What should students learn in the 21st century?
Coalition of key global players

- International organizations
  - ACT
  - ERB
  - OECD
  - UNESCO
  - World Bank

- Jurisdictions
  - Finnish National Board of Education
  - KEDI
  - Government of Alberta Education
  - Ontario
  - Singapore
  - Australia

- Academia
  - Harvard
  - MIT
  - Massachusetts Institute of Technology
  - Olin College
  - Penn
  - Stanford University

- Foundations & Non-Profits
  - Foundation Henri Moser
  - Bill & Melinda Gates Foundation
  - Hewlett Foundation
  - McGraw-Hill Research Foundation
  - New York City Education Foundation

- Corporations
  - Google
  - IBM
  - Intel
  - Microsoft
  - Promethean
  - Wolfram
Roger Schank’s view

There are only two things wrong with the education system:
1. What we teach
2. How we teach it.

CCR’s focus is “What”, and the interplay with “How”
CCR’s Approach (2)

WHAT

Character

Metacognition

Knowledge

Skills

HOW

Pedagogy & Practices

FUTURES

Learning Sciences

CURRICULUM
Knowledge – Traditional
- Languages
- Arts
- Humanities
- Maths
- Science
- Health

Knowledge – Modern
- Personal finance
- Entrepreneurship
- Technology & Engineering
- Etc.
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>8:30 – 9:30</td>
<td>Introductions, welcome, setting the stage - CCR and goals – Charles Fadel</td>
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<td>Presentation: Algorithmic &amp; Robotics progress - Charles Fadel</td>
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<td>9:30 – 10:30</td>
<td>Presentation: Education Futures 2020 - Jillian Darwish</td>
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<td>Break</td>
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<td>Lunch</td>
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<td>1:00 – 2:00</td>
<td>Group discussion: Human consequences of “Big Data”</td>
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<td>2:00 – 3:00</td>
<td>Group activity: Futurists table review – 2 groups</td>
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<td>Break</td>
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<td>3:15 – 4:30</td>
<td>Group activity: Futurists table review – 2 groups (continued)</td>
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<td>4:30 – 5:00</td>
<td>Group activity: review the groups’ results - all participants</td>
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<td>5:00 – 6:00</td>
<td>Group activity: What are good examples of Integrative STEM Disciplines? (Robotics, Synthetic Biology, etc.)</td>
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<td>Time</td>
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<td>8:30 – 9:15</td>
<td>Aggregate, breakfast, review past day, discuss how to proceed</td>
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<td>9:15 – 10:45</td>
<td>Group activity: Futurists table – top section; joint conversation including visualization options</td>
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<td>Break</td>
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<td>11:00-12:00</td>
<td>Group activity: Debate - Can formal systems catch up? What if they cannot ??</td>
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<td>Meeting Conclusion</td>
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Views & Assumptions

• Our horizon: 2020-2040
• Education systems can actually adapt and catch up (which will be debated)
• Add more assumptions here during the day:
  A)
  B)
Existing Providers

Learning Providers

New Entrants

Our Locus?

Source: Innovation Unit
Key questions to explore

• Is A.I./Robotics/automation the biggest technology disruptor (for employment) in the imminent future? (compared to BioTech and Neuroscience)
  – Can we plot its evolution and thresholds? (algorithms and robotics in particular?)
  – Longer-term, what is the impact of machine creativity?
  – Will it spur an arms-race for human augmentation?

• What are the negative consequences of Big Data/decision analytics?
  – Wisdom: Will we need a “do not watch” list?
  – Desensitization to observation, allowing “big brotherism”?
  – “Echo chamber” effects, polarizing opinions?

• Of STEM, we typically only teach S&M; What are the Technology and Engineering topics that should be taught in K-12? are there “Integrative Disciplines” (Robotics, Programming, etc.) that are multi-disciplinary?

• Design review of CCR’s white paper and decision table for education systems
Let’s Be Our Versatile Selves

Open-minded and open-hearted
Global and altruistic
Candid and respectful
Thorough yet concise
Deep and broad
Joyful and humorous

"The important thing is... to be able at any moment to sacrifice what we are for what we could become."

Charles Du Bos
Diving into ICT

Source: Aaron Kobler
On the road to ExoBrain

Source: Hans Moravec
Progress of Robotics
High-speed manipulation - Videos
Replace Workforce With Robots

Terry Guo, CEO of Foxconn, said last July that the Taiwan-based manufacturing giant would add up to one million industrial robots to its assembly lines inside of three years.
"All those in favour of accepting more robots?"
“The dancing salesman problem”

Source: Simon Colton, The Painting Fool
Music Decomposition

Features
- IR-Label: Process
- IR-Closure: -0.4332
- Pitch-Interval: -1
- Rhythmic context: s-s-1
- Duration Ratio: 0.301

Targets
- Timing: 0.036
- Articulation: 1.22
- Loudness: 0.2

Diagram showing features and their relationships with score and performance.
Example of Algorithmic progress

- Production planning model solved using linear programming:
  - 1988: 82 years
  - 2003: 1 minute
- A factor of roughly 43 million in 15 years
  - ~1,000 due to increased processor speed,
  - ~43,000 due to improvements in algorithms!

Source: Professor Martin Grötschel of Konrad-Zuse-Zentrum für Informationstechnik Berlin.
Sequencing costs dropping faster than Moore’s Law

![Baseline information graph showing cost of genome sequencing compared with Moore’s law for computers. Cost of computing (Moore’s law) and cost per million DNA bases are shown on a log scale from 1999 to 2010. Source: Broad Institute.]
Drawing too
Computerized Trading – Flash Crash

>2/3 of volume is now “high-speed trading”
Even Journalism?

“Computers will write more than 90 percent of news in 15 years, and will win a Pulitzer Prize within 5 years.”

Kristian Hammond, CTO and cofounder of Narrative Science, a company that trains computers to write news stories.
Innovation follows patterns \(\rightarrow\) automatable

**Mono bi poly system**

- One-blade propeller
- Two-blades
- Three-blades
- Four-blades
- Double four-blades

Different products evolve according to the same pattern

Source: Invention Machine “IM Labs”
Chess as example

• “Human strategic guidance combined with the tactical acuity of a computer was overwhelming.”

• “Weak human + machine + better process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process”


How about learning Processes?
So Let’s Think Together