GRAPHICAL REPRESENTATION OF MEANING

A survey presented to the Utilika Foundation
by S. M. Colowick

December 2007

Task: Discover and document graphics-based systems for the representation of illocutionary forces, predicate argument structures, and semantic relations and evaluations of such systems, with an emphasis on systems designed for use by lay users as well as domain experts.

Contents

1 Disclaimer

None of the systems reviewed here has the explicit goal of denoting meaning or illocutionary force in multilingual communication. More relevant systems and techniques could perhaps be unearthed by someone who knows how and where to look. However, some of the projects described below may provide ideas worthy of further investigation.

2 Systems for modeling concepts

2.1 Conceptual graphs

Conceptual graphs "express meaning in a form that is logically precise, humanly readable, and computationally tractable"; they are an "intermediate language for translating computer-oriented formalisms to and from natural languages" (Delugach, 2006). CGs seem to be used primarily in artificial intelligence, but there has been some research involving their hands-on use to facilitate collaborative/cooperative learning. Some of the terminology and techniques developed could be appropriate for adding annotations to multilingual communication.

Dimitrova, Brna, and Self (2002) studied whether students could build, read, communicate with, and manipulate CGs. Their experiment took place during a secondary-school computing lesson involving 16- to 18-year-olds with no prior knowledge of semantic networks or CGs. After 30 minutes of training, the students were able to understand information presented in CGs, but they found it slightly more difficult to manipulate them correctly, and they found it very difficult to construct new ones.

In the system's DISCUSS mode (illustrated below), users represent the content of a proposition, using graphical tools. Then they choose an illocutionary force, represented by a sentence opener.
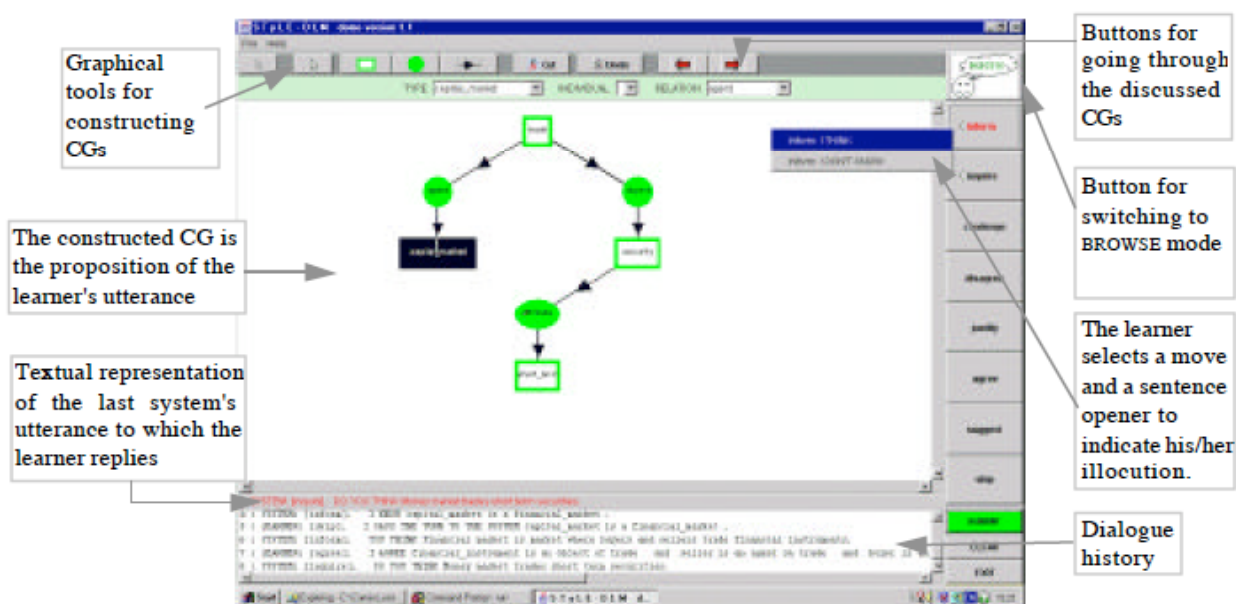
Sentence openers are grouped into 8 possible "dialogue moves":

- *Inform* (the speaker believes a proposition and informs the hearer about that)
- *Inquire* (the speaker asks about a proposition)
- *Challenge* (the speaker doubts a proposition)
- *Disagree* (the speaker disagrees with a proposition)
- *Justify* (the speaker explains why a proposition is correct)
- *Agree* (the speaker agrees with a proposition)
- *Suggest* (the speaker suggests a new topic for a discussion)
- *Skip* (the speaker skips a turn and passes the initiative to the hearer)

Sentence openers for *Inquire* included *What is* and *Is it true. Inform* openers include *I think* and *I don't know*. (Dimitrova, 2003)

Moulin (1993) has used conceptual graphs for modeling discourse, and he introduced a method of including temporal information in discourse graphs. His work, however, does not seem geared toward anyone other than linguists and knowledge engineers.
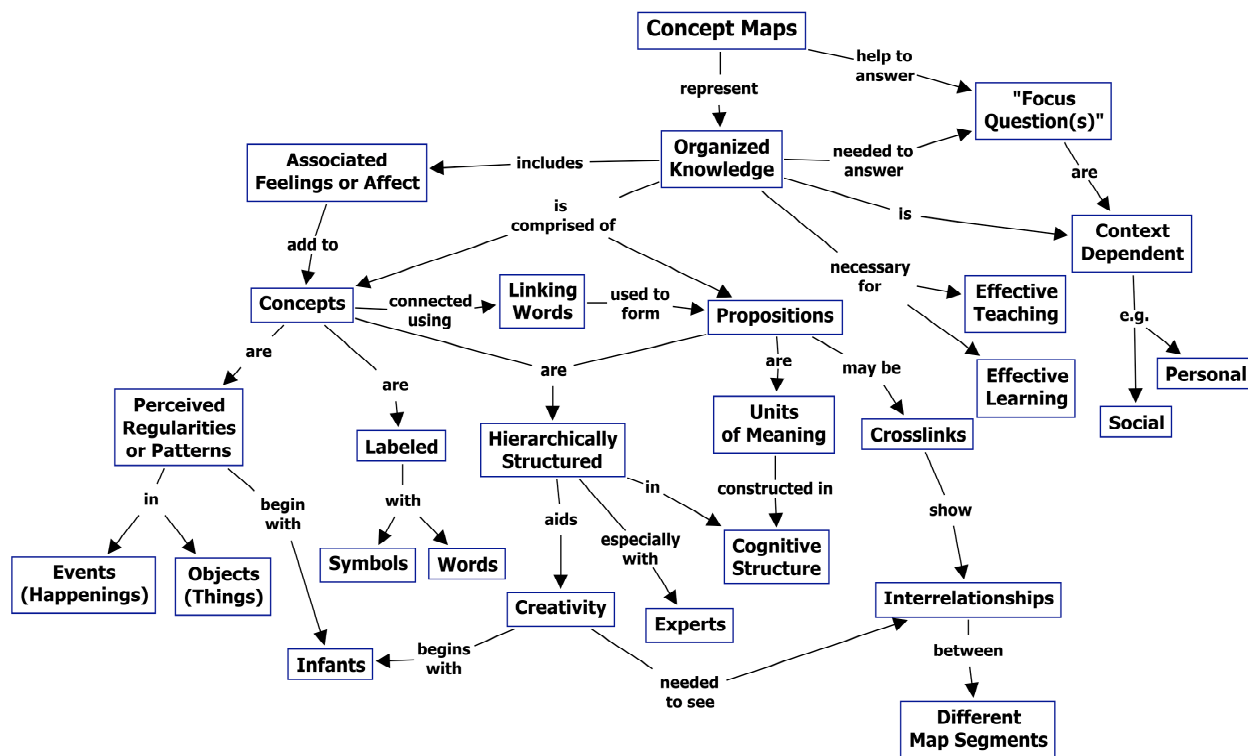
2.2 Concept maps

In Project Halo, domain experts use a graphical notation called *concept maps* to add new concepts to the AURA system. "We chose CMAPs," a research report explained, "because they are effective as a visual tool for formalizing and representing a range of knowledge types, and have even been shown to be used effectively in education." (Chaudrhi et al., 2007, p. 162) The researchers found CMAPS to be an improvement over the SHAKEN system they had used previously; user testing showed that users were more comfortable with a left-to-right layout than top-to-bottom. The example below shows a CMAP representation of a eukaryotic cell.
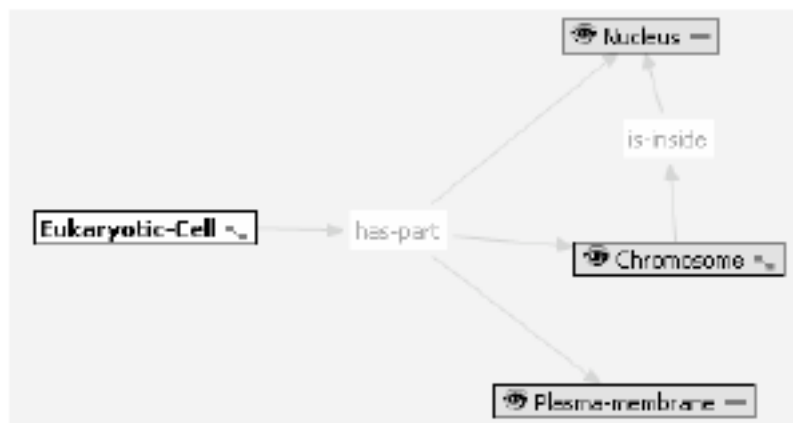
The conceptualizers of concept maps define *concept* as "a perceived regularity in events or objects, or records of events or objects, designated by a label." A *proposition* consists of two or more concepts connected by linking words or phrases to form a meaningful statement. "Propositions are statements about some object or event in the universe, either naturally

3

occurring or constructed. Sometimes these are called semantic units, or units of meaning." The concept map below presents a collection of propositions about CMAPs. (Novak & Cañas, 2006)

Concept Maps — represent → Organized Knowledge; help to answer → "Focus Question(s)"

Organized Knowledge — includes → Associated Feelings or Affect; is comprised of → Concepts; necessary for → Propositions; needed to answer → "Focus Question(s)"; is → Context Dependent

"Focus Question(s)" — are → Context Dependent; e.g. → Personal / Social

Associated Feelings or Affect — add to → Concepts

Concepts — connected using → Linking Words; are → Perceived Regularities or Patterns; are → Labeled; are → Hierarchically Structured

Linking Words — used to form → Propositions

Propositions — are → Hierarchically Structured; are → Units of Meaning; may be → Crosslinks

Effective Teaching / Effective Learning

Perceived Regularities or Patterns — in → Events (Happenings) / Objects (Things); begin with → Infants

Labeled — with → Symbols / Words

Hierarchically Structured — aids → Creativity; in → Cognitive Structure; especially with → Experts

Units of Meaning — constructed in → Cognitive Structure

Crosslinks — show → Interrelationships

Interrelationships — between → Different Map Segments; needed to see

Creativity — begins with → Infants

Context Dependent — e.g. → Personal / Social

The CMAP provides four types of graphical action – specialize, add, connect, and unify – for manipulating instances in the graph. CMAPs "tend to be read progressing from the top downward." This configuration seems contradictory to the left-to-right orientation preferred by the AURA subjects.

A program called Cmap Tools enables users to construct, navigate, share, publish, and edit concept maps. Features include automatic creation of Web pages and automatic formulation of Web queries that are relevant to a concept map. The program, which is free for educational use, can be downloaded at http://cmap.ihmc.us/download/. Nonprofit organizations with less than $1 million in yearly revenue are asked to contact Ceryph (http://www.ceryph.com/), distributors of the commercial version of the software (Ceryph Insight), and inquire about the "in-kind" program.

3 Pictographic representation of meaning

3.1 Introduction

Some text-free communication systems have the goal of facilitating translingual interaction, while others have been designed to enable communication for the disabled. Whatever their original purpose, no systems are in general use for multilingual communication. A few existing, proposed, or abandoned projects do make use of innovative techniques for representing

pragmatic, syntactic, or semantic features of discourse. These techniques could possibly be adapted for use with minimalistic textual communication.

While the use of ideograms or pictures seems like an ideal way to break down linguistic barriers, differing cultural backgrounds can lead to misinterpretation or even resentment of some symbols. De Mooij (2005) gives several examples of cross-cultural marketing that misfires. Clocks, she writes, are sometimes used in Western advertising to symbolize efficiency, but many cultures have such a different understanding of time that this reference does not work for them. She also discusses the significance of color, giving as an example the Danish people's dislike of the combination blue and gold, the colors of the flag that flew over them when their country was occupied by Sweden.

Cho et al. (2007) conducted an online survey in which 1,478 subjects (935 American and 543 Japanese) gave their interpretations of 120 pictograms. Analysis of the English and Japanese words submitted revealed that nearly 10 percent of the pictograms had culturally different interpretations, ranging from different perspectives on the same concept to a total lack of common concept represented by the image. The Blissymbols system, described in section 3.2.1, manages to overcome (or at least claims to avoid) all of these limitations, perhaps because the images used are very simple and abstract. The lack of detail could make it more likely that a symbol will have cross-cultural connotations.

3.2 Pictographic systems

3.2.1 Blissymbolics

Charles Bliss (born Karl Blitz) set out to invent a logical language that anyone could understand, regardless of native language. At first his three-volume *International Semantography* (later called *Blissymbolics*) was met with reactions ranging from apathy to derision, but then a school in Canada began using the language as a communication tool for disabled children. Soon this use of Blissymbolics spread, its success in this domain eventually eclipsing Bliss's intent for it to become a world language. In 1982 Bliss granted to the nonprofit Blissymbolics Communication International (BCI) a "perpetual, worldwide, exclusive licence for the use and publication of Blissymbols for persons with communication, language, and learning difficulties (http://www.blissymbolics.org/)." (Stott, 1997)

The Blissymbolics.us Web site has many resources for learning about and learning the language, including an online dictionary. (Another Blissword dictionary, at http://www.blisswords.co.uk/, suggests that the user can search for words in any language, but there don't seem to be any languages supported other than English.) The examples below include a Bliss-word formed from three Bliss-characters.

| house | question | person | automobile | limited time | taxi driver |

The first character in a multiple-character Bliss-word (e.g., "person" in the three-character word above) is called the *classifier*; it specifies the semantic or grammatical category to which the word belongs. Each symbol can also have one or more *indicators* that change its meaning. These Bliss-words demonstrate the indicators for action, quality, thing and plural:

For the purposes of multilingual communication, the most interesting aspect of Blissymbolics may be its indicators of grammatical features. Here are a few:

(Future tense   **)** Past tense   **□** Noun   **+** Possessive

There are also indicators to denote punctuation, intensity, opposition, temporality, figures of speech, slang, and more. All are described and illustrated in Blissymbolics Communication (2004). Examples can also be found at http://www.blissymbolics.us/lessons/indicators/ and at various other Web sites devoted to learning and promoting Blissymbols.

BCI has issued meticulously precise instructions for creating new symbols. Here, for example, is an excerpt from rule 4.3.4 of *The fundamental rules of Blissymbolics:* "In all cases in which the glyph of a Bliss-character extends above the skyline, indicators are located 1⁄4 of the matrix square above the ascender limit line (that is, hanging from the tall-indicator line)." (Blissymbolics Communication, 2004, p. 6) It would be amazing if children, especially those who are physically and mentally disabled, were able to adhere to these requirements. Fortunately, they don't have to, thanks to Blissymbol stamps, flash cards, and display boards called Bliss Boards with characters that the user can point to. There are also a few high-tech options, although it's unclear how widely these are used or how effective they are.

- Blisstalk, a symbol-to-speech device (Hunnicut, 1984)
- BlissInternet, a program for communicating by email (http://www.blissymbolics.org/blissinternet.shtml)
- BlissTool, a chat program (http://membres.lycos.fr/jfbouzereau/BLISS/bliss0.html)

An organization called Blissym makes Blissymbol fonts available for download (at http://www.blissym.com) and has developed a character set called BLISSCII, which is assigned to U+EBA1 thru U+EBFD in Unicode's Private Use Area. "If use of BLISSCII becomes widespread enough," the Web site states, "a new set of codes will be assigned, possibly U+2BA1 thru U+2BFD." (http://www.blissym.com/blisscii/index.html)

3.2.2 Vedo-Vedi

The Vedo-Vedi system, developed by Tanimoto & Bernardelli (1998), places imagery in frames, much like a comic strip, to create a narrative, or "script". The script typically describes a series of events in chronological order. There is a limited number of layout schemes, which means that

only certain topics can be discussed in a script; these include vacation travel, dates and time, dreaming and thinking, and human feelings.

The frame type indicates the verb of the sentence, while images in the slots attached to the frame indicate the various nouns and the roles that they play. A transportation frame contains a vehicle shown in the middle of the frame, a source slot on the left for an image of the departure place, and a destination slot on the right.

All narrative is from a first-person perspective. Fewer than 50 objects are initially available, but the user can define additional objects. Users also have the option to request animation of their scripts and to share the scripts with other Internet users by sending them a link and a "key" to unlock the link.

The script below describes a trip from Seattle to Tacoma. The narrator goes to a hotel and then dreams about traveling from Seattle to Hawaii by boat. The dream sequence is shown between yellow braces. At the end of the dream, the narrative returns to the current location, and the real trip continues.
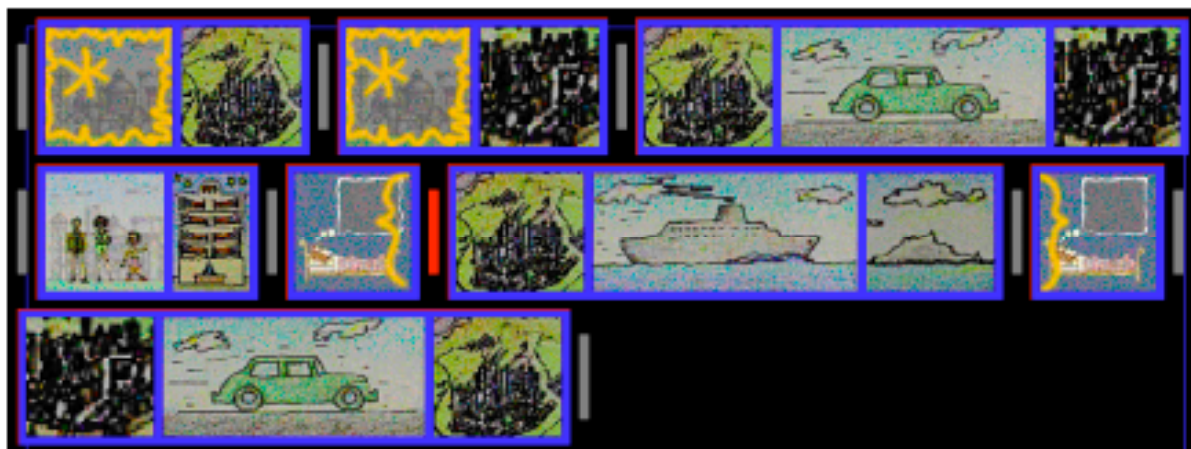
All events are described in the present tense. Particular dates and times within the script may indicate when an event will, or did, take place. Time and date can be shown either absolutely – using a clock or calendar frame – or relatively. In the script below, the clock frame shows absolute time, while the hourglass frame (and the sun frame?) indicates the passage of time.
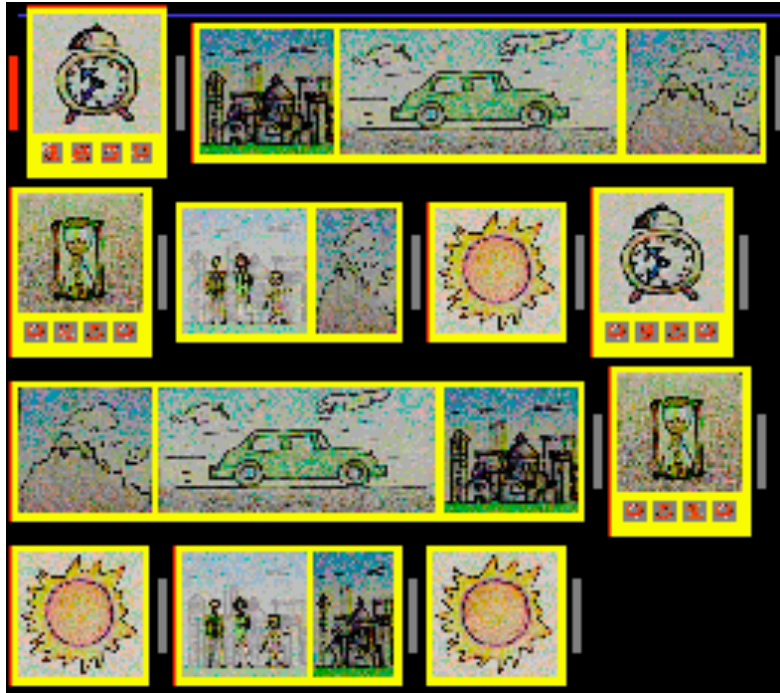
The frame below illustrates the relative method of showing time: animation of a weary traveler passing in front of the sun.

Un altro giorno è passato!

3.2.3 PicNet

Mihalcea and Leong (2006) described a system that automatically translates simple sentences into images. The translations are from a knowledge base called PicNet, which contains images associated with concepts. Only nouns, verbs, and pronouns are depicted; the source for pronouns is a set of line drawings made available to language teachers as part of a Purdue University project (http://tell.fll.purdue.edu/JapanProj/FLClipart/Pronouns.html).

The researchers compared subjects' interpretations of three types of translation: fully pictorial, fully linguistic, and mixed (see examples below). In the purely pictorial method, parts of the sentence that could not be translated with images from PicNet were rendered in a language the subjects did not know (Chinese), so that they would have no hints as to the meanings of the untranslated portions.

(a) Pictorial translation for *"The house has four bedrooms and one kitchen."*

(b) Mixed pictorial and linguistic translation (automatic) for *"You should read this book."*

I eat the egg and the coffee work as breakfast.

(c) Linguistic translation (automatic) for *"I eat eggs and coffee for breakfast."*

Fifteen subjects gave their interpretations of a set of 50 short sentences, which were randomly selected from language-learning courses and domain-specific texts. Not surprisingly, the most accurate interpretations tended to be for the fully linguistic sentences, with the mixed pictorial and linguistic translations a close second. Still, the authors believed the results showed "that a significant amount of the information contained in simple sentences can be conveyed through pictorial translations." (p. 124)

Acknowledging the limitations of communicating pictorially, the researchers expressed their belief that many thoughts are just too complex or too abstract to be conveyed through pictures. They also recognized that, as noted in section 3.1 above, cultural differences may interfere with comprehension of some concepts, as when, for example, a house is pictured that looks very different from any type of dwelling in the reader's experience.

3.2.4 Pictons

The Pangaea project aims to create a "universal playground" for children all over the world. Its Communicator program uses a dictionary of 500 "pictons", divided into nine categories (Takasaki & Mori, 2007, p. 202):

1. Basic: Frequently-used pictograms such as "I", "you", "OK", "like", and so on
2. Feeling: Facial expressions and emotional pictograms
3. Entertainment: Sports, game, music, shopping and so on
4. People: Family, friend, body part, and occupations
5. Place: Countries, building structures, and stores
6. Relation: Adjective and adverb pictograms as well as time and spatial pictograms
7. Food: Tastes, ingredient, utensils
8. Action: Motion and action pictograms
9. Encyclopedia: Symbols of Pangaea Activity and others

To ensure that pictons are understandable and culturally appropriate, an online Picton Survey (at the Pangaea Web site, http://www.pangaean.org/) allows users to record their interpretations of a series of individual pictons. The survey asks for the user's name, gender, age (4-16 or "other"), and country; oddly, it does not ask for the user's preferred or native language. Here are a few examples from a recent survey session:

## 4 Graphical representation of emotion

4.1 Emoticons

Annotating text to specify illocutionary force or semantic relations is not a common activity among casual Internet users, but many users do choose to encode the emotional content of their utterances. They often do this through the use of emoticons. Research has shown that four emotions/emoticons account for most emoticon use online, with the smiley face accounting for more than half of the use. (Rezabek & Cochenour, 1998)

The widespread adoption of this technique suggests that translingual communicators might be willing to use simple icons to add information about the meaning of their utterances. Arguably this procedure could be purely text-based, but rather than expecting users to compose their own sense-giving icons from ASCII characters, it would be preferable to have a menu of a few standard options.

4.2 TextTone

One drawback of using emoticons is that people from different cultures don't always represent emotions with the same symbols. In an attempt to address this issue, a system called TextTone provides a less culturally specific way to convey emotions online. In TextTone, each author chooses a method of representing each emotion. The representation is converted into a plain-text format – sort of an emotional interlingua – for distribution to readers. Each reader will also have selected a preferred method of showing each emotion. (Kalra & Karahalios, 2005).

TextTone offers a dozen preset "tones", including **happy, disappointed, very angry, confused,** and **winky**. For each tone, the user controls how the text is displayed, as shown here:

10
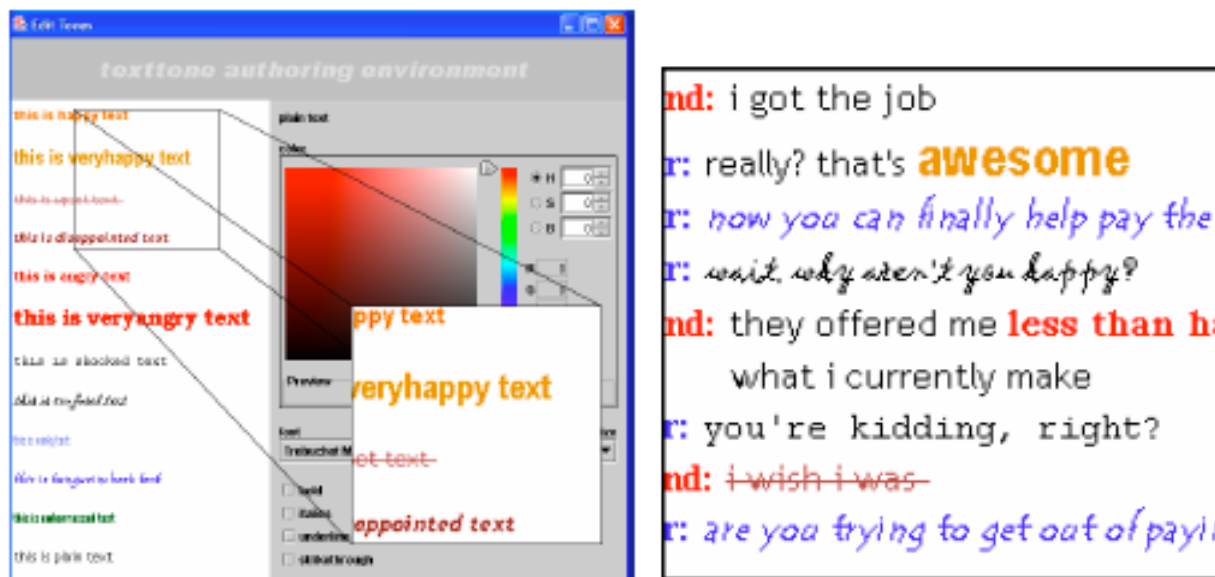
The TextTone researchers reported that their subjects found the system satisfying, although some felt a need "to be able to build mappings between tones and the corresponding visual representation." Presumably this means that the users had trouble remembering which combination of color, font, etc., represented which emotion. If a system offers just a few indicators to choose from – three or four, perhaps, instead of a dozen – they should be easier to remember.

Given the technological requirements imposed by elaborate text formatting, TextTone does not seem like an ideal way to express illocutionary force or semantic relations. However, a few simple text enhancements could conceivably help to convey the meaning or intent of purely lexemic/lemmatic utterances. The simplest approach would be to annotate only those utterances that would normally include some sort of punctuation. For example, the user could add a symbol or some type of formatting to questions, quotations, and exclamations, but leave all other utterances unannotated.

5 Summary and recommendations

As a technique for indicating meaning in translingual communication, graphical annotation seems more promising than the use of textual indicators. A few ideas for such an annotation system can be gleaned from some of the projects described above.

Blissymbolics offers some intriguing possibilities for enhancing lemmata semantically and syntactically. In particular, the symbols to indicate tense, part of speech, and number could be useful, as well as symbols to indicate illocutionary force – question, command, negation, etc. (see, e.g., http://www.blisswords.co.uk/SpecialBlisscharacters.asp).

The other pictorial systems have less complex grammars, but the Vedo-Vedi system includes some fairly elaborate methods of indicating time; some variation on one of these could be a useful addition to lemmatic communication. Also, the use of curly braces to indicate a dream

sequence suggests the idea of separating certain parts of a communication based on their intended meaning or purpose.

The use of icons to indicate certain emotions is a definite possibility. One that would be particularly useful would be an emoticon that indicates confusion or lack of understanding. Since people are already comfortable with enhancing their utterances in this way, it should also be possible to develop a set of simple icons to denote illocutionary force.

The system developed by Dimitrova, Brna, and Self (2002), while based on conceptual graphs, offers a set of textual sentence openers. These are grouped into "dialogue moves" that essentially represent types of illocutionary force. From these it may be desirable to choose a few common ones, such as **Inform, Inquire, Disagree, Agree,** and **Suggest,** and create icons to represent them. Perhaps Blissymbolics could be a source for such icons.

Finally, one must take into account the likelihood of cultural differences in symbol interpretation. Those who hope to develop a system for multilingual communication will need to do extensive testing, as the Picton researchers have done, to determine the universality of any graphical components of the system.

REFERENCES

Blissymbolics Communication International (2004). *The fundamental rules of Blissymbolics: creating new Blissymbolics characters and vocabulary.* http://www.blissymbolics.org/downloads/bliss-rules.pdf

Chaudhri, V.K., John, B.E., Mishra, S., Pacheco, J., Porter, B., & Spaulding, A. Enabling Experts to Build Knowledge Bases from Science Textbooks. (2007) *Proceedings of the 4th International Conference on Knowledge Capture,* pp. 159-166. http://www.ai.sri.com/pubs/files/1545.pdf

Cho, H., Ishida, T., Yamashita, N., Inaba, R., Mori, Y., & Koda, T. (2007). Culturally-situated pictogram retrieval. *Intercultural Collaboration,* 221-235.

De Mooij, M.K. (2005). Global marketing and advertising: understanding cultural paradoxes. Thousand Oaks, Calif.: Sage.

Delugach, H. (2006). Conceptual Graphs Home Page. http://conceptualgraphs.org/

Dimitrova, V. (2003) STyLE-OLM interactive open learner modelling. *International Journal of Artificial Intelligence in Education*, *13*, pp. 35-78.

Dimitrova, V., Brna, P., & Self, J. (2002). The design and implementation of a graphical communication medium for interactive open learner modelling, *Proceedings of the 6th International Conference on Intelligent Tutoring Systems,* pp. 432 – 441. http://www.comp.leeds.ac.uk/vania/papers/its2002.pdf

Hunnicut, S. (1984). Bliss symbol-to-speech conversion: Bliss-talk. *STL-QPSR, 25*(1), 58-77. http://www.speech.kth.se/prod/publications/files/qpsr/1984/1984_25_1_058-077.pdf

Kalra, A., & Karahalios, K. (2005). TextTone: expressing emotion through text. *Human-Computer Interaction - INTERACT 2005*, pp. 966-969. http://social.cs.uiuc.edu/papers/pdfs/interact2005-kalra.pd

Mihalcea, R., & Leong, B. (2006) Toward communicating simple sentences using pictorial representations. *Proceedings of the Conference of the Association for Machine Translation in the Americas*, pp. 119-127. http://www.mt-archive.info/AMTA-2006-Mihalcea.pdf

Moulin, B. (1993). The representation of linguistic information in an approach used for modelling temporal knowledge in discourses. In Mineau, G.W., Moulin, B., & Sowa, J. (eds.), *Conceptual graphs for knowledge representation* (pp.182-204). Berlin: Springer-Verlag.

Novak, J.D. & Cañas, A.J. (2006) *The Theory Underlying Concept Maps and How to Construct Them*, Technical Report IHMC CmapTools 2006-01, Florida Institute for Human and Machine Cognition. http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/TheoryUnderlyingConceptMaps.htm.

Rezabek, L.L., & Cochenour, J. J. (1998) Visual cues in computer-mediated communication: Supplementing text with emoticons. *Journal of Visual Literacy*, pp. 201-215.

Stott, G. (1997) A great Australian: The inventor of Semantography (Blissymbolics). http://www.blissymbolics.us/biography/

Takasaki, T., & Mori, Y. (2007). Design and Development of a Pictogram Communication System for Children Around the World, *Intercultural Collaboration (pp. 193-206*). Berlin: Springer.- http://www.pangaean.org/

Tanimoto, S.L., & Bernardelli, C.E. (1998). The design and implementation of Vedo-Vedi, a visual language for human communication in the Internet. http://www.cs.washington.edu/research/metip/vl/vv/UW-CSE-98-04-02.PDF