Educating the Next Generation of Software Engineers

Nicole Hutchison

Art Pyster, Kahina Lasfer

NDIA SE Conference
October 2009

nicole.hutchison@anser.org

Discussion Topics

- How the world has changed
- The current state of software engineering education
- Creating and disseminating a new reference curriculum
- And next?

There are precious few interesting man-made systems whose success is not critically dependent on software.

Twenty years from now, software people will be sitting at the table and the other disciplines will be sitting around the sides of the room.

Eberhardt Rechtin, 1993

There are precious few interesting software systems anywhere whose success is not critically dependent on the developers practicing good systems engineering.

What do we teach for a master's degree in software engineering?

- The last effort to create a reference curriculum for graduate software engineering education was by the SEI in the early 1990s.
- There are, in effect, no current community-endorsed recommendations on what to teach software engineers – nothing that recognizes how the world has changed.
- Response: create a project to create a new reference curriculum in software engineering

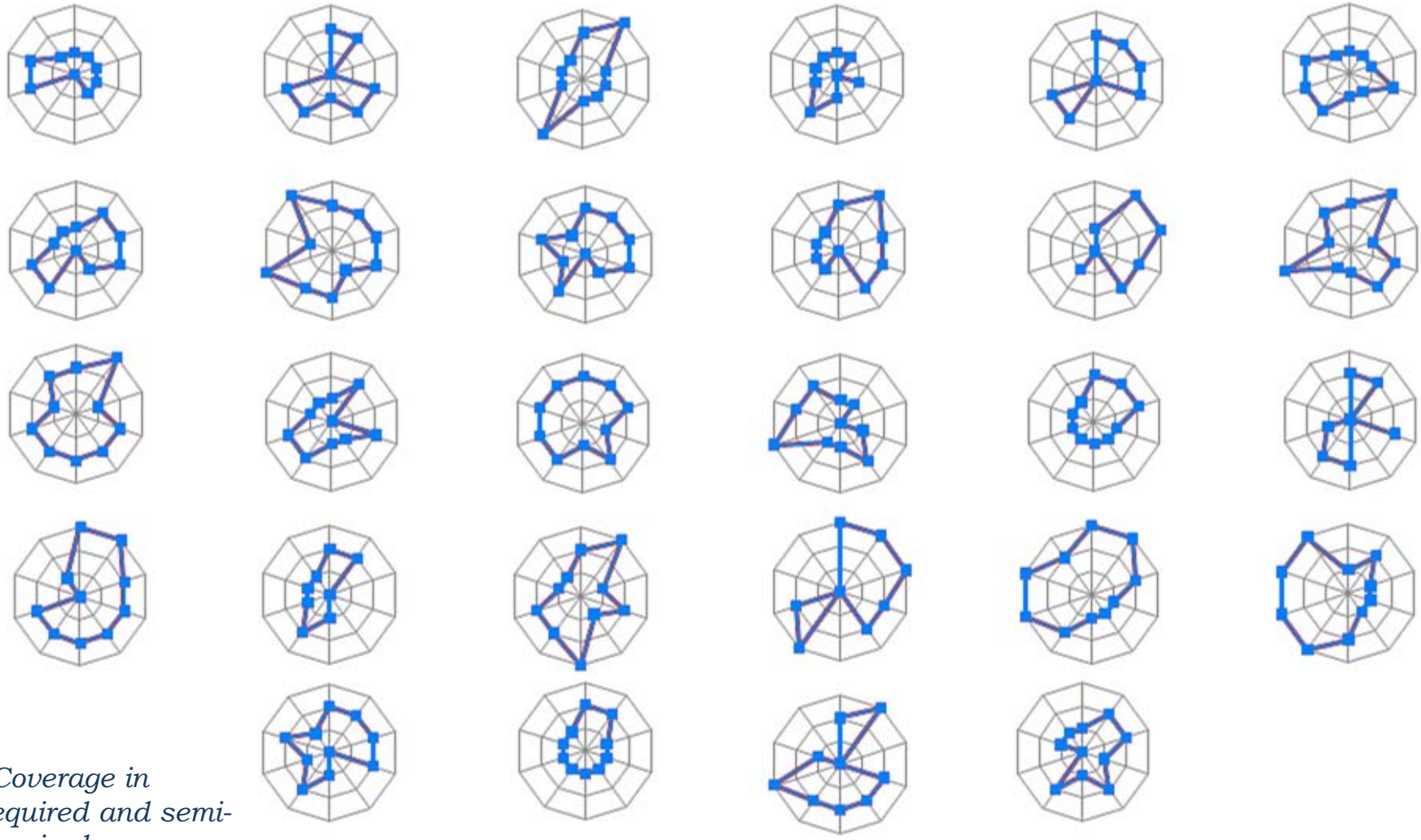
The Integrated Software and Systems Engineering Curriculum (iSSEc) Project

- Begun in May 2007 at Stevens Institute of Technology
- Sponsored by DoD Director of Systems and Software Engineering
- Three products planned:
  1. A modern reference curriculum for a master's degree in software engineering that integrates an appropriate amount of systems engineering
  2. A modern reference curriculum for a master's degree in systems engineering that integrates an appropriate amount of software engineering
  3. A truly interdisciplinary degree that is neither systems nor software engineering – it is both

1st Project – Graduate Software Engineering 2009

1. Understand the current state of SwE graduate education (November 2007)
2. Create GSwE2009 0.25 (formerly GSwERC) with a small team, suitable for limited review (February 2008)
3. Publicize effort through conferences, papers, website, etc (continuous)
4. Create GSwE2009 0.50 (formerly GSwERC) suitable for broad community review and early adoption (October 2008)
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

SWEBOK coverage* in 2007 across 28 SwE MS programs



**Coverage in required and semi-required courses*

The curriculum author team

- Rick Adcock, Cranfield University and INCOSE representative, UK
- Edward Alef, General Motors, USA
- Bruce Amato, Department of Defense, USA
- Mark Ardis, Stevens Institute of Technology, USA
- Larry Bernstein, Stevens Institute of Technology, USA
- Barry Boehm, University of Southern California, USA
- Pierre Bourque, Ecole de Technologie Superieure and co-editor of 2010 SWEBOK update, Canada
- John Brackett, Boston University, USA
- Murray Cantor, IBM, USA
- Lillian Cassel, Villanova and ACM representative, USA
- Robert Edson, Analytic Services Inc., USA
- Richard Fairley, Colorado Technical University, USA
- Dennis Frailey, Raytheon and Southern Methodist University, USA
- Gary Hafen, Lockheed Martin and NDIA, USA
- Thomas Hilburn, Embry-Riddle Aeronautical University, USA
- Greg Hislop, Drexel University, and IEEE Computer Society representative, USA
- David Klappholz, Stevens Institute of Technology, USA
- Philippe Kruchten, University of British Columbia, Canada
- Phil Laplante, Pennsylvania State University, Great Valley, USA
- Qiaoyun (Liz) Li, Wuhan University, China
- Scott Lucero, Department of Defense, USA
- John McDermid, University of York, UK
- James McDonald, Monmouth University, USA
- Ernest McDuffie, National Coordination Office for NITRD, USA
- Bret Michael, Naval Postgraduate School, USA
- William Milam, Ford, USA
- Ken Nidiffer, Software Engineering Institute, USA
- Art Pyster, Stevens Institute of Technology, USA
- Paul Robitaille, Lockheed Martin, USA
- Mary Shaw, Carnegie Mellon University, USA
- Sarah Sheard, Third Millenium Systems, USA
- Robert Suritis, IBM, USA
- Massood Towhidnejad, Embry-Riddle Aeronautical University, USA
- Richard Thayer, California State University at Sacramento, USA
- J. Barrie Thompson, University of Sunderland, UK
- Guilherme Travassos, Brazilian Computer Society, Brazil
- Richard Turner, Stevens Institute of Technology, USA
- Joseph Urban, Texas Tech University, USA
- Ricardo Valerdi, MIT & INCOSE, USA
- David Weiss, Avaya, USA
- Mary Jane Willshire, Colorado Technical University, USA

Creating GSwE2009 0.25

1. Understand the current state of SWE graduate education (November 2007)
2. *Create GSwE2009 0.25 (formerly GSwERC) with a small team, suitable for limited review (February 2008)*
3. Publicize effort through conferences, papers, website, etc (continuous)
4. Create GSwE2009 0.50 suitable for broad community review and early adoption (October 2008)
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

Publicize effort

1. Understand the current state of SWE graduate education (November 2007)
2. *Create GSwE2009 0.25 with a small team, suitable for limited review (February 2008)*
3. *Publicize effort through conferences, papers, website, etc (continuous)*
4. Create GSwE2009 0.50 suitable for broad community review and early adoption (October 2008)
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

Publicize effort

1. Past and planned presentations and workshops at numerous conferences, including:
   - NDIA Systems Engineering Conferences 2007, 2008, and 2009; INCOSE International Symposium 2008 and 2009, ASEE 2008, Asian-Pacific INCOSE Conference 2008, SIGCSE 2008 and 2009, ICSE 2009, CSEET 2009, …
2. Short articles and announcements in SEWORLD, INCOSE Insight, …
3. Full article on survey of existing programs to appear in *IEEE Software* in fall 2009
4. Website at www.GSwE2009.org
5. Additional full articles in IEEE and ACM magazines planned

Creating GSwE2009 0.50 and 1.0

1. Understand the current state of SWE graduate education (November 2007)
2. Create GSwE2009 0.25 with a small team, suitable for limited review (February 2008)
3. Publicize effort through conferences, papers, website, etc (continuous)
4. *Create GSwE2009 0.50 (formerly GSwERC) suitable for broad community review and early adoption (October 2008)*
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

Creating GSwE2009 0.50 and 1.0

1. Understand the current state of SWE graduate education (November 2007)
2. Create GSwE2009 0.25 with a small team, suitable for limited review (February 2008)
3. Publicize effort through conferences, papers, website, etc (continuous)
4. *Create GSwE2009 0.50 (formerly GSwERC) suitable for broad community review and early adoption (October 2008)*
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

Expectations at entry (from version 0.5+)

DEGREE:

The equivalent of an undergraduate degree in computing or an undergraduate degree in an engineering or scientific field and a minor in computing

SWE COURSE:

The equivalent of an introductory course in software engineering

EXPERIENCE:

At least two years of practical experience in some aspect of software engineering or software development

Outcomes at graduation (from Version 0.5+)

CBOK:

Master the Core Body of Knowledge

DOMAIN:

Be able to apply software engineering in at least one application domain, such as finance, medical, transportation, or telecommunications, and in one application type, such as real-time, embedded, safety-critical, or highly distributed systems. That ability to apply software engineering includes understanding how differences in domain and type manifest themselves in both the software itself and in their engineering, and includes understanding how to learn a new application domain or type.

DEPTH:

Have mastered at least one knowledge area or sub-area from the Core Body of Knowledge to at least the Bloom Synthesis level.

Outcomes at graduation

ETHICS:

Be able to make ethical professional decisions and practice ethical professional behavior.

SYSTEMS ENGINEERING:

Understand the relationship between software engineering and systems engineering and be able to apply systems engineering principles and practices in the engineering of software.

TEAM:

Be able to work effectively as part of a team, including teams that may be multinational and geographically distributed, to effectively communicate both orally and in writing, and to lead in one area of project development, such as project management, requirements analysis, architecture, construction, or quality assurance.

Outcomes at graduation

RECONCILIATION:

Be able to reconcile conflicting project objectives, finding acceptable compromises within limitations of cost, time, knowledge, risk, existing systems, and organizations.

PERSPECTIVE:

Understand and appreciate the importance of feasibility analysis, negotiation, effective work habits, leadership, and good communication with stakeholders in a typical software development environment.

LEARNING:

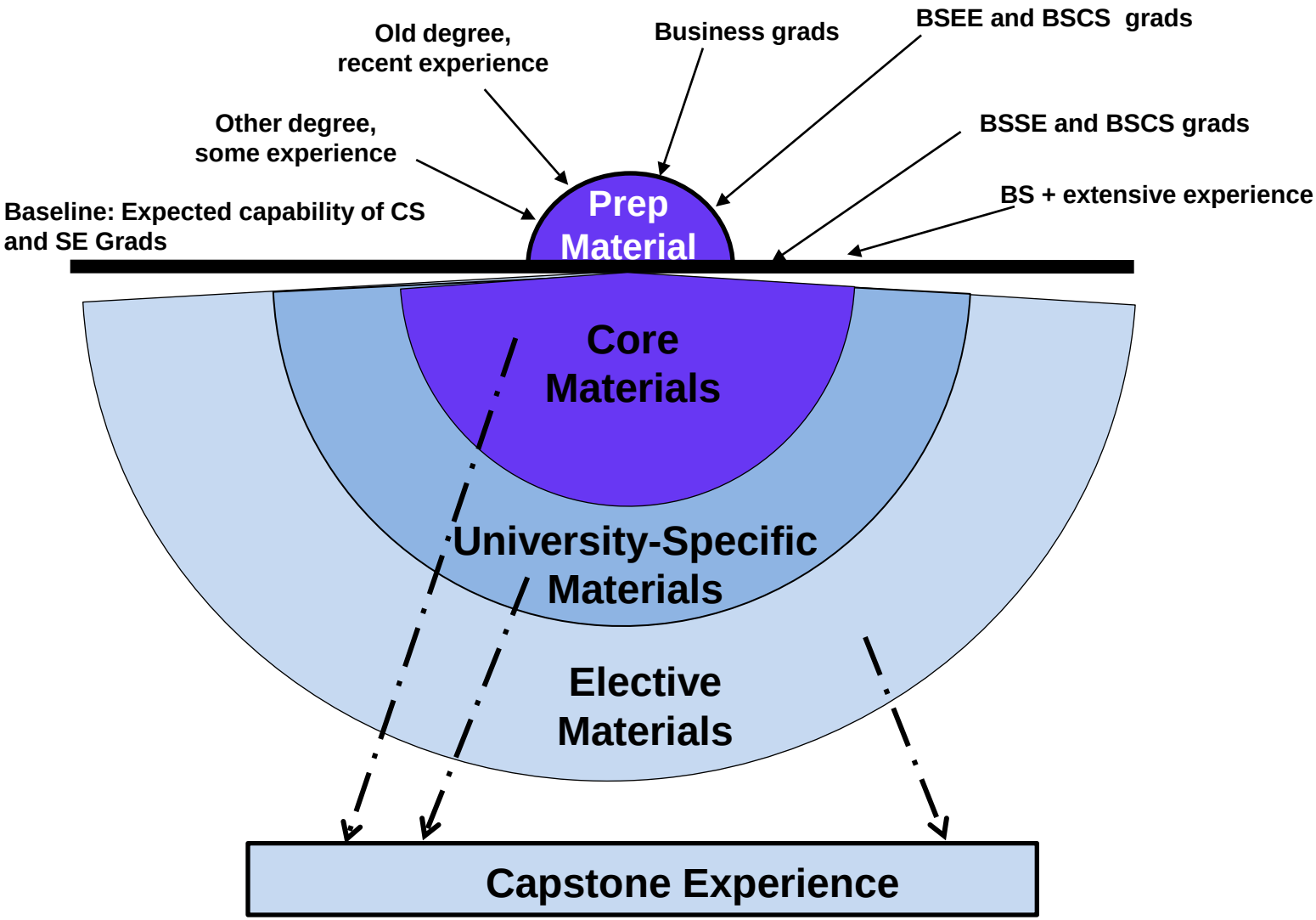
Be able to learn and apply new models, techniques, and technologies as they emerge, and appreciate the necessity of such continuing professional development.

Outcomes at graduation

TECHNOLOGY:

Be able to analyze a current significant software technology, articulate its strengths and weaknesses, compare it to alternative technologies, and specify and promote improvements or extensions to that technology.

Curriculum architecture



GSwE2009 Release

- Version 1.0 was released to the international SwE community Sept. 30, 2009.
  - Delivered to US DoD OSD
  - Delivered to ACM EB, IEEE CS, INCOSE, and CAT
  - The document is available online at www.gswe2009.org/curriclum/recommendations/document.pdf

Post-version 1.0 governance

1. Understand the current state of SWE graduate education (November 2007)
2. Create GSwE2009 0.25 with a small team, suitable for limited review (February 2008)
3. Publicize effort through conferences, papers, website, etc (continuous)
4. Create GSwE2009 0.50 suitable for broad community review and early adoption (October 2008)
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

Implementation help

- Comparison of existing graduate software engineering programs with GSwE2009 recommendations – know how big the gap is between recommendations and practice
- Strategies recommended by the authors to implement GSwE2009
- Hypothetical modifications of existing programs to more fully satisfy GSwE2009
- Workshops targeted to department heads and faculty
  - Build a business case for GSwE2009
  - Facilitate curriculum modification or development to align with GSwE2009 recommendations

Preparing for Post 1.0 World

- GSwE2009 v1.0—primary recommendations document—released Sept 30, 2009
- Two companion documents for GSwE2009 will be delivered October 2009:
  - Implementation guidance organized as an FAQ
  - Comparison of current SwE programs to GSwE2009
- Primary recommendations are typical of what professional societies traditionally shepherd
- Implementation guidance and comparisons are less typical of what professional societies traditionally shepherd

Possible long-term governance

- ACM, IEEE CS, INCOSE, NDIA SE, and the Brazilian Computer Society all participating in GSwE2009 creation.
- Joint ACM and IEEE CS (primary), and INCOSE (supportive) governance model for Curriculum Recommendations is desirable with periodic updates.
- Small volunteer body to provide periodic updates of FAQ and comparisons materials with website support including forums, wikis, and other open collaboration structure.
- Implementation workshops at conferences, summer faculty workshops, and other activities would promote adoption. The CAT is currently seeking assistance from the NSF to support these workshops.

BKCASE

- INCOSE sponsored a graduate systems engineering (SE) reference curriculum published in 2007.
- The SE curriculum development process did not have the scale of participation that GSwE2009 has and is limited by the fact that the INCOSE SE Body of Knowledge (see http://g2sebok.incose.org) is much less robust and mature than SWEBOK.
- INCOSE would like to mature the SE body of knowledge, which would be a strong foundation on which to base an upgraded SE curriculum.
- The U.S. Department of Defense is considering sponsoring a project to update and mature the SE body of knowledge with INCOSE and create a mature SE reference curriculum. The effort would be similar to GSwE2009 with open collaborative international participation and fully shared resulting intellectual property.
- Other professional societies would be welcome to participate.

Summary

- GSwE2009 v1.0 delivered September 30, 2009.
- Professional societies are considering taking ownership of the curriculum after it is published.
  - IEEE CS Educational Advisory Board voted to become sponsors of GSwE2009 October 2009
- GSwE2009 companion documents scheduled for release Fall 2009
- Adoption workshops anticipated summer 2010

Questions?