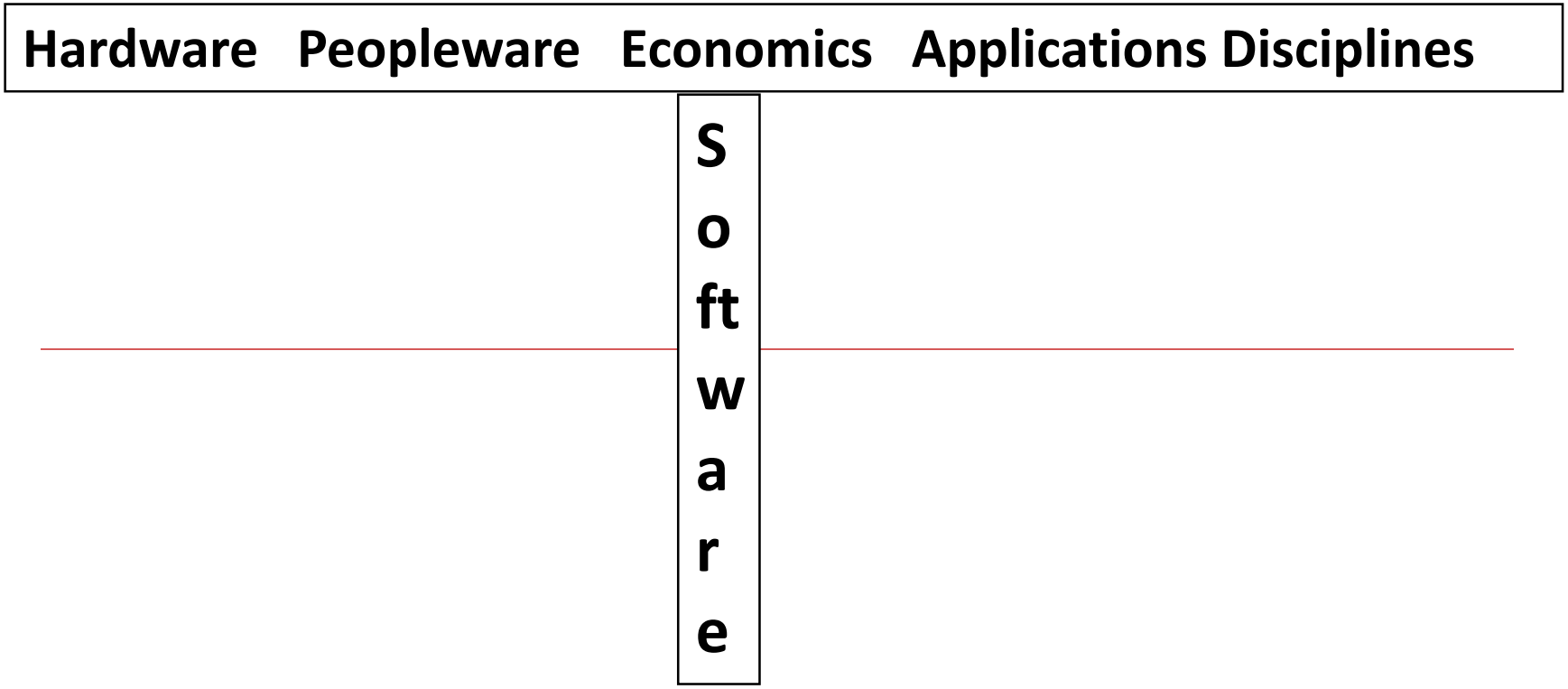


**Barry Boehm, University of Southern California**

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# Personal USC Agenda

- Simon Ramo: Our best TRW engineers are T-shaped
  - Strong in at least one technical discipline
  - With working knowledge of other success-critical disciplines
- But most of our software new-hires were I-shaped CS grads
- Early retirement decision: try to create T-shaped SW-engineers
  - USC MS-CS with specialization in software engineering
  - Key courses include software architecture, user interaction, software test & analysis, software management & economics
  - And 2-semester real-client project course (2000 students to date)
    - Foundation-stone rather than capstone
    - Clients generally unfamiliar with software technology
    - Fall semester focused on software-intensive systems engineering
      - Operations concept, Winbook requirements negotiation, prototyping, architecture, life cycle plans, compatibility and feasibility evidence

# Factors contributing to I-shaped software engineer problems

- An increasing number of new computer science (CS) degree programs fill up CS students' schedules. CS "breadth courses" are more CS courses.
- Hardware-first system engineering practices often discourage software engineers to participate in system engineering activities.
- Narrow-focused Software-CMM (Capability Maturity Model) provided further discouragement. Here is KPA 1 (Rqts Engr), Activity 1:
  - Analysis and allocation of the system requirements is not the responsibility of the software engineering group but is a prerequisite for their work

# Example problems created by I-shaped software engineers

- **The Golden Rule:** Do unto others as you would have others do unto you, i.e., build programmer-friendly user interfaces for doctors,
  - **Platinum Rule:** Do unto others as they would be done unto.
- **Computer scientists prize abstraction**
  - **User name:** U1, U2 vs Jim, Tina
  - Inventing personas effectively helps students represent classes of stakeholders
- **Making programmer-convenient, but user-inconvenient decisions**
  - 10-day data buckets vs weekly, monthly reporting

# T-shaped MSCS-SwEngr degree program

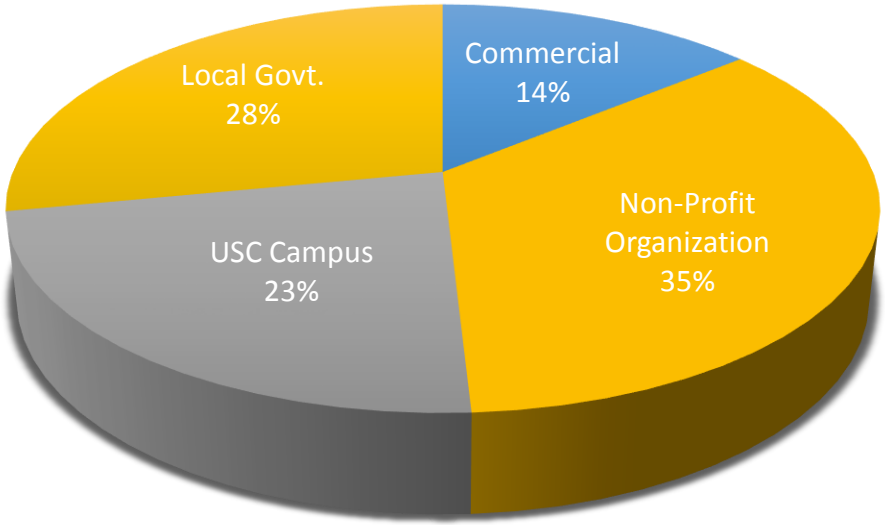
- Foundation-stone real-client project course
- Software Management and Economics
- User Interface Design and Development
- Hardware-Software Embedded Systems
- Systems and Software Architecting
  - Using Rechtin Systems Architecting approach
- Later courses in agile methods, software verification and validation, systems and software requirements

# Software Engineering Project Class

- **Objectives**
  - **Prepare students for software leadership careers through the 2050's**
- **Covers**
  - **Stakeholder Win-Win, requirement management, object-oriented analysis and design, risk management, quality management, peer reviews, configuration management, and value-based software engineering**
- **12 weeks in Fall**
  - **Focuses on software plans, processes, requirements, architectures, risk analysis, and feasibility analysis**
- **12 weeks in Spring**
  - **Focuses on software product creation, integration, test, and maintenance**

# Software Engineering Project Clients

- **E-services applications**
- **USC Neighborhood organizations**



# Foundation-Stone Course Practices (1/2)

## Joint with Sue Mobasser while at USC

- Visit clients' workplace and jointly develop a desired concept of operation
- Jointly negotiate prioritized stakeholder win-win requirements
- Jointly develop evaluation criteria for choices of non-developmental items
- Jointly determine and prioritize project risks, develop risk mitigation plans
- Develop clients' business case linking investments to quantitative and qualitative benefits

# Foundation-Stone Course Practices (2/2)

- Identify complementary client activities
- Participate in 4 major milestone reviews with clients and instructors
- Develop initial increment and hold a client Core Capability Drivethrough
- Jointly negotiate prioritized end-game revisions
- Transition software and support materials

# Resulting Student Benefits

## Hiring organizations come back for more

- CS students need more than CS skills to survive in an inter-disciplinary world
- With T-shaped curriculum, students can
  - Build up their job interview portfolio
  - Acquire non-outsourceable skills
  - Have a better understanding of hiring manager needs
  - Come up a rapid assimilation curve, and
  - Learn how to learn
- Rapid changes in technology make systems-oriented software engineers critical to the success of most future system developments