Connecting Workplace STEM Needs to Classroom Practice

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Computational Thinking in Action in America’s STEM Workplaces

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CT defined

- Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science.

- Computational thinking is the use of abstraction, along with automation and analysis, in problem solving.
### Computational Thinking (Wing)

<table>
<thead>
<tr>
<th>IS</th>
<th>IS NOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptualizing</td>
<td>(Only) Computer programming</td>
</tr>
<tr>
<td>Fundamental</td>
<td>Rote skills</td>
</tr>
<tr>
<td>A way humans think</td>
<td>A way that computers think</td>
</tr>
<tr>
<td>Complements and combines</td>
<td>Only mathematical and engineering thinking</td>
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<tr>
<td>mathematical and engineering</td>
<td></td>
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<tr>
<td>thinking</td>
<td></td>
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<tr>
<td>Ideas</td>
<td>Artifacts</td>
</tr>
<tr>
<td>For everyone, everywhere</td>
<td>Only programming, computer</td>
</tr>
<tr>
<td></td>
<td>science jobs</td>
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Occupational Analysis of the CT-enabled STEM worker

- Technical Committee
- Learning occupation
- Expert panel
- DACUM Analysis ("Developing a Curriculum")
- Validation
- Action Statements
- Scenarios
Technical Committee

- Larry Snyder, U Washington
- Duane Bailey, Amherst College
- Mitch Resnick, MIT Media Lab
- Irene Lee, Santa Fe Institute
- Joseph Wong, Raytheon
Expert CT Panel

- Mark Galassi, Theoretical Physicist, Astrophysicist, Los Alamos National Lab
- Neil Henson, Material Scientist, Chemist, Los Alamos National Lab
- Nadine Miner, Computer Engineer, Sandia National Labs
- Melanie Moses, Biologist/Computer Scientist, University of New Mexico
- Bela Nagy, Computer Science & Statistics (Statistician), Santa Fe Institute
Expert CT Panel

- Doug Roberts, Chemical & Industrial Engineer, RTI
- Chris Rose, Electromagnetic Physicist, Los Alamos National Lab
- Amy Sun, Chemical Engineer, Sandia National Lab
- Joshua Thorp, Computational Modeler, Santa Fe Institute
- Eleanor Walther, Operations Research Analyst, Sandia National Lab
- Chris Wood, Neuroscientist, Santa Fe Institute
DACUM chart

- Front side
- Definition of the computational thinking enabled STEM professional.
- Job functions
- Activities

- Back side
- Knowledge
- Skills
- Tools
- Behaviors / Dispositions
- Industry trends (coming soon)
Computational Thinking Enabled STEM Professional:

Engages in a creative process to solve problems, design products, automate systems, or improve understanding by defining, modeling, qualifying and refining systems, processes or mechanisms generally through the use of computers. Computational thinking often occurs in collaboration with others.
Job Functions

- Engages in a creative process
- Collaborates
- Documents
Job Functions

- **Defines**
  - Identifies the Problem
  - Specifies Constraints

- **Models**
  - Designs the model/system
  - Builds the model
  - Develops experimental design

- **Qualifies**
  - Verifies the model

- **Refines**
  - Optimizes the user interface and model
  - Facilitates knowledge/discovery
Computational Thinking in America’s Workplaces

A COMPUTATIONAL THINKING ENABLED STEM WORKER:

• engages in a creative process to solve problems, design products, automates systems, or improve understanding by defining, modeling, qualifying and refining systems, processes or mechanisms generally through the use of computers. Computational thinking often occurs in collaboration with others.
CT in Action!

What Computational Thinking Looks Like in the Workplace

Short statements illustrating how various people in STEM jobs use computational thinking as they perform routine tasks and solve the problems they usually encounter on the job.
Strong CT in Action Statements include:

- A real (authentic) work activity/challenge
- Technical language that speaks to the workers illustrated in the example
- Depth of detail that represents the work activity
- Detailed career information such as:
  - Job titles
  - Where people work
  - Whom they report to
  - What they do routinely on the job
  - What types of problems they commonly solve
  - What tools they use
  - Whom they interact with
A computational scientist verifies the numerical convergence of a solid mechanics finite-element model, by refining the mesh associated with a mechanical assembly, for the purpose of assessing the correct implementation of the mathematical equations.

Qualifies: Verifies the model
(F1 – Verifies the model)
CT in Action

A nuclear engineer validates a coupled thermo-mechanical computer model, by comparing the model predictions with existing thermal stress experimental data, to assess the performance of a nuclear fuel element for the purpose of extending the operational lifetime of the fuel in the reactor.

Qualifies: Validates the model
(F6/F3 Validates the model/by comparing the behavior of the model to a known solution.)
Testing the forest fire evacuation plans for Santa Fe.

SURVIVING A WILDFIRE
IN SANTA FE

Are you prepared?
Role for computer science teachers in preparing CT-enabled STEM professionals

Looking at the DACUM chart

- Which of the activities do you already incorporate into your curriculum? (circle these)
- Which of the activities would you like to incorporate? (star these)
- Which of the activities are irrelevant to what you think you should be teaching? (cross these out)

What would you like to see our project to do next to provide information or support around this topic?

What involvement would you like to have in this process?
QUESTIONS?
Computational Thinking in America’s Workplaces

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