# Representation and Learnability in Visual Languages for Web-based Interpersonal Communication

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## Abstract

*Computer-based visual languages have been developed primarily in order to help people program and operate computers. Now that many people in the world have personal computers with good graphics and Internet connections, we are seeing a great deal of informal electronic visual communication via web pages. More formal visual languages can be expected to appear on the Internet in the near future. Visual languages offer various possible advantages to textual email, such as permitting communication between people who don't speak or read the same textual language and such as permitting the incorporation of rich graphical material. Designing these languages requires making some important decisions about ontology, visual representation, interactivity, and how users learn the language, as well as about the more traditional issues of language design such as syntax. The power of the computer to generate alternative views of a language object can be harnessed by incorporating an iconic-symbolic continuum as a basic representational axis. Concreteness of representation in limited domains can be achieved by the use of microworld-like simulations. However, the objects in these simulations can convey richer meanings by associations with real-world people and objects. This paper presents a variety of research questions and briefly attempts to answer a few of them.*



## 1 Introduction

Let us begin with the reasons for this study, some sample research questions, and a brief historical view.

### 1.1 Motivation

The World-Wide Web is connecting people all over the world in new ways, and it is growing at a remarkable rate. How are people from different countries going to relate to one another through this medium? There are doubtlessly many answers to this question, but an important one is that pictorial communication has great new potential in a digitally wired world. Iconic representation goes back at least tens of thousands of years. Today it is found in a wide variety of media including everything from children's drawings through movies and interactive "applets" on the World-Wide Web. The remarkable technological changes of the past five years make it particularly timely to investigate anew the role of iconic representation in human communication.

### 1.2 Sample Questions

This paper raises research questions and highlights or identifies actual or potential features of visual languages that may lead to improved means of communication and understanding among people in a planet connected by a global digital network. How learnable are languages that mix iconic and symbolic representation? What is the role of resolution in communication of everyday events using visual languages? How do graphical elements of color, texture, and animation affect not only the ease with which a message is understood but also the time and effort it takes to compose the message? What does the philosophy of language suggest to those who design computer-based iconic languages? What are some of the linguistic questions that arise out of the new aspects of graphical communication in the Internet: interactivity, international aspects, time delays, distortions and possible misinterpretations due to bandwidth limitations? What is the relationship between a visual language and its associated ontology? Within what social situations are visual languages effective?

### 1.3 A Historical View

The use of drawings for human communication is very old and fundamental [1]. From the cave paintings at Lascaux to children's drawings today, iconic representation has played a fundamental role in human expression. Images and spatial forms are not only used to represent scenes and physical objects but also processes and more abstract notions. Over time, pictographic systems have evolved into alphabets and symbol systems that depend much more heavily on convention than on likeness for their representational power. Visual languages have been informal, as in most art, and they have also been more formal, especially in modern times with ship semaphore systems, traffic symbols, and international icons for amenities in public spaces such as telephones, restaurants, emergency exits, etc. During the last thirty years, there has been intense interest in visual languages for human/computer interaction [11], [12]. Window-system interfaces using desktop metaphors with folders, file cabinets, trash cans, drawing tools and other familiar objects have become standard for personal computers, because they make computers easier to use and easier to learn.

Today visual languages continue to have appeal because of the following actual or potential features that they have: internationality (lack of dependence upon particular spoken or written languages), learnability that results from the use of visual representations, computer-aided authoring and display that facilitate use by the drawing-impaired, automatic adaptation (e.g., larger display for the visually impaired, recoloring for the color-blind, more explicit rendering of messages for novices), and use of sophisticated visualization techniques [14], [26], [29], [33]. Thus far, almost all of the recent interest in visual languages has been for communication between people and computers to make it easier for people to control computers. However, now that the Internet is making the computer as much an instrument of communication as one of computation, it is time to look carefully at the properties of visual languages for human-to-human communication in order to understand the potential impact of visual languages on international, interpersonal electronic communication.

## 2 Issues in Iconic Representation

The distinction between icon and symbol is of central importance in designing a visual language for people of different native tongues. But in addition, the style of the graphics and the mechanics of composing are important issues.

### 2.1 Icon versus Symbol

The essential difference between iconic and symbolic representation was characterized by the American philosopher Charles Peirce: "An Icon is a sign which refers to the Object that it denotes merely by virtue of characters of its own... A Symbol is a sign which refers to the Object that it denotes by virtue of a law, usually an association of general ideas, which operates to cause the Symbol to be interpreted as referring to that Object." (Peirce in Buchler [8], 1955, p.102). In other words, the meaning of an icon is in principle independent of the person making the interpretation. This independence of meaning on the particular interpreter is what makes a visual language potentially international in character.

But there are difficulties and limitations in achieving purely iconic representations for complex meanings. Psychologists have found cultural dependencies even at the perceptual level, where bushmen unaccustomed to perceiving pictures did not recognize the objects depicted. Perception depends upon context as well as image, and the role played by a particular sign may be icon, index, or symbol, depending upon whether its relationship to its interpretation is a result of its intrinsic (e.g., shape, color) characteristics, its real-world relationship to the object, or an artificial association, i.e., through linguistic convention [20], [4], [17], [21], [22], [32], [34].

### 2.2 Interpolating in a Continuum

It is often possible to create a succession of increasingly stylized signs, beginning with a realistic image and ending with an abstract symbol, that permits a novice to readily understand an abstract symbolic association [43]. Furthermore, iconic representation can sometimes be taken to an information-theoretical extreme, and surprisingly abstract concepts can be communicated using minimal icons [40], [10]. Just as signs in natural languages such as Chinese have presumably evolved from explicit pictorial representations to highly stylized calligraphic figures, icons can "morph" from detailed images to abstract symbols on a computer screen, but in seconds rather than centuries.

Another kind of image evolution occurs in the restoration of paintings, now an advanced art in itself that uses a pictorial information system at the Vatican [31]. The transformation of images on computer screens can have semantic as well as aesthetic implications. How can signs change their forms to help people communicate? Within what limits can signs change without distorting someone's intended meaning? How does context narrow or widen the range of permissible transformations? Erich Neuwirth at the Technical University of Vienna has found a means to take an image of someone's face and automatically compute a caricature of it that intensifies the individual's distinguishing characteristics; can or should caricature algorithms be incorporated into interactive visual languages to help writers or readers exaggerate visual representations?

### 2.3 Other Representational Questions

Other representational issues for new visual languages relate to their dependence upon particular media and the types of primitive elements they employ. Are there advantages to line or stroke-based representations in computer-mediated visual languages for human communication? How important is it that people be able to compose their messages on paper as well as on-screen? How does resolution trade off with context in the intelligibility of messages? What kinds of multiresolution representations are consistent with these languages? Are many alternative levels of detail desirable? Can we find relatively "culture-independent" or

"international" visual representations for key objects and actions? If not, how can multiple visual representations be joined to a single concept without introducing too much confusion?

How should visual representations for particular sets of concepts be created? Language designers may need one set of guidelines and facilities, whereas users who compose messages are likely to need a wholly different kind of tool. Metaphor has been important in visual languages for operating computers [28]; how should metaphor be supported for human-to-human communication? Is there a proper role for a "typewriter for icons" or is the need better met with enhanced drawing tools? Perhaps human drawing activity is inherently limited to two dimensions without depth or hypermedia links [16]. What is the best way for users to express themselves in a computer-mediated visual language? Should they first compose their messages in their native languages and then proceed to translate them into pictograms? Or should they create their representations directly in pictorial form using computer tools?

## 3 Example Languages

The best examples of intentionally-designed systems of pictorial signs for general communication are as yet pre-computer-age. Here are perhaps the best known of these. (Heavily evolved languages such as written Chinese are related, but excluded from this discussion.)

### 3.1 Blissymbols

The most comprehensive modern visual language for communication among humans is with little doubt the system developed by Charles Bliss [6] called "Semantography." This system, originally developed during the 1930s and 1940s, had as its objective the elimination of written language barriers among people, especially scientists, all over the world [35]. While this extremely ambitious goal was never achieved, the symbol system was adopted for use in the world community of paraplegically disabled. Known as "Blissymbols" in this community, the system has permitted people to communicate (by pointing to symbols) who would otherwise be cut off from expressing themselves [24]. Because the Blissymbolics Institute is headquartered in Toronto, Canada, there was an electronic demonstration of Blissymbol communication at the Canada Pavilion of Expo 86 in Vancouver; two Macintosh computers at opposite ends of the hall were connected by a cable so that visitors could send messages by clicking the mouse on a tableau of visual symbols.

Much thought was put into Bliss' system of symbols. They are composed from graphical primitives that are easy to learn and which combine readily to form compound meanings in logical and rather consistent ways. (For example, see Figure 1.) In comparison with today's visual languages for computer interfaces, however, the Bliss symbols appear somewhat plain, linear, and conventional. An important item for visual languages research is an evaluation of Bliss' system in terms of its ontology, its learnability, its adaptability to computer implementation (including the addition of interactivity, transformation of icons, animation, etc.), and its appeal to current-day users of the Internet.

Figure 1: Bliss symbols representation of "Man ploughs from sunrise to sunset" (after Bliss 1965).

### 3.2 Minspeak

Another example of a visual language for the handicapped is Minspeak [2]. Unlike Bliss symbols, Minspeak was designed explicitly with handicapped users in mind. (A sample Minspeak expression is shown in Figure 2.) A formal design technique called "semantic compaction" was employed, and a special iconic keyboard was created for Minspeak [12]. The methodology used in Minspeak is applicable to the design of other visual languages, and another potentially interesting research direction is to study the relationship between the semantic compaction technique and the ontology of the resulting language—the range of meanings that are expressible in the language.

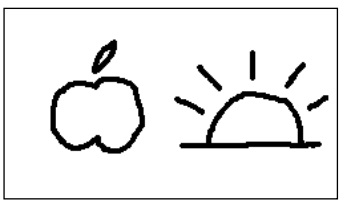

Figure 2: Minspeak representation of "breakfast" (apple + morning) —illustration based on Chang et al, 1992.

### 3.3 Augmentative Languages

A small but illustrative visual language currently used in Internet email is the "smiley face language" of depictions of attitude. For example, someone who includes the character sequence :-) in her or his message wishes to indicate a positive attitude (a smile when viewed sideways from the right). Similarly, the sequence ;-) is a winking-eye face, indicating that the preceding statement should be considered tongue-in-cheek. These signs, composed of ASCII characters, are sometimes called "emoticons." This language is an *augmentative* one; it is used to add inflections to textual messages. Unlike the textual messages themselves, which are in English, French, Italian, etc., the smiley faces are international.

Email technology is currently almost all text-based, but its capabilities are improving, and we can expect to see more embedded images, sounds, and active computational objects in messages in the coming years. It is not hard to imagine the smiley face language growing beyond the limits of ASCII characters and evolving into a more general visual language, so that the relative volume of the textual parts of email shrink over

the years, and the visual parts grow.

### 3.4 Recent Developments

Colin Beardon has proposed iconic systems for human communication based on such formalisms as Conceptual Dependency and animations specified by rules [3]. Timothy Ingen-Housz has developed a beautiful system of pictographs featuring smoothly curved strokes and a simple two-dimensional grammar for composing sentences [25] (see Figure 3). Beardon's systems assume that computers are part of

Figure 3: The Elephant's Memory representation of "The rabbit is bleeding because a car hit it" (after Ingen-Housz 1997).

the medium. Ingen-Housz has proposed to adapt his originally purely graphical language to an electronically mediated form.

Some noteworthy recent technological developments raise additional questions for a study of visual languages for human communication. These developments are (1) the growth of the World-Wide Web and its visual languages (informal and formal), (2) the progress of visual programming languages (e.g., as in Burnett and Ambler [9], and as described in Glinert et al [19] ), and (3) the advent of groupware, including liveboards, MUDs (usually manifested as shared real-time text-oriented conversation spaces), and shared virtual realities.

Some of the visual languages of the World-Wide Web are (a) the graphical conventions of HTML and its browsers, (b) GIF images used in typography: bullets, icons, math formulas, (c) GIF images used as images, (d) whatever authors put in Java applets, such as animated text, online simulations, etc., (e) "Comic Chat" [27] which augments textual dialog with automatically generated comic-strip graphics composed from pre-drawn bitmaps, (f) three-dimensional virtual-reality spaces as specified by VRML descriptions, and (g) other plug-ins and extensions to Netscape Navigator and Microsoft Internet Explorer. To what (very limited) extent do these mechanisms already meet a need for natural-language-independent global communication? To what extent do they create expectations for what an international visual language ought to be? How will experience with existing web languages affect people's abilities to learn or use new visual languages?

## 4 Learnability

One of the most appealing features of visual languages generally is that they can be easy to learn, in comparison with textual languages. For example, it is not necessary to know the alphabet or how to spell in order to learn the meaning of the icon for the left baggage counter in a train station. It is especially important that a visual language for human-to-human communication be easily learnable if it is to attract users. Otherwise, people would just as soon master a foreign language as invest a lot of time and effort on some unproven system of icons.

Several aspects of a language's design contribute to its learnability. These include the simplicity and explicitness of its underlying ontology, the visual representations it uses and their relationships to the concepts they stand for, the extent to which the objects in the language can "explain themselves," the extent to which the explanations maintain the visual and semantic contexts of the object instances, and the provision of metalinguistic capabilities for the language.

### 4.1 Ontology

Formal visual languages for communication between human beings have been most successful in limited domains such as ship semaphores, mathematical notations, and chemical diagrams. An ontology for a language — the set of objects and concepts assumed to exist in a Platonic sense – is basic, and it largely determines the set of meanings that can be expressed in the language. The microworlds found in video games have particular ontologies. Relatively explicit ontologies for subsets of natural language and "common sense" have been developed by researchers in artificial intelligence (see, for example [42], p.188). Methodologies for constructing ontologies have also been developed [23].

Learnability of a language is enhanced if the ontology for the language is simple and explicit. If a person understands the ontology, s/he knows what can be expressed in the language. If the ontology is explicit, then it is easier to learn than if it is hidden. If it is simple, then it is also easier to learn.

An ontology for a small visual language for human communication is described in a later section.

### 4.2 Self-Explaining Icons

A visual language is made easier to learn if its language objects are given the ability to explain themselves. For example, an object representing the verb to fly can present itself in a number of ways, including as a highly stylized icon, a detailed image, and with an animation. A simple kind of explanation is the presentation of a more detailed view of the object.

### 4.3 Maintaining Context During Explanations

There are many possible means to help maintain the visual and semantic context of a language object during its explanation. One way is to present the explanation as one or more views with additional detail in such a way that transitions from one view to the next are smooth and avoid inconsistencies during the transitions. Transitions may have discontinuities (places where new details emerge). However, transitions should not have degenerate points where information is actually lost as one increases the level of detail.

When an object is displayed in more detail, the objects around it in an expression change themselves only to the extent necessary to maintain their important visual and semantic relationships with the object being explained. We might call this the "minimum disruption principle" for explanation mechanisms. A consequence of this principle is that the user should be able to request a more detailed view of a particular linguistic object in a script without being forced to take more detailed views of all the other objects in the script. Fisheyeing is one attractive approach to this problem [15], but a challenge with all these approaches is maintaining an invariant perception of the context; this typically involves finding a compromise among (1) geometric continuity of the zooming transformation, (2) differential scaling of components, and (3) invariance of shape, straightness, and spatial position of visual components.

### 4.4 Translation

Although one user group for a visual language may be pre-literate children, users who can already read and write in English, Italian, Chinese, etc., may learn the visual language more easily using textual views of their messages translated automatically into their native languages. A limited ontology and a concrete semantics for the visual language imply that natural language translations can be produced without introducing new ambiguity. Such a translation facility could also make these visual languages useful tools for learning to read or speak a first language, second language, etc.

### 4.5 Metalanguage

One way to facilitate learning a language is to identify or to provide a metalanguage that the learner can use to discuss the target language. Although the user's native language can be that metalanguage, words or symbols for additional concepts may be made available to describe any unique structural features of the new interactive visual language. It may be possible and desirable for the visual language to contain such a metalanguage, so that conversations about the language can take place in the new language itself. For a visual language, an ontology of iconic representation should be explicated and the metalanguage built or extended to encompass it. Such an ontology would include the concepts of semantic detail, spatial resolution, color resolution, and the structure of scripts and animations.

### 4.6 Targeting Learners

One approach to making a language get learned is by designing it specifically for those potential users most able to learn such things. In some ways children are better language learners than adults. If the language provides for the needs of children through its ontology and through its easily understood representations, then these efficient learners stand a chance of getting interested in the language and learning it. If the domain is technical or professional, adults might be the more efficient learners, and designing the language to meet their needs and abilities would be in order.

## 5 System Structure

A variety of approaches are possible for structuring a system that provides a visual language and tools for human communication. Here, one particular structure is described.

### 5.1 Assumptions

This structure is based on several assumptions. First we have the *static representation assumption*: every language object has at least one static (non-animated) visual representation. Adhering to this assumption assures that hardcopy versions of messages are at least possible. Without these, learners may be unnecessarily handicapped.

Secondly, it follows a *weak animation assumption*: most sentences can have animations involving objects moving on screen, but not all sentences need have them.

It also follows a *strong ordering assumption*: messages are described in scripts, which are totally ordered sequences of units called frames. Without this assumption, we would fail to take advantage of people's intuition about chronology in narratives, and another mechanism would need to be added in order to express the time sequence of events.

### 5.2 Script Editor

The sender of a message composes a sequence of frames using a tool called the script editor. The editor provides a menu of icons representing frame objects (described below) and a script workspace where the sequence of frames is created. There should also be a cache of commonly used frames that is personal and which persists from session to session.

Double-clicking on a frame icon should open a detailed view of the frame and enable composing the frame's various slot values.

### 5.3 Script Animator

When the recipient of a message receives it, the script should appear in its default, static form. Then by pressing a button on the screen, an animated presentation of the message should be made. Different styles of animation might be supported: a highly stylized animation would exploit motion but be concise; a cartoon-like animation would include more inflection and detail; a relatively realistic animation would use likenesses or models of the actual people and places referred to by the pronouns in the script. These more detailed animations could be controlled by intelligent animation mechanisms that automatically make cinematographic decisions or that synthesize message details for visual effect or visual completeness. Portions of such animations could also be based on simulations of 2-D or 3-D environments or could include autonomous agents that interpret their roles in the script and perform them with situation-specific embellishments and flair.

The script animator and the editor could be integrated into one tool, but by separating them, it may be easier to incrementally make improvements to the system.

### 5.4 Java Classes for Language Objects

In order to discuss at least a small part of this system structure concretely, let us refer to a specific (incomplete) implementation of a visual language that is, let us say, called "Vedo/Vedi," to use the native language our symposium's hosts. (This means "I see/you see.")

A message is represented by a script. A script is a sequence of frames.

```
public class VVScript extends Vector {
  VVImage scriptImage; // icon for the script.
  Hashtable properties; // misc. attributes.
  }
```

Each frame is an object which has a frame type and zero or more slots (named attributes). A frame can display itself in a standard view. It can also explain itself in one or more ways, such as presenting a more detailed view of itself. If its current preferred resolution is low enough, it displays itself by retrieving an image from the image database and drawing it; otherwise it calls a method which displays the frame in detail by separately painting the objects in the frame's various slots.

```
public class VVFrame extends Canvas {
  int frameType;
  float preferredResolution;
  Hashtable properties;
  VVFrame() { //constructor.
    super();
    preferredResolution = 4.0;
    resize(128,128);}
  public void paint(Graphics g) {
    if (preferredResolution > 4.0)
      drawDetailedFrame();
    else {
      g.setColor(Color.black);
      g.drawRect(0,0,128,128);
      Image im = ImageBase.getVVImage(
                  linguisticType,
                  preferredResolution);
      if (im != null)
        g.drawImage(im,0,0,Color.blue, this);
      } } }
```

The various visual views for a frame normally are ordered along an axis indexed from 0.0 to 10.0 in which a highly stylized icon rests near one extreme (at 1.0) and a highly detailed picture rests near the other (at 9.0). The default view is a moderately detailed bitmap of size 128 by 128, and this corresponds to position 4.0 on the axis.

The values of attributes in a frame have types which depend on the particular slot of the particular frame. These are typically specified with icons. For example, a transportation frame for "I flew from Seattle to Rome" would contain slots for agent, source and destination; the destination would be specified by an icon for Rome. Some slots would take entire scripts (subscripts) as values. In a default view of the top-level script, the lower-level script might not be displayed in any detail; it would be displayed when the frame is asked to explain itself.

### 5.5 Post Office Support

In order to facilitate Internet communication, the recipient of a message requires both the message and the tool that presents it. One approach to this is to use decentralized storage: each message is transmitted electronically directly from sender to recipient, and each participant must have the appropriate tools. The presentation tool could be embedded in the message in case the recipient doesn't already have the tool. This system has the disadvantage that it is difficult for the designers to evaluate how the language is being used.

An alternative storage approach uses a special web server as a post office, where messages are stored and retrieved. Provided message volumes are not too high, this is a more attractive method for language designers, since it becomes easy to monitor the volume and patterns of usage of the language.

A sample post-office facility has been set up on a University of Washington server in order to support experiments in visual communication. The use of this structure involves a pattern of information flow illustrated in Figure 4.

## 6 Roads to Development

It appears likely that a variety of new visual languages will be developed in attempts to facilitate nontextual electronic communication among people. The community of people who have been studying visual languages now has an opportunity to have a positive influence on the evolution that takes place, and perhaps even to propose compelling designs to lead in this new area.

If developers in this new field keep some simple thoughts about cooperation in mind, various dead ends might be avoided. Here are some ideas: (1) adherence to some common ontological templates may allow connections or even merging of languages; (2) adherence to common object structures may allow merging of authoring environments and animation tools.

As a "seed" to facilitate cooperation, I propose a relatively simple domain that can support the exploration of issues described above.

### 6.1 Postcard Ontology

This sketch of a simple ontology for one kind of human-to-human communication is intended to serve as a starting point for possible collaborations. The language for this ontology should allow children of ages 8 to 12 to compose the kind of messages they might normally write on a picture postcard to a friend or relative. In order to keep the ontology simple, it is limited to narratives about traveling, about the health of family members, and about simple aspects of friendship, feelings, time and communication.

1. Travel: transportation, cities, countries, popular tourist sites, accommodation.

2. Health: wellness, sickness, injury, birth, death.

3. Family relations: mother, father, son, daughter, brother, sister, grandmother, grandfather, uncle, aunt, cousin, pet dog, pet cat.

4. Friendship: introducing friends, missing friends.

5. Greetings: hello, please, thank you, goodbye.

6. Time: date, time of day, past, present, future, yesterday, today, tomorrow, when, before, after.

7. Communication: message, reply, "I don't have time to finish this," "I don't understand," "Do you understand?" "I'm not sure I'm writing this correctly," "I know this doesn't make sense; I'm just fooling around," "To be continued," "I can't explain; this language is too limited," "It/I doesn't/don't really look like this."

### 6.2 Linguistic Objects

Frames for Vedo/Vedi come in 9 types. Types 1 and 2 introduce people and places. An introduction is expressed as an association between a detailed image showing the person or place and an icon that serves as a pronoun; it is this pronoun with which the person or place is referenced in following frames. A type 3 frame describes a transportation event. Type 4 frames describe health events. A type 5 frame expresses a family relationship between two people. A type 6 frame expresses a friendship relationship. A type 7 frame expresses a greeting. A type 8 frame establishes a time or time relationship for following frames. A type 9 frame asserts one of the statements (or question) about communication.

Pronouns, displayed as icons, refer to individual people or to individual places such as cities and tourist landmarks. Pronouns are shown in frames to denote particular slot values.

There are only a few nouns in Vedo/Vedi. Like pronouns, they are displayed as icons, and they refer to specific objects such as the current message, the message to which the current message is a reply, an unspecified message, a specific time, a specific date, etc. Unlike a pronoun, a noun does not require that the author provide a frame to bind it with an antecedent.

A frame that is part of one script may have another script as the value of one of its slots. The way in which the meaning of the embedded script affects the meaning of the frame containing it depends upon the type of frame and which of its slots contains the script.

### 6.3 Standards

Once any language gains a significant following, it becomes important for its community to agree upon standards. For example, Blissymbolics Communication International (a nonprofit organization headquartered in Canada) coordinates the extensions to the official list of Bliss symbols [7]. If a new language is developed, it would need a similar committee in order to respond to the needs of its community. When each language object can have multiple views, additional work is needed to ensure that the views use representational conventions consistently.

In developing any new system, one should also ask whether the new need can be satisfied using existing standards. For example, the Bliss symbols might be adequate for some of the purposes described earlier. (A system called BlissNet is currently under development that will integrate Bliss symbols with word processing for web-based communication.) Regarding software implementation, perhaps an existing graphics editor or text editor could be adapted to edit visual scripts. Also, it might be possible to translate scripts into an animation specification language, so that it is not necessary to build a new animation engine but simply to connect it up to the script translator.

## 7 Conclusion

The Internet and World-Wide Web have great promise in furthering international communication, but language remains a key obstacle for many. Visual languages can take on new dimensions when mediated not by paper, but by electronic computers. For example, pictographs can move or morph, cartoons can be animated, and images can contain hypermedia links that bring up more details or related information. While we can expect many interesting visual languages to appear over the coming years, the visual languages research community has an opportunity to influence these developments. Perhaps the most important general domain for our attention is everyday concerns of people and the kinds of things that people like to tell each other using postcards, letters, and electronic mail. By establishing a clear and general framework for the development of a computer-mediated visual language for human-to-human communication, we may help to avoid a visual-language Tower of Babel. The Vedo/Vedi home page is at `trillium.cs.washington.edu:8080/tanimoto/vv/`.

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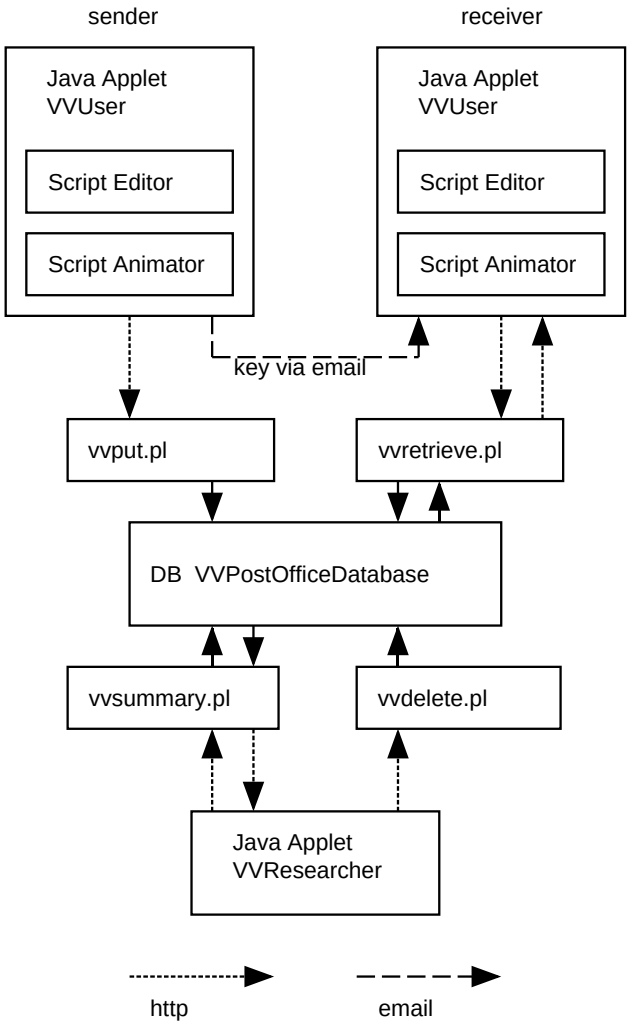


Figure 4: Information flow in Vedo/Vedi. The users and researchers access the system through their Java-enabled Web browsers. When a visual message is sent, it is posted via a Perl script in a persistent associative memory on a central server. At the same time, a URL containing a unique key is sent via email to the recipient, who later uses it to retrieve the message and launch its animation.