Learning, Creating, and Using Cmaps: Successes and Challenges for Concept Maps as facilitative tools in corporations

Brian Moon
Chief Technology Officer

Perigean Technologies LLC
My Self

Background in social and cognitive sciences

Founded Perigean Technologies in 2007
8 employees
# My Clients

## Federal Government
### Prime Contractor
- Advanced Distance Learning Initiative
- Veterans Health Administration
- Army Research Laboratory Human Research and Effectiveness Directorate
- Defense Advanced Research Projects Agency
- Federal Bureau of Investigations
- Sandia National Laboratories
- Joint Forces Command
- Veterans Health Administration

### Subcontractor
- Central Intelligence Agency
- Intelligence Advanced Research Projects Agency
- Marine Corps
- Office of Naval Research
- National Institute for Occupational Safety & Health

## State Government
- New York Power Authority

## Education
- University of Edinburgh
- University of Mary Washington
- Vanderbilt University

## Commercial
- Numerous Fortune 5,000 companies
- ReliabilityFirst
- Electric Power Research Institute
- Alion Science and Technology
- General Dynamics
- Cognitive Training Solutions / Cognitive Performance Group
- Cognitive Medical Systems, Inc.
- Charles River Analytics
- Kutta Technologies, Inc.
- Aurora Flight Sciences
- NAV CANADA
- TNO, The Netherlands
- Klein Associates Division / Applied Research Associates
- Security Analysis and Risk Management Association
- National Contract Management Association
- Federal Management Partners
- Indiana CPA Society
- WBB Consulting
- CACI
- Fredericksburg Regional Chamber of Commerce
- Strategic Knowledge Solutions
First exposure to Concept Mapping circa 2002
Robert Hoffman, IHMC
My Focus

Applied Concept Mapping:

1) The application of Concept Mapping to problem solving in the workplace

2) Adults
My View
My View

Concept Mapping and Concept Maps offer incomparable value.

“What tool would you use now if you didn’t use Concept Mapping?”

-London-based practitioner
Application of Concept Mapping and Concept Maps has not yet achieved – and may never achieve – the desired potential: ubiquity.

“Now that CmapTools and training support are available (see: www.perigeantechnologies.com), we may see an acceleration in the application of concept mapping … to business problems.”

-Novak, Learning, Creating, and Using Knowledge
2nd Edition, p. 103
THE UNIVERSALITY AND UBIQUITOUSNESS OF CONCEPT MAPS

Joseph D. Novak & Alberto J. Cañas
Institute for Human and Machine Cognition (IHMC), USA
www.ihmc.us

1 Introduction: The Origins and Evolution of the Concept Mapping Tool

The concept map was developed as a response to the necessity by Novak’s research group at Cornell University in the early 1970s to find a better way to represent children’s conceptual understandings and to be able to observe explicit changes in the concept and propositional structures that construct those understandings, as part of a 12-year longitudinal study following a 2-year instructional period using audio-tutorial instruction in grades one and two (Novak, 1972). The research program was based on Ausubel’s (1963, 1968) Assimilation Theory of cognitive learning, and an emerging constructivist epistemology that viewed knowledge as a human creation involving the construction on new concepts and propositions through the process of high levels of meaningful learning, as described by Ausbel, and Novak’s Human Constructivist epistemology (Novak, 1993, 1998). While we found structured interviews to be useful in capturing children’s understanding, it was difficult to discern specific changes in the children’s concept and propositional ideas as they progressed through schooling. Working with a talented group of graduate students, Novak and his colleagues came up with the idea of transforming interview transcripts into a hierarchically arranged set of concepts and propositions representing the knowledge expressed in the interview. Mapping a child’s interview transcript often revealed ambiguities not seen previously that required more careful listening to the interview tape to discern additional cues for the child’s thinking. Thus was born the concept map tool for representing human knowledge.

“If concept maps are applicable to so many domains and are used by people of all ages, why is it that we don’t ‘run into’ concept maps more often?”
On ubiquity

- Knowledge representation
- Format, and some method, but few constraints
- Difficult to do well
- Little training
- Crap / Brilliance
On ubiquity

✓ Extensive hyperlinking
✓ Knowledge representation
✓ Format & more constraints
✓ Difficult to do well
✓ Little training
✓ Crap / Brilliance
On ubiquity

Unconstrained

Constrained
My Intent

Show you my work

Offer honest assessment

Suggest visions

*Controversial statements will be red.*
My Work

Concept Mapping as an enabler

*remember this one
My Work

Concept Maps as products

What are the key strategies for managing, initiating and responding to ice stoppage and flood notification?

Key strategies

include use of

Ice Boom

Ice Island

Analysis

PROGRAM ACRONYM - Canadian

is of

is about

Breakage

What’s causing ice flow?

i.e., either

Sink to let ice flow over

also known as

Ice Run

Logging

is tracked through

is done by

Ice Watch

is designed to

Ice Watch

Ice Run

also known as

Ice Boom

Perigean Technologies LLC
My Work

Concept Maps as artefact
My Work

Concept Mapping for analysis
My Work

Concept Maps as interfaces
My Work

Training in Applied Concept Mapping

Suggestive linking phrases

<table>
<thead>
<tr>
<th>Causal</th>
<th>Classificational</th>
<th>Nominal</th>
<th>Property</th>
<th>Explanatory</th>
<th>Procedure or Method</th>
<th>Event</th>
<th>Uncertainty</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>can lead to</td>
<td>involves</td>
<td>which area, e.g.</td>
<td>consists of</td>
<td>explains</td>
<td>is followed by</td>
<td>becomes</td>
<td>always</td>
<td></td>
</tr>
<tr>
<td>causes</td>
<td>is a type of</td>
<td>is a, is</td>
<td>has</td>
<td>reasons for</td>
<td>produces</td>
<td>evolves to</td>
<td>may or may not</td>
<td></td>
</tr>
<tr>
<td>requires</td>
<td>types of which are</td>
<td>i.e.</td>
<td>has feature</td>
<td>requires</td>
<td>done by</td>
<td>sometimes is</td>
<td>is more likely</td>
<td></td>
</tr>
<tr>
<td>because</td>
<td>includes</td>
<td>for example, e.g.</td>
<td>has defining feature</td>
<td>is a way to do</td>
<td>is more common</td>
<td>can be</td>
<td></td>
<td></td>
</tr>
<tr>
<td>categories</td>
<td>referred to as</td>
<td>has property</td>
<td>results in</td>
<td>is highly probable</td>
<td>is more likely to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>examples</td>
<td>such as</td>
<td>have</td>
<td>demands</td>
<td>is typical</td>
<td>is more likely to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>is a kind of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Protocol

- Selecting relations exercise

<table>
<thead>
<tr>
<th>Concept</th>
<th>Relation</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico</td>
<td>contributes to</td>
<td>Drug Traffic</td>
</tr>
<tr>
<td>Mexico</td>
<td>suffers from</td>
<td>Drug Traffic</td>
</tr>
<tr>
<td>Drug Traffic</td>
<td>comes from</td>
<td>Mexico</td>
</tr>
<tr>
<td>Drug Traffic</td>
<td></td>
<td>Mexico</td>
</tr>
</tbody>
</table>

Doctors / Nurses
Nurses / Doctors
Academia / Applied Research
Applied Research / Academia

Basic Protocol

- Elicit links to form propositions
  - Describe the nature of the relationship
  - Short and concise phrase
  - Suggested categories
My Work

Community Building

2015 Symposium on Applied Concept Mapping
acmsymposium.info
@acmsymposium

Sponsored by

Perigean Technologies LLC

Applied Concept Mapping
Capturing, Analyzing, and Organizing Knowledge

@perigean
My Work

Concept Map-based learning assessment

serolearn.com/cmcc2016
Assessment

Successes

Failures

Learning • Creating • Using
Successes

Ongoing concern: Almost 10 years

Satisfied customers

“Can you send me a copy of the big concept map that you prepared for our conference last year. [University President] is going to refer to it in his comments this year and we want to show it on the screen during his comments.”

-Former Client

Organic growth

“We are a small company (70 employees), but among other things, we perform training of people in the Power Industry on various aspects of Grid Reliability. It struck me that using Sero might be a good alternative to Death by Powerpoint.”

-Current Client

Awakenings

“I’ve come across Perigean Technologies website and I thought I should get in touch. I am writing because during the last six years we have been using mind mapping for our knowledge management. We are an engineering consultancy and knowledge is key for us, but the level of adoption is not as high as we would like it to be. In any case, we thought it’s now time to talk with the experts!”

-International Prospect
Failures

Adoption
  Scarce beyond champions

Sustainability
  Shelf-ware
    “Examples”, “Demonstrations”, “Pilots”

Ubiquity
  Narrow usage

Why?
Successes and failures for Concept Maps as Facilitative Tools in Schools and Corporations

Joseph D. Novak

Second Edition

Concept Maps
- represent
- Knowledge
- to aid
- Teaching
- Learning

Concepts
- are connected with
- Linking words
- Propositions
- Hierarchically Structured
- Crosslinks

Labeled
- are
- in
- Creativity
- needed to see
- Interrelationships

Perceived Regularities
- are
- a basis for
- aids
to show

Symbols
- Events
- Objects

Different Map Segments
- in

Concept Maps as Facilitative Tools in Schools and Corporations

Learning, Creating, and Using Cmaps

@perigean
Learning

Training
Cmapology workshop
Cognitive Task Analysis workshops
Expertise Management workshops

Learning
IAKM 61095 Expertise Management at Kent State University
20-year professional

Graduate student
Concept Mapping is difficult.

“(Good, Novakian) Concept Maps are (not so) easy to (efficiently and effectively) make and use.”

-Moon et al, ACM
Propositional thinking is challenging, and at times, inefficient and awkward.

“Worker A must provide Product to Worker B.”
Learning

Concept Mapping requires extensive skill development.

STUDIES SHOW IT TAKES TEN THOUSAND HOURS OF PRACTICE TO BE GREAT AT ANYTHING.

I WOULD THINK A WILLINGNESS TO PRACTICE THE SAME THING FOR TEN THOUSAND HOURS IS A MENTAL DISORDER.

THAT MAKES ME FEEL BETTER ABOUT MY MEDIOCRITY.

YOU'RE WELCOME.
Learning

Ericson’s 10,000 hour ‘rule’ for achieving expertise

Deliberate practice
Constantly pushing oneself beyond one’s comfort zone, following training activities designed by an expert to develop specific abilities, and using feedback to identify weaknesses and work on them.
Moon’s 10,000 propositions ‘rule’ for achieving Cmapping expertise

- 3 (Proposition)
- ~33 per map
- 100 maps
- 100 focus questions

1 succinctly stated concept
+ 1 meaningful linking phrase
+ 1 connector to another properly stated concept

Informative map (cmc.ihmc.us = 33)

Range of challenging propositions, crosslinks, elicitations, spacing, designs

Diversity in goals and topics
Assessment:

Ubiquity will never happen unless Concept Mapping expertise is widespread.
Creating Knowledge Models

Reporting

Organizing
Knowledge Modeling: ~150 – 200 Concept Maps + Resources

Knowledge Model removed for public dissemination.

For example, see NASA Mars Exploration Knowledge Model.
Creating Reporting
Creating Concept Maps are difficult to read.

“We’d like to get your help in doing the following: Creating 1-page summaries of all key topics.”

-Current Client

“I understand that this (outline) format omits some of the concept associations that would be part of a Concept Map, but the trade-off is an artifact that end user clinicians can immediately grasp and provide us feedback.”

-Current Client
Creating

Reading Concept Maps vs. Text

<table>
<thead>
<tr>
<th></th>
<th>Traditional text</th>
<th>Hypertext</th>
<th>Cmap</th>
<th>PowerPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparation time</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>1080</td>
<td>3120</td>
</tr>
<tr>
<td><strong>Review time</strong></td>
<td>22.13</td>
<td>21.38</td>
<td>1080</td>
<td>3120</td>
</tr>
<tr>
<td><strong>Pre-test score (%)</strong></td>
<td>16.67</td>
<td>15.63</td>
<td>1080</td>
<td>3120</td>
</tr>
<tr>
<td><strong>Post-test score (%)</strong></td>
<td>56.58</td>
<td>52.81</td>
<td>1080</td>
<td>3120</td>
</tr>
<tr>
<td><strong>Pre- and Post-test score difference</strong></td>
<td><strong>39.92</strong></td>
<td><strong>37.19</strong></td>
<td><strong>34.03</strong></td>
<td><strong>33.75</strong></td>
</tr>
<tr>
<td><strong>Recreation wordcount</strong></td>
<td>168.67</td>
<td>153.38</td>
<td>126.46</td>
<td>184.57</td>
</tr>
<tr>
<td><strong>Recreation proposition count</strong></td>
<td>38</td>
<td>35.69</td>
<td>33.77</td>
<td>43</td>
</tr>
<tr>
<td><strong>Recreation format (net-like only)</strong></td>
<td>0</td>
<td>1</td>
<td>3³</td>
<td>0</td>
</tr>
</tbody>
</table>
Creating

Concept Maps are, at best, an ambiguous mechanism for organizing information.
Assessment:

Ubiquity may never happen for many types of Concept Map products.
Using Knowledge Models

Analysis

Learning Assessment
Knowledge Models are, at best, underused.

Customer story: 2010 to 2015
Using
Analysis Dichotomy: Concept Maps must be small to be readable; Small Concept Maps offer limited insight.
Concept Maps are difficult to assess.
(not in red!)
(But more importantly,)
Assessing Concept Maps is laborious.
Using CmapTools can be challenging for corporate IT.

May 17: “…we plan to stand up the server…”
August 9: “We are in the process of getting a server stood up for Cmap, but that is not yet complete. I will keep you updated.”
Assessment:

Ubiquitous use will not happen unless Concept Mapping/Maps are useful and efficient means to other ends.
Reflections

Learning

Concept Mapping is difficult.

Propositional thinking is challenging, and at times, inefficient and awkward.

Creating

Concept Maps are difficult to read.

Concept Maps are, at best, an ambiguous mechanism for organizing information.

Using

Knowledge Models are, at best, underused.

Analysis Dichotomy: Concept Maps must be small to be readable; Small Concept Maps offer limit insight.

Concept Maps are difficult to assess.

Assessing Concept Maps is laborious.
Vision

Learning
10,000 propositions (very difficult to achieve)

Deliberate practice
I’m looking at your example cmap ...and I noticed that under the “grains” category, you have some larger linking phrases for grains->myotoxin and for grains->affitoxin. If it were me, I would made “wet, humid conditions” and “drought conditions” separate concepts on their own instead. Is that wrong?

-Perigean employee

Exercises
Hoffman’s are very useful
New Exercise: Unpacking
“People → drive → cars”
How deep do we unpack? When is “driv(ing)” a concept?
Vision

Creating

Need help with:
- Navigation through Knowledge Models
- Complex representations / hybrids
- Sharing and presenting
- Converting to other formats

Extend utility as products
Vision

Using

Help with analyzing big maps
Big ‘qualitative’ Data: 1,000s/1Ms propositions
Merging multiple maps
Semantic integration and qualitative analysis tools
Save audit trail
Show all propositions connected to this one

Help with the tedium
Arranging
Global changes
Future

Mental model assessment: process support
Embedding: Virtual reality presents opportunities, QR codes - Tobias Ley’s example
Interface: Cmaps that do something
Hybrids: Integrate with other representations
Games: Make Cmapping fun
Empirical study: Primarily of usability and utility

NOTE: Corporations do not care about features of the maps – they care about content, efficiency, and utility
Ubiquity in education will not happen until the market requires it.

Illustrative Item

In this task, middle and high school students used a customized software program to create concept maps. Students received 18 environmental science terms and 7 link labels. Students could drag and drop these concepts onto the grid space of the mapping program and add, erase, and link the items in their newly constructed maps. (See appendix C for more information about this task.)

Link labels should not be provided to students on the NAEP Science Assessment. See the Specifications.
Thank you,
Priit and Alberto!