Computing Curriculum 2020: A Global Initiative
Alison Clear

ACM COMPUTE 2018, Chandigarh 14th Oct 2018
Alison Clear

- Associate Professor at Eastern Institute of Technology, Auckland campus
- Fellow ITPNZ
- Fellow CITRENZ
- Over 40 years of teaching computing
- Previous Vice chair and Board member of SIGCSE
- Co-Chair CC2020
Introduction - New Zealand
New Zealand
New Zealand - India
CC2020 - What is it?

A multi-organizational global project to build on CC2005, consolidate all new curricular reports and produce futuristic tools for educators, students and employers
To produce a modern replacement for the CC2005 Computing Curricula Document by the end of 2020
Sponsors

- ACM
- IEEE - Computer Society
- AITP-EDSIG
- AIS
- SIGCHI
CC2020 Task Force Structure

Steering Committee
- A subset of the task force, currently, 13 people
- Does overall visioning and planning for the group
- Two co-chairs (ACM and IEEE Computer Society)

Task Force:
- Currently 36 people, representing 16 countries, from 6 continents
- Members handle much of the ongoing activities

Additional Participants
- Contributors
- Reviewers
# Steering Committee Members

<table>
<thead>
<tr>
<th>Steering Committee Members</th>
<th>Sponsor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alison Clear (New Zealand)</td>
<td>ACM</td>
</tr>
<tr>
<td>Allen Parrish [USA]</td>
<td>IEEE</td>
</tr>
<tr>
<td>Ernesto Cuadros-Vargas [Peru]</td>
<td>IEEE</td>
</tr>
<tr>
<td>Stephen Frezza [USA]</td>
<td>IEEE</td>
</tr>
<tr>
<td>John Impagliazzo [USA]</td>
<td>ACM</td>
</tr>
<tr>
<td>Heikki Topi [USA]</td>
<td>AIS</td>
</tr>
<tr>
<td>Gerrit van der Veer [Netherlands]</td>
<td>SIGCHI</td>
</tr>
<tr>
<td>Abhijat Vichare [India]</td>
<td>ACM</td>
</tr>
<tr>
<td>Arnold Pears [Sweden]</td>
<td>IEEE</td>
</tr>
<tr>
<td>Shingo Takada [Japan]</td>
<td>ACM</td>
</tr>
<tr>
<td>Les Waguespack [USA]</td>
<td>AITP-EDSIG</td>
</tr>
<tr>
<td>Pearl Wang [USA]</td>
<td>IEEE</td>
</tr>
<tr>
<td>Ming Zhang [China]</td>
<td>ACM</td>
</tr>
</tbody>
</table>
## Full Task Force Members

<table>
<thead>
<tr>
<th>Full Name</th>
<th>Country</th>
<th>Full Name</th>
<th>Country</th>
<th>Full Name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alison Clear</td>
<td>NZ</td>
<td>Allen Parrish</td>
<td>US</td>
<td>Hala Alrumaih</td>
<td>Saudi Arabia</td>
</tr>
<tr>
<td>Ernesto Cuadros-Vargas</td>
<td>Peru</td>
<td>Adrienne Decker</td>
<td>US</td>
<td>Eric Durant</td>
<td>US</td>
</tr>
<tr>
<td>Eiji Hayashiguchi</td>
<td>Japan</td>
<td>John Impagliazzo</td>
<td>US</td>
<td>Richard LeBlanc</td>
<td>US</td>
</tr>
<tr>
<td>Tania McVeety</td>
<td>US</td>
<td>Bruce McMillin</td>
<td>US</td>
<td>Linda Marshall</td>
<td>South Africa</td>
</tr>
<tr>
<td>Mirella Moro</td>
<td>Brazil</td>
<td>Arnold Pears</td>
<td>Sweden</td>
<td>Teresa Pereira</td>
<td>Portugal</td>
</tr>
<tr>
<td>Ariel Sabiguero</td>
<td>Uruguay</td>
<td>Simon</td>
<td>Australia</td>
<td>Shingo Takada</td>
<td>Japan</td>
</tr>
<tr>
<td>Paul Tyman</td>
<td>US</td>
<td>Gerrit van der Veer</td>
<td>Netherlands</td>
<td>Abhijat Vichare</td>
<td>India</td>
</tr>
<tr>
<td>Les Waguespack</td>
<td>US</td>
<td>Pearl Wang</td>
<td>US</td>
<td>Ming Zhang</td>
<td>China</td>
</tr>
<tr>
<td>Olga Bogoyavlenskaya</td>
<td>Rus</td>
<td>Marisa Exter</td>
<td>US</td>
<td>Jane Yung</td>
<td>China</td>
</tr>
<tr>
<td>Barry Lunt</td>
<td>US</td>
<td>Nancy Mead</td>
<td>US</td>
<td>Melinda Reno</td>
<td>US</td>
</tr>
<tr>
<td>Heikki Topi</td>
<td>US</td>
<td>Heikki Topi</td>
<td>US</td>
<td>Barbara Viola</td>
<td>US</td>
</tr>
<tr>
<td>Stu Zweben</td>
<td>US</td>
<td>Ming Zhang</td>
<td>China</td>
<td>Stu Zweben</td>
<td>US</td>
</tr>
</tbody>
</table>
Scope

- A three year project
- Not just a rewrite of CC2005
- A document that can be used by all areas of computing
- A document that can be used globally
- A “futuristic” document
- International collaboration
COMPUTING

- Information Technology
- Data Science
- Information Systems
- Cyber Security
- Software Engineering
- Computer Science
- Computer Engineering
- Artificial Intelligence
Degree Names

- Bachelor of
  - Science
  - Computer Science
  - Computer and Information Sciences
  - Information Systems
  - Information Technology
  - Computer Science and Technology
  - Technology
    - And many thousands more
What do we call the field/industry/profession

Information and Communications Technology

Information Technology

Computer Science

Hi-Tech

Computer Systems

Google!

Software Industry
CC2020 Activities

Adopted the word “Computing” as a unifying term

Adopted “Competency” to represent the future of all computing reports  
\[ \textit{Competency} = \textit{Knowledge} + \textit{Technical Skill} + \textit{Human Disposition} \]
to become the foundation for those reports

Develop modern visualizations to represent computing competency

Generate interactive computing tools useful for academia and industry
What is CC2005?

CC2005 = Computing Curricula 2005

Defined the computing disciplines at the baccalaureate level

Illustrated the knowledge scope of five computing disciplines

Provided comparison tables contrasting the five disciplines
CC2005 Areas of Computing

- Computer Engineering
- Computer Science
- Software Engineering
- Information Systems
- Information Technology
ACM Curriculum Documents

- IS2010
- CS2013
- SE2014
- CE2016
- IT2017
- Cyber Security
- Data Science (in development)
Visualization from CC2005
Visualization from CC2005 Computer Engineering
Visualization from CC2005 Computer Science
Visualization from CC2005 Information Systems

Organizational System Issues
Application Technologies
Software Development
Systems Infrastructure
Computer Hardware and Architecture

Theory Principles Innovation
DEVELOPMENT
More Theoretical More Applied
Application Deployment Configuration
Visualization from CC2005
Information Technology
Visualization from CC2005
Software Engineering
Visualization from CC2005
All Computing
Accords: Washington & Seoul

- Washington Accord - Requires countries to create a body to develop accreditation NBA
- Seoul Accord - countries accredit programs under the criteria of the accord. All signatories agree to accredit programs according to the set criteria
- My own institution accreditation

- ABET - used CC2005 to develop criteria
- CC2020 will be able to be used by accreditation bodies to develop accreditation criteria
CC2020 Deliverables

- Report in two parts
  - How all the areas of computing/curricular documents work together now and in the future
  - The future of computing education

- Interactive “heat map” website
  - All knowledge areas, data driven, based on competencies
  - Ability to “map” your own degree programs
  - “example” degree programs from each area
Data Collection to date..

- 2017 Survey 2000+ replies
- Dissemination at
  - FIE (USA)
  - SIGCSE (USA)
  - ITiCSE (Europe)
  - EDUCON (Spain)
  - EDUNINE (South America)
  - ACE (Australasia)
  - TURC (China)
  - Computing Education Futures (China)
  - FIE (San Jose, USA)
- Meetings planned for
  - Lima, Peru and Latin America, October 2018
  - Chengdu, China, May 2019
  - Goa, India, October 2019
Global Implications

1. CC2020 should have a far-reaching and global effect on computing programs worldwide

2. Nomenclature varies globally and even within countries
   a. Universities better able to design their curriculum benchmarking other institutions

3. Countries wishing to be part of change can become increasingly involved
   a. Earlier curricular reports were mostly U.S.-centric efforts
   b. Professional societies from non-English speaking countries can translate documents into their local languages
   c. Sixteen countries already part of the CC2020 project
Competencies

Competency = Knowledge + Skill + Disposition

in Context

Competency = Knowledge + Skill + Ability
Competency = Knowledge + Skill + Behavior
Competency = Knowledge + Skill + Human Attributes
Past and Current Situation

Body of Knowledge
The complete set of concepts, terms and activities that make up a professional domain, as defined by the relevant professional association.

It is more than simply a collection of terms ... or a collection of information.

It is the accepted ontology for a specific domain.

[Institute for Competitive Intelligence]

Learning Outcomes
Learning outcomes are written statements of what a learner is expected to know and be able to demonstrate at the end of a learning unit (or cohesive set of units, course module, entire course, or full program)

[IT2017 Report]
Competency

Information Systems

Competencies represent a dynamic combination of cognitive and meta-cognitive skills, demonstration of knowledge and understanding, interpersonal, intellectual and practical skills, and ethical values.

[MSIS2016 Report]

Software Engineering

[Competency is the] demonstrated ability to perform work activities at a stated competency level, which is one of five increasing levels of ability to perform an activity ...

[SWE Competency Model - 2014]
Competency

Information Technology [a]

Competence refers to the *performance* standards associated with a profession or membership to a licensing organization.

[IT2017 Report]

Information Technology [b]

Assessing some *level of performance* in the workplace is frequently used as a competence measure, which means measuring aspects of the job at which a person is competent.

[IT2017 Report]
Disposition

The affective component that deploys skill and knowledge into appropriate action in a specific context.

• Enacted Values
• Reflected through choices
• Informed by one’s character and community
• Learned, Learnable
• Application shift with one’s understanding of the context/circumstances
• Attitude
Competencies in IT Context

**Knowledge**
- Mastery of content knowledge
- Transfer of learning

**Skills**
- Capabilities and strategies for higher-order thinking
- Interactions with others and world around

**Dispositions**
- Personal qualities (socio-emotional skills, behaviors, attitudes) associated with success in college and career

**Professional Context**
- Workplace-bound
- Employer involvement
- Expert mentorship
- Authentic problems
- Relevant IT aspects of work
- Collaborative
- Project-based
- Diverse teams
- Reflective practice
- Professional tools
Competencies in IT Context

- **Knowledge**
  - Mastery of content knowledge
  - Transfer of learning

- **Skills**
  - Capabilities and strategies for higher-order thinking
  - Interactions with others and world around

- **Dispositions**
  - Personal qualities (socio-emotional skills, behaviors, attitudes) associated with success in college and career

- **Professional Context**
  - Workplace-bound
  - Employer involvement
  - Expert mentorship
  - Authentic problems
  - Relevant IT aspects of work
  - Collaborative
  - Project-based
  - Diverse teams
  - Reflective practice
  - Professional tools
Competencies - IT example

- ITE-GPP Global Professional Practice

- ITE-GPP-01 Perspectives and impact
  - a. Describe the nature of professionalism and its place in the field of information technology.
  - b. Contrast ethical and legal issues as related to information technology.
  - c. Describe how IT uses or benefits from social and professional issues.

- ITE-GPP-02 Professional issues and responsibilities
  - a. Contrast the professional context of information technology and computing and adherence to ethical codes of conduct.
  - b. Describe and critique several historical, professional, ethical, and legal aspects of computing.
Competencies - SE example

- **Software Requirements**

  - Identify and document software requirements by applying a known requirements elicitation technique in work sessions with stakeholders, using facilitative skills, as a contributing member of a requirements team.

  - Analyze software requirements for consistency, completeness, and feasibility, and recommend improved requirements documentation, as a contributing member of a requirements team.

  - Specify software requirements using standard specification formats and languages that have been selected for the project, and be able to describe the requirements in an understandable way to non-experts such as end users, other stakeholders, or administrative managers, as a contributing member of a requirements team.

  - Verify and validate the requirements using standard techniques, including inspection, modeling, prototyping, and test case development, as a contributing member of a requirements team.

  - Follow process and product management procedures identified for the project, as a contributing member of the requirements engineering team.
Competencies - CE example

- **CE-CAO**

  Manage the design of computer hardware components for a multidisciplinary research project and integrate such components to provide complete hardware systems which function reliably and efficiently demonstrating sensitivity for the context of the design envelope within which they were conceived.

  *Measuring performance; Processor organization; Distributed systems architecture; Multi/Many-core architectures; Peripheral subsystems*
Progress on Competencies

- Completed Competencies
  - Computer Engineering
  - Software Engineering
  - Information Technology
  - Computer Science
  - Information Systems

- New Competencies
  - Cyber Security in the new curricular document
  - Data Science under development
Overview of CC2020 Report

Introduction
Guiding Principles
Landscape of Computing
Computing Education
Competency Modeling
Tool
Contextualizations
Glossary
Appendices

Computing Terminology Worldwide
What is in a computing degree
References

Next Steps
“Heat Map” Model

<table>
<thead>
<tr>
<th>Job</th>
<th>Job</th>
<th>Job</th>
<th>Job</th>
<th>Job</th>
<th>Job</th>
<th>Job</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace</td>
<td>Foundry</td>
<td>Poruing</td>
<td>crucible lifting</td>
<td>flasks or mould boxes</td>
<td>mould making</td>
<td>Safety 1</td>
<td>Safety 2</td>
</tr>
<tr>
<td>high-tech</td>
<td>high-tech</td>
<td>military</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
</tr>
<tr>
<td>high-tech</td>
<td>high-tech</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
</tr>
<tr>
<td>deep drill</td>
<td>deep drill</td>
<td>rarely?</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
</tr>
<tr>
<td>Food</td>
<td>annual harvest</td>
<td>seasonal</td>
<td>R&amp;D effort</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
<td>via electric</td>
</tr>
<tr>
<td>Tempering sand (mixing H2 02)</td>
<td>Furnace operation/control</td>
<td>Quality control/inspections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
So what do our stakeholders want?

- Students  
  a tool to understand the areas of computing
  a tool to choose the best degree for you

- Industry  
  a tool to understand the breadth and depth of a future employees degree
  a tool to understand the areas of computing

- Government and Professional Bodies  
  defining standards
  accreditation

- Faculty  
  a document to help plan curricula and courses
  a document to benchmark globally
  A tool to help understand under graduate degrees
The “Heatmap” tool will help

- Compare and contrast baccalaureate programs
- Benchmark against other programs globally
- Show where on each axis the program fits
- Show employers the competency range of graduates
- Show potential students the academic range of each program
Progress to date

- Task Force Sub group completed the competencies
- Task Force sub group drafted first chapters of report
- Task Force sub group developing prototype of the visualisation tool
- Presentations
  - Workshops
  - Panels
  - Roundtables
  - Work-in-progress papers
  - Full papers
We welcome your input!

- We welcome feedback on interim products
- We welcome input on how best these products will help
  - Faulty design
  - Students learn
  - Industry employ
- We invite volunteers for subgroups
Conclusion CC2020

- A global effort to provide a global overview of computing curricular
- A futuristic document
- Collaboration between organisations
- Collaboration between education and industry
- We are very excited to produce useful tools that are
  - Global
  - Futuristic
  - Helpful
Thank you
New Zealand
New Zealand