The New ABCs of Research

Ben Shneiderman  ben@cs.umd.edu  @benbendc

Distinguished University Professor,
Dept of Computer Science
Founding Director (1983-2000),
Human-Computer Interaction Lab

Member, Institute for Advanced Computer Studies

Photo: BK Adams
Tools for Governance in Cyber Social Systems:

Community Formation/Management, Deliberation, Conflict Resolution

Ben Shneiderman, August 28, 2016
University of Maryland

NSF CRA CCC Workshop: Cyber Social Systems
CSS Framing Document

• Transform all major sectors of our society:
  • Healthcare delivery, education, community services, transportation,
  • Justice, civil rights, environment,
  • Homeland & international security, bio-security,
  • Business & commerce

• Novel syntheses of computer & information science & engineering with human & social sciences:
  • Human cognition and communication; collaboration & teamwork; mechanism design, including social reward & recognition;
  • Ethics; behavioral, social, and organizational design; behavior change; social psychology; practice culture; implementation science; complexity & network science;
  • Online community design; motivation & persuasion; behavioral economics; sociology; political science; humanistic thinking; ethnographic methods
Cyber-Social System Participants

Concerned Users/Stakeholders:
Patients, Customers, Passengers, Students

Professionals, Managers, Researchers, Designers, Analysts, Staff

Governments
Regulate

Journalists
Review/Report

Provide Service
Provide Feedback

Malicious Actors
Threaten
Cyber-Social System Activities

Data → Knowledge

- Analysis
- Discussion
- Decision
- Persuasion

Action
Example CSS

Great successes

- Air Traffic Control System
- American College of Cardiologists
- World Wide Web: W3C, ICANN, etc.
- Linux/Apache, Mozilla, R, etc.
- Wikipedia
Example CSS

Great successes

• Air Traffic Control System
• American College of Cardiologists
• World Wide Web: W3C, ICANN, etc.
• Linux/Apache, Mozilla, R, etc.
• Wikipedia

BUT 98% failure rate

• NASA’s EOSDIS
• NCI’s CaBIG
• Open source projects
• Wikis
From Reader to Leader: Motivating Technology-Mediated Social Participation

Preece & Shneiderman, AIS Trans. Human-Computer Interaction 1 (1), 2009
aisel.aisnet.org/thci/vol1/iss1/5/
Governance Tools in CSS

1) Deliberative systems design
2) Large-scale teamwork monitoring systems
3) Collaboration toolkits & remote teamwork
4) Online dispute or conflict resolution tools
1) Deliberative systems design

How to engage large numbers of people in:

• Sharing ideas
• Refining ideas into plans
• Developing consensus
• Obtaining & allocating resources
• Getting commitment to shared goals
2) Large-scale teamwork monitoring systems

- Enabling 1000+ people to work together towards a common goal
- Assigning tasks (Linux-like strategies for posting tasks that members take on)
- Sharing of critical path diagrams to monitor progress
- Evaluating peers & mentoring for improvement
- Bug reporting schemes (e.g. Bugzilla)
- Repairing problems as they emerge (github-like posting of issues and closing them)
- Collecting guidelines for future use
3) Collaboration toolkits

- Checklists
- Communications tools
- Shared documents, calendars
- Task lists & schedules
- Remote work support
4) Online dispute or conflict resolution tools

- Ebay, PayPal, Amazon, etc.
- Online mediation services
- Modern Delphi methods
Science, Engineering & Design

- **Scientific Method**
  - Controlled Laboratory Tests
  - Reductionist Thinking
- **Engineering Process**
  - Iteratively refine prototypes
  - Guided by measurable criteria
  - Modular design, interdependent components
- **Design Thinking**
  - Challenge the goals/requirements
  - Empathize with users
  - Divergent/Convergent thinking
  - Celebrate teamwork & diverse viewpoints
Science, Engineering, Design

https://books.google.com/ngrams
Scientist, Engineer & Designer

NY Times articles

http://chronicle.nytlabs.com/
Teams that follow SED & ABC Principles are more likely to produce breakthroughs

New collaboration technologies empower research groups

Greater ambition to take on societal challenges

- Healthcare delivery
- Environmental sustainability
- Energy conservation
- Community safety
- Education, Housing, Transportation, …
Applied & Basic Combined

• Teams that follow SED & ABC Principles are more likely to produce breakthroughs
• New collaboration technologies empower research groups
• Greater ambition to take on societal challenges
  • Healthcare delivery
  • Environmental sustainability
  • Energy conservation
  • Community safety
  • Education, Housing, Transportation, …

www.cs.umd.edu/hcil/newabcs
Interdisciplinary research community
- Computer Science & Info Studies
- Psych, Socio, Educ, Jour & MITH

www.cs.umd.edu/hcil
vimeo.com/72440805
Designing the User Interface

- Guidelines & Theories
- Input devices & strategies
  - Keyboards, pointing, voice
  - Direct manipulation
  - Menus, forms, commands
- Output devices & formats
  - Windows, color, sound
  - Text, tables, graphics
  - Instructions, messages, help
- Social Media
- Visualization
- Design
- Search

http://bit.ly/1T5UGn0
Sixth Edition: 2016
The New ABCs of Research (Oxford, 2016)

Guide for
Junior researchers

Manifesto for
Senior researchers
Academic administrators
Business leaders
Funding agencies

www.cs.umd.edu/hcil/newabcs
The New ABCs of Research

Context
Guiding Principles
Lifecycle Strategies
New Knowledge

Immense Problems
The New ABCs of Research

Context

Guiding Principles

Lifecycle Strategies

New Knowledge

Immense Problems

New Technologies
The New ABCs of Research

Context
- Immense Problems
- New Technologies
- Raised Ambitions

Guiding Principles

Lifecycle Strategies

New Knowledge
ABC Principle

Applied & Basic Combined

Combining applied with basic research produces more rapid progress in both
Blending Science, Engineering & Design produces higher-impact research
Science, Engineering, Design

https://books.google.com/ngrams
Scientist, Engineer & Designer

NY Times articles

http://chronicle.nytlabs.com/
The New ABCs of Research

Context
- Immense Problems
- New Technologies
- Raised Ambitions

Guiding Principles
- Applied & Basic Combined

Lifecycle Strategies
- Science, Engineering & Design

New Knowledge
The New ABCs of Research

**Context**
- Immense Problems
- New Technologies
- Raised Ambitions

**Guiding Principles**
- Applied & Basic Combined
- Science, Engineering & Design

**Lifecycle Strategies**
- Choose actionable problems: civic, business & global priorities
- Apply observation, intervention & controlled experiments
- Form teams with diverse individuals & organizations
- Test ideas & prototypes with realistic interventions
- Promote adoption & assess impact

**New Knowledge**
The New ABCs of Research

Context

- Immense Problems
- New Technologies
- Raised Ambitions

Guiding Principles

- Applied & Basic Combined
- Science, Engineering & Design

Lifecycle Strategies

- Choose actionable problems: civic, business & global priorities
- Apply observation, intervention & controlled experiments
- Form teams with diverse individuals & organizations
- Test ideas & prototypes with realistic interventions
- Promote adoption & assess impact

New Knowledge

- Solutions
- Theories
The New ABCs of Research (Oxford, 2016)

Guide for
  Junior researchers

Manifesto for
  Senior researchers
  Academic administrators
  Business leaders
  Funding agencies

www.cs.umd.edu/hcil/newabcs
The New ABCs of Research

Context
- Immense Problems
- New Technologies
- Raised Ambitions

Guiding Principles
- Applied & Basic Combined
  Science, Engineering & Design

Lifecycle Strategies
- Choose actionable problems: civic, business & global priorities
- Apply observation, intervention & controlled experiments
- Form teams with diverse individuals & organizations
- Test ideas & prototypes with realistic interventions
- Promote adoption & assess impact

New Knowledge
- Solutions
- Theories
The New ABCs of Research

Context

Guiding Principles

Lifecycle Strategies

New Knowledge

Form teams with diverse individuals & organizations
The New ABCs of Research

Form teams with diverse individuals & organizations
Teamwork is the New Norm

Percentage of publications by more than one author

Cooke & Hilton (Eds), *Enhancing the Effectiveness of Team Science*
http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science
Teams: Guidelines

• Formation
  1. Choose those with previously successful collaborations
  2. Create balanced teams: skills, age, gender, personality, …
Teams: Guidelines

• Formation
  1. Choose those with previously successful collaborations
  2. Create balanced teams: skills, age, gender, personality,…
  3. Ensure collaboration readiness
     • Willing/eager to work in teams
     • Fluent with technology
     • Experienced in working remotely
Teams: Guidelines

• Formation
  1. Choose those with previously successful collaborations
  2. Create balanced teams: skills, age, gender, personality,…
  3. Ensure collaboration readiness
     • Willing/eager to work in teams
     • Fluent with technology
     • Experienced in working remotely
  4. Recruit experienced leadership
Teams: Guidelines

- Management
  5. Define goals & roles clearly
  6. Make explicit statements of who does what by when
Teams: Guidelines

• Management
  5. Define goals & roles clearly
  6. Make explicit statements of who does what by when
  7. Practice good communication: listening, speaking, writing, etc.
  8. Hold regular & open discussions
  9. Use effective brainstorming strategies: diverge then converge
Teams: Guidelines

- Management
  5. Define goals & roles clearly
  6. Make explicit statements of who does what by when
  7. Practice good communication: listening, speaking, writing, etc.
  8. Hold regular & open discussions
  9. Use effective brainstorming strategies: diverge then converge
  10. Provide adequate administrative resources & services
Books: Teamwork

  
  http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science


Teams: Guidelines

• Formation:
  • Previously successful collaborations
  • Balanced teams
  • Collaboration readiness
  • Technology readiness for remote teamwork
  • Technology readiness for collaboration
  • Trained experienced leadership
Teams: Guidelines

• Formation:
  • Previously successful collaborations
  • Balanced teams
  • Collaboration readiness
  • Technology readiness for remote teamwork
  • Technology readiness for collaboration
  • Trained experienced leadership

• Management
  • Clearly defined goals & roles
  • Explicit statements of who does what by when
  • Good communication
  • Regular and open discussions
  • Use of effective brainstorming strategies

• Adequate administrative resources and services
### National Academies Report (2015): *Enhancing the Effectiveness of Team Science*

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity</td>
<td>Homogeneous</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>Disciplinary Integration</td>
<td>Unidisciplinary</td>
<td>Transdisciplinary</td>
</tr>
<tr>
<td>Team or group size</td>
<td>Small (2-10)</td>
<td>Mega (1000s)</td>
</tr>
<tr>
<td>Goal alignment</td>
<td>Aligned</td>
<td>Divergent</td>
</tr>
<tr>
<td>Permeable boundaries</td>
<td>Stable</td>
<td>Fluid</td>
</tr>
<tr>
<td>Proximity</td>
<td>Co-located</td>
<td>Globally distribute</td>
</tr>
<tr>
<td>Task interdependence</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Cooke & Hilton (Eds), *Enhancing the Effectiveness of Team Science*  
http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science
Research Project: 2 parents, 3 children

- Basic Theories
- Applied Problems
- Research Project
- Refined Theories
- Practical Solutions
- Guidance to Future Researchers
The New ABCs of Research

**Context**
- Immense Problems
- New Technologies
- Raised Ambitions

**Guiding Principles**
- Applied & Basic Combined
- Science, Engineering & Design

**Lifecycle Strategies**
- Choose actionable problems: civic, business & global priorities
- Apply observation, intervention & controlled experiments
- Form teams with diverse individuals & organizations
- Test ideas & prototypes with realistic interventions
- Promote adoption & assess impact

**New Knowledge**
- Solutions
- Theories
The New ABCs of Research

Context
Guiding Principles
Lifecycle Strategies
New Knowledge

Promote adoption & assess impact
Promote Adoption & Assess Impact

- Clear writing begets clear thinking
  - Story-telling trajectories

- Promote adoption
  - Send Five & Thrive
  - Papers, websites, videos, tweets, blogs

- Assess impact
  - Citations, downloads, tweets, blogposts
  - Best Paper Awards, testimonials, usage reports
Promoting Adoption: Becker Model

- Ideas travel through networks and relationships
- Cultivate champions.
- Present, Present, Present!
- Join relevant committees & insert your findings into decision making
- Don’t wait for publication. Disseminate early

https://becker.wustl.edu/impact-assessment/strategies
Online Services

• Open Research: arXiv.org, PLOS, Open Science

• Community Building Sites:
  • Academia: platform for academics to share research papers…
    to accelerate the world's research (19M users)
  • ResearchGate: connect researchers
    share scientific output, knowledge & expertise
  • ORCID, VIVO, FORCE11, …

• Research Paper Managers:
  • Mendeley: The best free way to organize your research
  • Zotero: free, easy-to-use tool to help you collect, organize,
    cite & share your research sources
  • CiteULike: free service to help you to store, organise & share
    the scholarly papers you are reading
The New ABCs of Research

Applied & Basic Combined
Achieving Breakthrough Collaborations
Analysis Based on Creativity
Actively Build Connections
Ask Bigger Questions
The New ABCs of Research

Immense Problems

New Technologies

Raised Ambitions

Applied & Basic Combined

Science, Engineering & Design

Guiding Principles

Lifecycle Strategies

New Knowledge

Choose actionable problems: civic, business & global priorities

Apply observation, intervention & controlled experiments

Form teams with diverse individuals & organizations

Test prototypes with realistic interventions

Promote adoption & assess impact

Solutions

Theories
Information Visualization & Visual Analytics
Information Visualization & Visual Analytics

- Visual bandwidth is enormous
- Human perceptual skills are remarkable
- Trend, cluster, gap, outlier...
- Color, size, shape, proximity...

Three challenges:
- Meaningful visual displays of massive data
- Interaction: widgets & window coordination
- Process models for discovery
Information Visualization & Visual Analytics

• Visual bandwidth is enormous
• Human perceptual skills are remarkable
• Trend, cluster, gap, outlier...
• Color, size, shape, proximity...

Three challenges
• Meaningful visual displays of massive data
• Interaction: widgets & window coordination
• Process models for discovery

1999  2004  2010
Information Visualization: Cultural Meme
Spotfire: DC natality data
10M - 100M pixels: Large displays
100M-pixels & more
1M-pixels & less

Small mobile devices
Information Visualization: Mantra

• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
• Overview, zoom & filter, details-on-demand
Information Visualization: Data Types

**SciViz**
- **1-D Linear**
  - Document Lens, SeeSoft, Info Mural
- **2-D Map**
  - GIS, ArcView, PageMaker, Medical imagery
- **3-D World**
  - CAD, Medical, Molecules, Architecture

**InfoViz**
- **Multi-Var**
  - Spotfire, Tableau, Qliktech, Visual Insight
- **Temporal**
  - EventFlow, TimeSearcher, Palantir, DataMontage
- **Tree**
  - Cone/Cam/Hyperbolic, SpaceTree, Treemap
- **Network**
  - Pajek, UCINet, NodeXL, Gephi, Tom Sawyer
- **Text**
  - TagClouds, Wordle, ManyEyes, Ngram Viewer

flowingdata.com   visualcomplexity.com   eagereyes.org
visual.ly        perceptualedge.com    datakind.org
infosthetics.com  visualizing.org      infovis.org
EventFlow Project: Temporal Events

hcil.umd.edu/eventflow
Treeversity: Traffic Bottlenecks

www.cs.umd.edu/hcil/treeversity
Books: Teamwork

  


Books: Writing


The New ABCs of Research

Context

Immense Problems
New Technologies
Raised Ambitions

Guiding Principles

Applied & Basic Combined
Science, Engineering & Design

Lifecycle Strategies

Choose actionable problems: civic, business & global priorities
Apply observation, intervention & controlled experiments
Form teams with diverse individuals & organizations
Test ideas & prototypes with realistic interventions
Promote adoption & assess impact

New Knowledge

Solutions
Theories
Apply observation, intervention & controlled experiments
Research Methods → Solutions & Theories

- Observation
- Intervention
- Controlled Experiment

Solutions & Theories
- Clear Descriptions
- Causal Explanations
- Reliable Predictions
- Practical Guidelines
Teams: Winning Strategy

- *Powers of Two* (End of the Lone Genius) (Shenk, 2014)

- Teams: Difficult to form, hugely effective
- Takes practice to gain skills
  - Clear goals, clear roles: Who Does What by When
  - Trust, communication, recognition
  - WJU2007: teams $\rightarrow$ 2.1 times the impact
- Large teams need administrative support
- FUN!

scienceofteamscience.org  www.teamsciencetoolkit.cancer.gov