
DEFINING GESTURE

A Visual Dictionary for American Sign Language



Sue-Ellen Johnson, 2004

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INTRODUCTION

Abstract

The goal of my thesis project is to create an interactive, multi-media dictionary for American Sign Language (ASL) and English. This dictionary will serve the same purpose as any two-language dictionary (e.g. a German/English dictionary) and will act as a supplemental resource for people who are learning ASL in a classroom or tutoring setting.

My thesis grew from a life-long interest in languages and a desire to better communicate with my nephew, who had trouble hearing, and was learning ASL. My thesis project also presented me with the challenge of designing a visual, as opposed to text-driven, database interface.

This visual interface is the main component of my thesis project. Users can conduct searches, sort through results, and access detailed information about particular signs.

The underlying theoretical issue driving my work is this: How to best organize, present, and interact with information that is fundamentally visual. I believe that my response to this issue can provide a model for other applications that require visual database solutions.

Motivation

My motivation for this thesis project is threefold. Initially, I was inspired by the idea that visual information could be identified in purely visual terms, without the need for word-based descriptions.

Second, I realized that there was a need for this type of project in my own family. My (then three-year old) nephew, who had hearing trouble, was learning ASL to communicate. While his parents understood enough, the extended family was at a loss to communicate with him. I thought that we could benefit from a tool that would help us identify ASL signs and provide the English equivalents.

Finally, I have a life-long interest in language—not just foreign languages, but grammar and vocabulary (and often malapropisms!). I studied both French and German throughout high school and college, and took two semesters of ASL. I chose to major in German Literature. I also lived in Germany for eight months, immersing myself in the language, while traveling around Europe to experience other languages and cultures.

For two and a half years in college, I lived with students from around the world—Spain, Mexico, Holland, Italy—and picked up tidbits of various languages that I've held on to. I also studied Swedish and visited my distant relatives in Sweden while I lived in Europe.

Examining the visual grammar and composition of American Sign Language (ASL), is a very satisfying part of my thesis research.

Context

My thesis work intersects many disciplines and industries, all of which are included in my research.

Most importantly, I hope that my work will live among the thousands of two-way dictionaries that exist between the world's many languages. There are many examples of dictionaries that allow users to look up an English word to find the ASL equivalent, but so far, only a few attempts to create a dictionary that works "in the other direction."

In addition, my project should live in the visual- and interactive media- design industries as an exploration of the nature of non-textual/non-quantitative information, and how to create interfaces to that information.

RESEARCH

RESEARCH

In order to best meet the challenges my thesis project presented, I spent the first part of my investigation *learning*. Rather than experimenting with interface design from the start, I began by searching for precedents; taking ASL classes; reading books about ASL; speaking to experts in ASL linguistics and the Deaf community; and attending events where ASL would be used.

ASL Classes

As part of my initial research, I took an ASL class at Emerson college. It was taught by a local Deaf woman. She was very friendly and encouraging, and taught the class entirely in ASL—no talking allowed. The class was made up of a mix of people—some who just wanted a “foreign language” credit to graduate, and others (like me) who really wanted to learn—and was a very useful part of my research.

Rather than experimenting with interface design, I began by learning about ASL.

In addition to basic vocabulary, I learned about many important qualities of ASL:

- ▶ Facial expression can change the meaning of a sign, and subtle body movements also add meaning
- ▶ The size of a sign’s gesture can emphasize the degree to which it is true/important
- ▶ Signers will often identify their physical surroundings before telling a story, and then refer throughout the story to the objects and people they have placed around them.

I then took ASL classes at Boston Center for Adult Education (BCAE). These classes were taught by a man who identified himself as “Hard of Hearing.” He spoke fluent ASL, but had also worn a hearing aid for most of his life, so that he could hear a certain level of spoken communication. In combination with reading lips, was able to converse verbally with Hearing people. He spoke fluent, colloquial English, with only slight errors in pronunciation, and used verbal communication as the primary mode in our classes. We followed a workbook and practiced individual signs and some short sentences, but did not achieve the same level of conversation as my class at Emerson.

However, my teacher’s unique position between the Deaf and Hearing worlds gave him insight into many of the differences between ASL and English. Most importantly, he always highlighted ASL grammar and word order, and how it relates to Deaf Culture rather than to the grammar of the English language. This information was very helpful to me as I began to understand what elements combine to create this rich language.

Interpreted Events

Throughout my research, I attended ASL-interpreted events around Boston, including many lectures at the Boston Museum of Science, and the Museum of Fine Arts. A variety of local interpreters work at the lectures, and there are usually two interpreters per lecture, who alternate approximately every half hour.

By watching all of the different interpreters at these lectures, I was able to see how they each performed signs differently. Through this, I learned a few very important things about the nature of ASL usage in real life.

One of the first insights I gained from this experience was that ASL is malleable, just like any spoken or written language. There are important elements of each sign that makes it identifiable as itself, but there are also elements that can be changed, left out, or approximated, without changing the readability of the sign. In particular, I noticed that letter shapes are often only partially enunciated when words are quickly spelled out. This observation was not only confirmed by Lane, Hoffmeister, and Bahan in *A Journey Into the Deaf-World*, but identified as one of the ways the language grows over time:

Some fingerspelled words have been transformed into signs over time. An example is JOB, which began as a fingerspelled word J-O-B, with three separate elements... The sign JOB elides the original O, allowing a smooth transition between J and B and giving it a closer resemblance to other signs. (Lane, Hoffmeister, and Bahan, p. 65)

I also saw a parallel between this and “cursive” writing—where the letters are all joined and are more fluid than in “printing” where each letter is executed individually. Common word endings like “-tion” or “-ing” are also performed as one quick fluid motion, rather than the series of three or four specific letter shapes. This also seemed to reflect the way people read the overall shapes of written words rather than reading each letter.

At these lectures, I was also able to recognize the grammar of Deaf Culture described by my ASL teacher at BCAE. The lecture topics were often dry or scientific—like the geology of diamond mining in Canada. The ASL interpreters translated these lectures into stories with emotion, drama, and suspense through the order in which things were signed, and how topics were introduced. Take the following sentence for example:

“The miner drilled deep into the earth and found Kimberlite ore.”

In ASL, this thought would not be signed exactly as it is rendered in English. Instead, the interpreter would sign:

“The miner drilled into the earth, deep down.”

He would emphasize the depth of the drilling by making the sign for drilling move down toward his knees and making a facial expression that emphasized the importance of the depth. He would then sign:

“What did the miner find?”

His facial expression would change, to emphasize the question. After this, he would pause a moment to let the suspense of the question build, and then answer the question by signing:

“Kimberlite!”

He would fingerspell the word in an animated fashion, with a knowing expression on his face.

Even though the content of this sentence isn’t particularly exciting, the animated way in which it is told in ASL adds energy to the topic. As I was learning the long names of various minerals found at different depths beneath the earth, I found myself engaged in the “story” being told by the ASL interpreter in a way that the dry scientific information being delivered in English couldn’t do.

In addition to showing me how engaging and vibrant ASL is, these experiences made clear to me how important elements like facial expression and order of words are to the understanding of ASL. I saw that signs aren’t just specific renderings of particular shapes, but relate to the context in which they are made, as well as the individuality of the people making them. This perspective has been very valuable in my understanding of how to create my visual interface.

As my project’s design started to come together in late spring 2004, I started to arrive early or stay after these events chat with the interpreters a bit about my project, to get their opinions and feedback. They were excited that I was working to create an aid for communication with the Deaf community, and encouraged me to become an interpreter myself.

These experiences made clear to me how important elements like facial expression and order of words are to the understanding of ASL.

Precedents

Traditional Media Precedents

My initial research for precedents turned up three attempts to record the shapes and motions of ASL in still characters that could be drawn or printed on paper.

Stokoe Notation

Stokoe Notation is named for its creator, William Stokoe (see *Annotated Bibliography for information about Stokoe's work*), and uses a combination of letters and symbols, along with diacritical marks to represent ASL.

By using symbols to represent the component parts of American Sign Language, [Stokoe] was able to demonstrate how these parts fit together to form a linguistic structure identical with that of spoken language. The original notation consisted of 55 symbols in three groups, each representing one of the formational parameters of a sign; Location, HandShape, and Movement. They were written in a strict order with meaning dependent on placement within the string. The Location and Movement symbols were iconic while Hand Shape was represented by units taken from the number system and manual alphabet of ASL. (Martin, <http://www.signwriting.org/forums/linguistics/ling006.html>)

The image shows four lines of Stokoe Notation for the ASL sign 'Goldilocks'. The notation consists of various letters, numbers, and symbols with diacritical marks such as dots, bars, and arrows. The symbols are arranged in a way that represents the linguistic structure of the sign.

Line 1: $B_a B_a z^{\sim} \ddot{N} \ddot{N} \dot{a} \cdot 3^{\perp} [] J C^{\dagger} J C^{\vee} \cdot \} Y^{\circ} J G_{\Lambda} <^{\vee} <$

Line 2: $\bar{B}_a \sqrt{B_{\Lambda}} \psi G^{\perp} B_{\Lambda}^{\dagger} B_{\Lambda}^{\ddagger} \mathcal{D} \dot{A}^{\circ x} \underline{B}_D B_D^{\perp}$

Line 3: $G^{\triangleright} \wedge \dot{5}^x [] J C^{\dagger} J C^{\vee} \cdot X_1 X_1 \dot{a} B_T V_D^{\vee} \cdot$

Line 4: $\bar{B}_a L \# \cdot X_1 X_1 \dot{a}$

Figure 1: A few lines of the ASL version of "Goldilocks" written in Stokoe Notation

HamNoSys

HamNoSys uses newly shapes and markings that in some cases approximate abstracted hands, but in others are simple diacritical markings or arrows.

HamNoSys was developed by a group of hearing and deaf people as a scientific/research tool and first made publicly available in 1989. The purpose of HamNoSys, unlike SignWriting, has never been an everyday use to communicate (e.g. in letters) in sign language. It was designed to fit a research setting and should be applicable to every sign language in the world. It consists of about 200 symbols covering the parameters of handshape, hand configuration, location and movement. (Bentele, <http://www.signwriting.org/forums/linguistics/ling007.html>)

.. 𐀀 𐀁 𐀂 𐀃 → 𐀄	what	[𐀅 ↑]
.. 𐀆(𐀇𐀈) [𐀉 𐀊 → 𐀋]	quote	[𐀅 ↑]
𐀌𐀍𐀎 𐀏.	three	[[𐀐] 𐀑] [𐀅 ↑] :
.. 𐀒𐀓 X . 𐀔) ([𐀕 → 𐀖]) +	bears	
𐀗 2 5 𐀘 𐀙) ([𐀚 < 𐀛] [X 𐀜 2] [𐀝 → 𐀞] [𐀟 → 𐀠]	Goldilocks	
𐀡 𐀢 𐀣 [𐀤 → 𐀥]	somewhere wandering	[𐀅 ↓]
: 𐀦 [𐀧 𐀨] [𐀩 𐀪] X [𐀫 [[𐀬 → 𐀭] + 𐀮]]	deep forest	[𐀅 ↓]
𐀰 𐀱 [𐀲 → 𐀳] [𐀴 → 𐀵] †	somewhere wandering	
𐀷 𐀸) (oh! look! there!	[𐀅 ↑]

Figure 2: Excerpt from ASL version of "Goldilocks" written in HamNoSys.

SignWriting

SignWriting uses abstracted drawings of a person's head and hands, with various markings, to represent the signs. While it seems to be a versatile system, it is very unwieldy to write, and doesn't aid in the communication between Deaf and Hearing people.

SignWriting is a writing system which uses visual symbols to represent the handshapes, movements, and facial expressions of signed languages. It is an "alphabet" - a list of symbols used to write any signed

language in the world...SignWriting makes it possible to have books, newspapers, magazines, dictionaries, and literature written in signs. It can be used to teach signs and signed language grammar to beginning signers, or it can be used to teach other subjects, such as math, history, or English to skilled signers. (from www.signwriting.org)

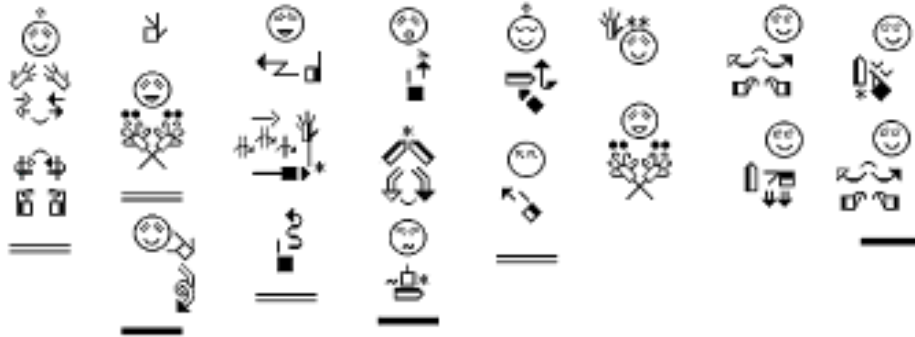


Figure 3: Excerpt of "Goldilocks" written in SignWriting.

In each of these cases, I was frustrated by the idea of asking my users to learn a THIRD language in order to understand the relationship between English and ASL. In addition, I found these methods limiting in the way they attempted to represent three-dimensional space in two dimensions, as well as representing motion in still images. So I narrowed the focus of my research to finding multimedia precedents.

Multimedia/Interactive Precedents

Multimedia Dictionary of American Sign Language (MM-DASL) by Wilcox, S., J. Scheibman, D. Wood, D. Cokely, and W. Stokoe.

This project was started in 1993, and is outlined in a PDF found online at <http://www.unm.edu/~wilcox/research/MM-DASL/mmdasl.html>. It is the first known attempt to create a visual, multimedia dictionary for ASL through which users can look up signs based on their physical components and movements. It is a direct precedent, but was, unfortunately, never completed. I met with Dennis Cokely, one of the project's creators, to find out why the project was not completed. He defined the problem with creating this tool as a lack of the actual information that would be needed to fill in the "definition" parts of the interface. As far as he was concerned, the search interface had been successfully created, and was just missing the actual data.

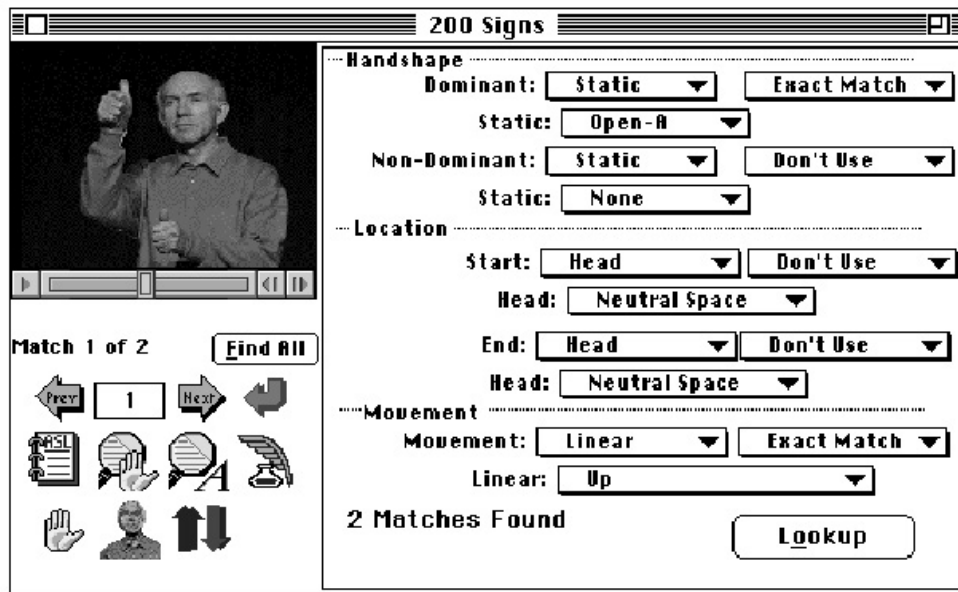


Figure 4: Main search interface for the *MultiMedia Dictionary of American Sign Language (MM-DASL)*

Based on the limited visuals I have seen from this project, I felt that there was still much room for improvement on the usability of this interface. I saw opportunities to move beyond the traditional interface elements of scrolling and drop-down menus, as well as the need for improved visual design and usability.

Following are the notes from my detailed review of the MM-DASL:

Main Search Screen (see Figure 4, previous page):

The vocabulary used (neutral space, dominant, etc.) is tailored to experts and linguists. There are no visual cues for the elements on the screen—either in the search options, or in the result (“2 matches found”). The user is overwhelmed with text-based choices that seem unrelated to the motion graphic in the upper left.

Handshape Search Screen:

More use of expert/linguistic vocabulary (non-dominant, etc.). The hand is shown out of context, probably not as easy to associate with what user has seen without context of the body. Offers “fuzzy search” capability in “exact match” drop-down, but I believe this type of functionality, if necessary, could be transparent—i.e. not exposed to the user. Also, always asks the user to identify what BOTH hands are doing—why not offer step 1 as “does this sign use one or both hands?”

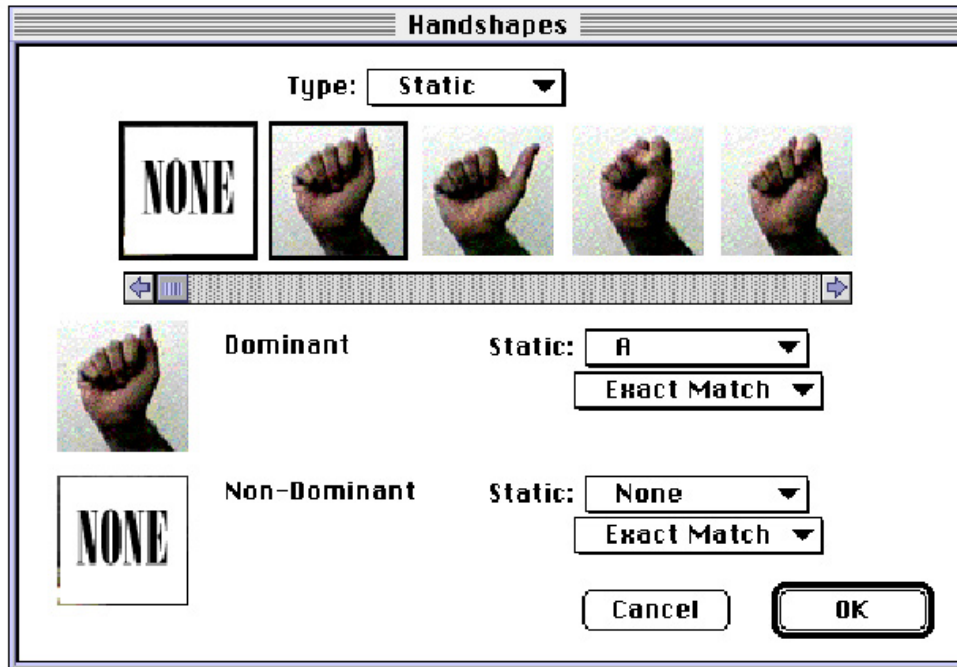


Figure 5: MM-DASL handshape search interface

In a later iteration (see Figure 6, below), a “drag and drop” functionality has been implemented. The user scrolls through the horizontal collection of handshapes, and drags one to “dominant” and one to “non-dominant” areas. This is an interesting idea, worth exploring as a possible interface element, but only if done differently. Also, rather than the horizontal scroll bar offering ALL handshapes, there needs to be an easier way that the user can initiate the group of signs to choose from by some initial input—closed hand vs. open, etc. (taxonomy)



Figure 6: Later iteration of MM-DASL handshape search interface

Location Screen (see Figure 7, next page):

This screen is based on the same drag and drop functionality as handshape screen. Good idea to show areas near head where sign could have taken place. But again, no need to scroll through so many options—why not show ONE head (offer frontal and side views), and make areas around the head clickable?



Figure 7: MM-DASL location search interface

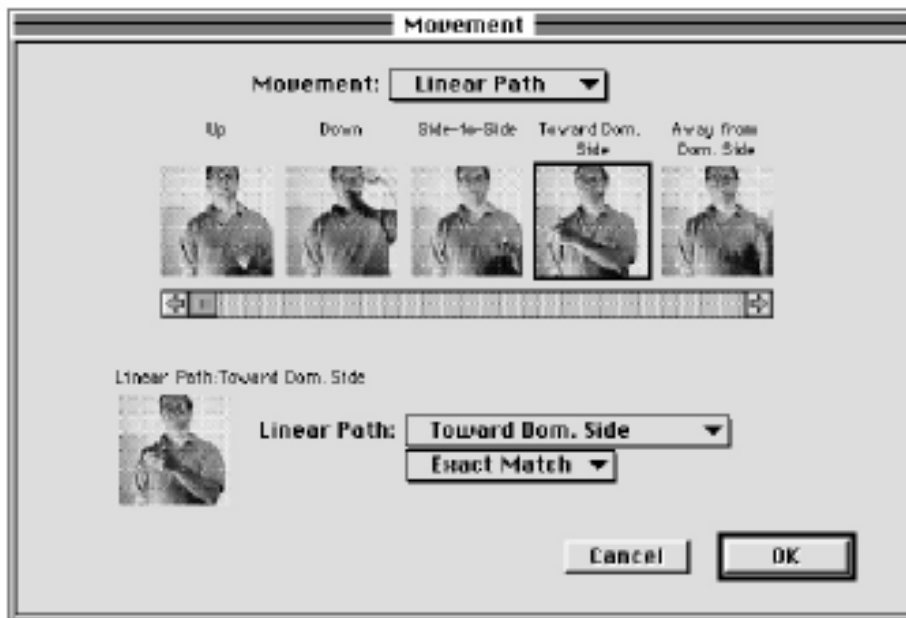


Figure 8: MM-DASL movement search interface

Movement Screen (see Figure 8, previous page):

Expert vocabulary (“linear path,” etc.), again. No need to show multiple representations of the body—why not show ONE body, and let the user indicate where sign moves by clicking on different areas? Also, in general, there is no need to have separate screens for each of the elements of the sign (location, movement, etc.).

Main/Definition Screen:

Function of buttons/icons is not evident. No directions on screen to guide user through process. Good idea to have QT movie that user can play back or go frame-by-frame through, but no taken advantage of as much as it could be. No movie for use of sign in context/sentence; no view of other people making the sign to see variations.

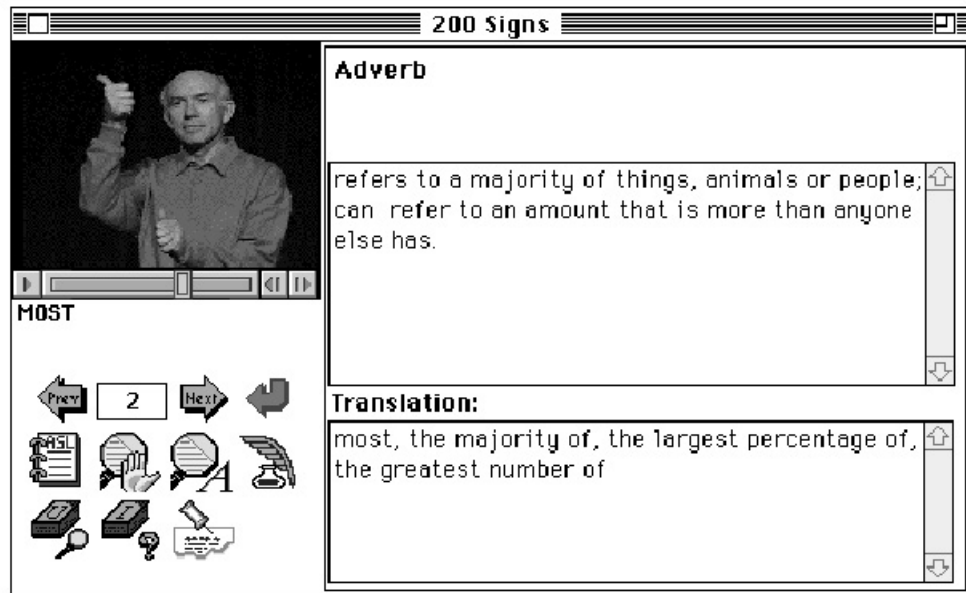


Figure 9: MM-DASL definition interface

I found many areas of the MM-DASL that I would like to improve upon or avoid in my own project:

- ▶ *Know your audience* – use plain vocabulary and don't expect people to learn the linguistic language about ASL in order to use this tool
- ▶ *Take advantage of motion graphics* – this is a ground-breaking use of video at the time, but there are many more opportunities for use of motion graphics, including editing the films to highlight important areas, etc.
- ▶ *Keep context of the body* – instead of showing a series of disembodied hands, show whole body with hand in context, then maybe “zoom” in on hand part to show specifics
- ▶ *Streamline* – instead of having a series of screens to perform the search (main search, handshape, location, movement); use context of showing whole body to give opportunity for user to input more information about the sign through ONE interface—additional steps will offer more clarity within what the user has already chosen.
- ▶ *Hide “fuzzy search”* – MM-DASL offers users the option to search for an exact match based on their input, or varying levels of variation—I believe that this could be accomplished by order of results shown, rather than making the user choose from the get-go—what if they choose “Exact” but they have made an error in their input?
- ▶ *Think about “drag and drop”* – explore the possibility of this type of interface element, but keep in mind the clunkiness of its use in MM-DASL
- ▶ *Improve general interface functionality* – MM-DASL uses the same functionality and elements for handshape, movement, and location interfaces, even though the nature of these three parts of information are different. Explore treating each element of information in the interface in a unique manner that is the most appropriate for the type of information. Also, make sure to include other important information like facial expression, etc.
- ▶ *Improve usability* – like the *American Sign Language Video Dictionary and Inflection Guide* (discussed below), there are no directions on how to best/correctly use elements of these interfaces. The “definition” interface, in particular, has a plethora of buttons and icons with no instruction about their use.

Treat each element in the interface in the manner that is most appropriate for the type of information.

American Sign Language Video Dictionary and Inflection Guide, 2000. National Institute for the Deaf, Rochester Institute of Technology, Rochester, NY.

This CD-Rom is presented as a new approach to the idea of an ASL dictionary. However, it is based more on the kinds of information given as “definitions” than on how to access the signs. So it only serves as a precedent for the definition portion of my interface. It does not deal with the visual nature of ASL as an approach to searching, nor does it identify the discrete parts of signs in the videos it shows, which could help students learn to make the signs themselves.

Following are the notes from my detailed review of the *ASL Video Dictionary and Inflection Guide*:

Initial/Main Screen:

The interface opens in full-screen mode with no option to change this. The main screen has many sections but no instructions on what to do. When you type in a word, the scrolling alphabetical list

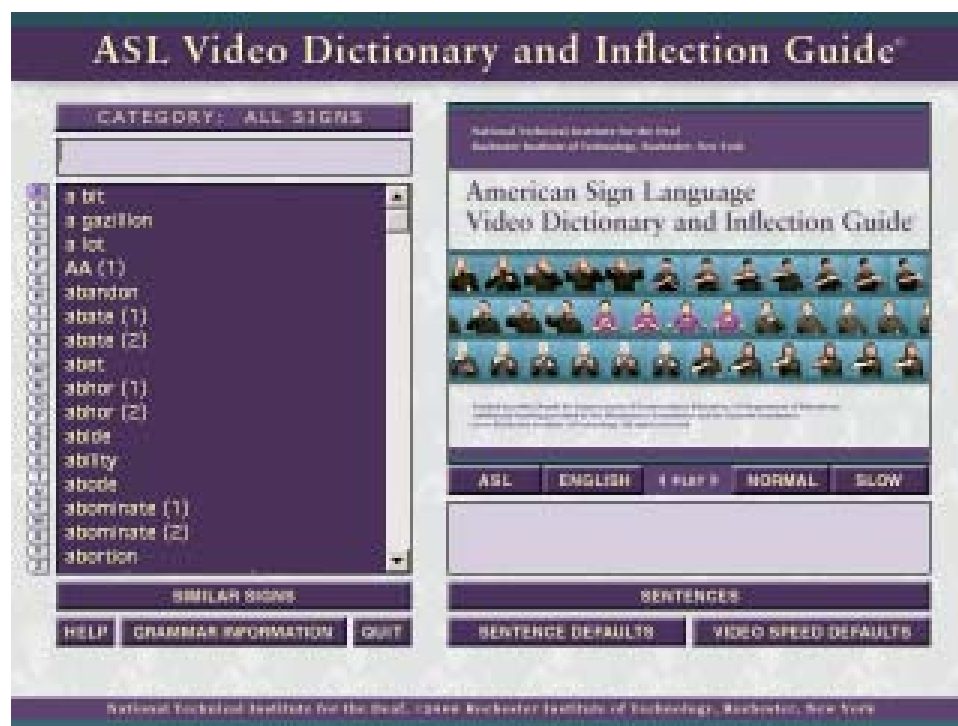


Figure 10: Main interface for *ASL Video Dictionary and Inflection Guide*

automatically advances to that word, highlighting it in blue, unsure which button to use, I hit “Return” on my keyboard, and was brought to the “definition” interface.

Main Definition Screen:

When you click on “play” it’s choppy, and hard to tell what’s the beginning or end of the sign. “English” button puts the word in the window below sign. “ASL” button shows the movie playing. When there is more than one option for a sign, it is listed in the alphabetical list with numbers (for example, “hot dog (1),” “hot dog (2),” etc.) so you have to click on the word to find out which meaning you’re looking up. When you click on “similar signs” it gives a drop-down list of english words, and the list overlaps the “help,” “grammar,” and “quit” buttons.

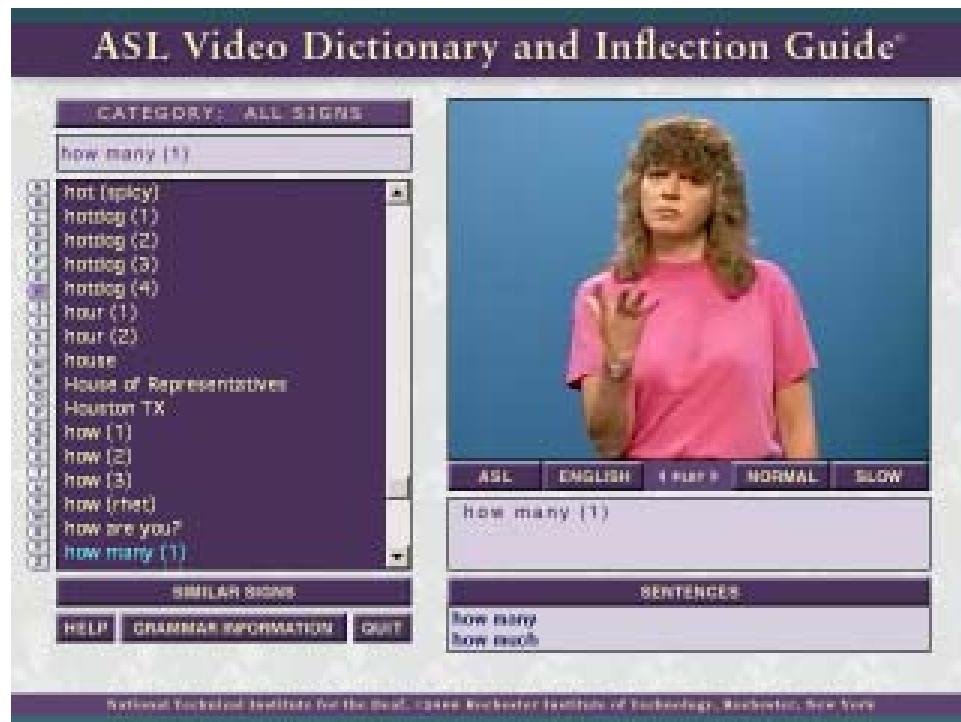


Figure 11: ASL Video Dictionary and Inflection Guide definition interface

Grammar Information Screen:

Clicking on “Grammar Information” opens a help-type screen, but doesn’t give grammar info specific to the sign you’re on.

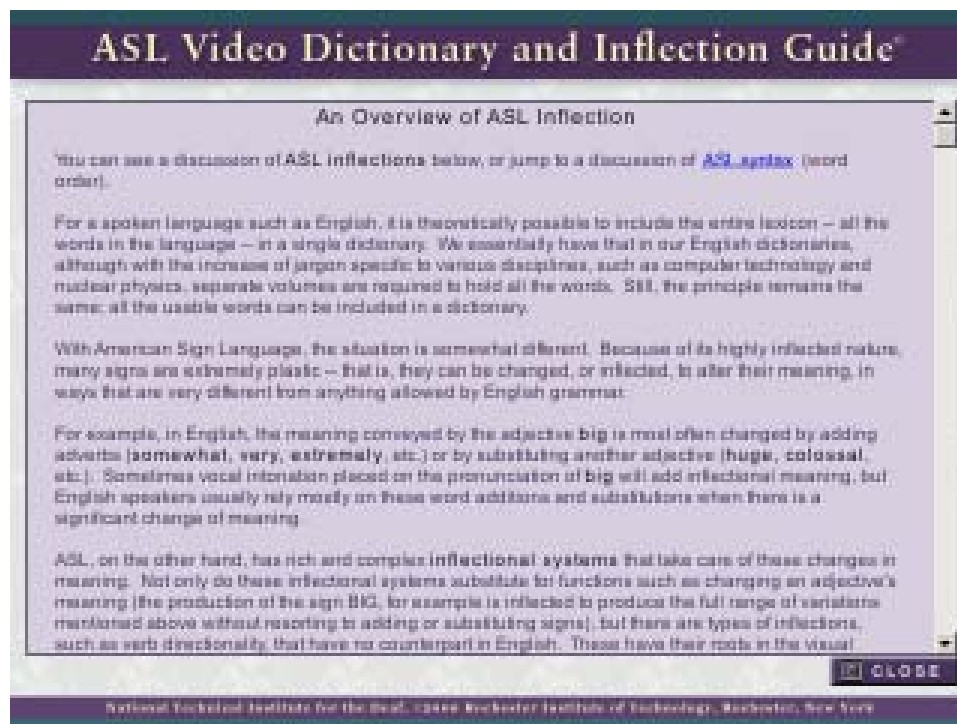


Figure 12: ASL Video Dictionary and Inflection Guide “Grammar Information” screen

As with the MM-DASL, I found many elements here that could be improved upon or avoided in my own work:

- ▶ *Explore using multiple models* – when model A is in the main definition, models B, C and D do the sentences with the word. This is good, but would be better if you could see all three or four models do EACH part, so you could see the range of variation within a sign (like seeing how four different people write the letter “A”).

-
- ▶ *Provide better access to similar signs* – could be shown side by side with the initial sign, to really show difference/similarity; also, when you click on a similar sign, you are brought to the similar sign's "Definition" page with no "back" button to retrace your steps.
 - ▶ *Improve use of motion graphics*– could do a better job indicating what part of the sentence the sign shows up in, provide movies of more than one signer for every entry
 - ▶ *Describe ASL grammar* – writing out of sentence is in English order, doesn't help with understanding of ASL word order or the signs that mean each word in sentence (or each thought). Also offer "grammar information" about EACH sign.
 - ▶ *Improve usability* – use clear directions on how to use every part of interface; clearly mark action buttons; don't let parts of interface block out other parts; always give user option to get back where they came from, and context of how they got there.
 - ▶ *ASL grammar – Similar/Related signs* – when there are multiple possible definitions/entries, offer them with some context/information (not just "hot dog (1), hot dog (2)"); also, always keep reference of first sign when showing similar/related signs

I believe that there is much to be improved upon and learned from in this interface, but I do NOT envision my project having much in common with it when it is done.

Always give users the option to get back to where they came from, and context of how they got there.

Interviews with Experts

Dennis Cokely, Director of the ASL Program, Northeastern University

Having learned about him through my discovery of the MM-DASL, and finding that he was in Boston, I set up a meeting with Dennis Cokely, to get his input on my thesis ideas. He defined the problem with creating the kind of tool I envisioned as a lack of a complete repository for linguistic information about ASL, which therefore made the creation of an interface to ASL information virtually useless. He believed that the real work that needed to be done was to create this universal resource—an ASL equivalent of the Oxford English Dictionary—and his ideas inspired me to follow this tangent for a while during my research. Ultimately, however, I realized that his opinions were based in his position as a professional linguist. He did not see the opportunity and challenge in simply creating a way to look up english equivalents of ASL signs.

Robert Hoffmeister, Director, Programs in Deaf Studies, Developmental Studies and Counseling, Boston University

One of the authors of *A Journey into the Deaf World* was also in the area, so I set up an interview with him as well. His reaction to my ideas was very different than Dennis Cokely's. Dr. Hoffmeister viewed my idea as an epic project, and he seemed to believe that I was naively approaching something that was nearly impossible, and acted quite dismissive of me.

WORK PROCESS

Getting Started

A Studio Database Project

My thesis began as a studio class project. The assignment was to explore the idea of “database” and create an interface to a particular type of information. I was inspired by the idea that visual

“newArchive” Project, Fall 2001

This project will focus on an essential concept of interactive media—a database/repository/archive. The task is to research, conceptualize, design, and prototype an interface for a specific *information space*.

information could be identified in purely visual terms, without the need for word-based descriptions.

While pursuing this idea, I saw that there was a similar need in my own family—my (then three-year-old) nephew, who had hearing trouble, was learning American Sign

Language (ASL) to communicate. His parents understood enough to give him what he needed, but the extended family could barely communicate with him. It seemed we needed a tool that could help us identify ASL signs and learn the English equivalents.

So I decided to focus my work on a visual interface to American Sign Language that could be used by family and friends of Deaf and Hard of Hearing people.

When I began to develop this idea for a “Visual Sign Language Dictionary” I first imagined that it would be a database program. Although it would be based on visual representations, the program would be driven by text-based identifiers (that described visual characteristics). I assumed that I could use traditional database/search form elements to input and search for this visual information.

Through the interface, users would be able to:

- ▶ indicate whether the sign was made with one or two hands,
- ▶ identify a handshape that was used in the sign,
- ▶ indicate what area(s) of the body were used to create the sign, in addition to the hands, and
- ▶ indicate whether the sign was moving or still in relation to the body.

An alphabet handshape reference tool would also show thumbnails of the signs for the letters of the English alphabet. By clicking on a thumbnail, the user could open a larger detail of the handshape, including any necessary motion.

After the user made his or her choices, the search results page would show thumbnail drawings of all the signs that fit the search criteria. When clicked on, a pop-up would appear with a detailed motion graphic of the sign being made. The user would be able to play and replay the action as many times as desired.

When I had finished planning this path through the information, I started to design a visually-based interface to it. Although I had originally drafted my interface using abstracted drawings of people and hand shapes, I decided instead to use images of real people. By doing this, I would always keep the user focused on the context of each sign, and its relationship to the body, rather than abstracting the visuals and removing the familiar context of a real person.



Figure 13: Screen Mock-Up for Visual Sign Language Dictionary

Users could identify elements of the sign by clicking on the image of the person. They could also identify a hand shape if possible, and choose other elements from drop-down menus and checkboxes.

My development of this project ended here, for the semester at least.

Turning a Studio Project into a Thesis

I decided to continue work on my “Visual Sign Language Dictionary” for my Master’s Thesis project. The first step was to clarify the concept. Rather than just a visual database, I wanted to develop a two-way dictionary between English and American Sign Language. In some ways it would be similar to an English/French or English/German dictionary.

However, the relationship of English and ASL is fundamentally different than relationships between many other languages. For example, English has an alphabet, the letters of which represent particular sounds, and which can be combined in various groups to create words with meaning. This is also true of French, German, Spanish, Italian, Swedish, etc. However, ASL is not a language that is broken down into component parts like this. There are letter-shape signs, but most common signs are not created by combining these letter shapes.

I knew that, before I could create an interface between the languages (the dictionary), I would need to learn about the structure of ASL itself.

At first, I worked with the impression that I could identify a discrete number of movements and shapes that would be, in essence, the “alphabet” from which all ASL signs could be built. I soon learned (*see section on ASL Classes in “Research”*), that there is much more than hand shape and motion in each sign. The facial expression of the signer, the direction in which he or she makes the sign, the intensity of the movement, the size of the movement, and the area of the signer’s body at which the sign is made, all contribute to the meaning of a sign.

In order to create a usable database of information, I would need to catalog and sort these complex elements, which required a deeper understanding of how they combined to create ASL.

I looked for precedents for creating a database of elements of ASL. I soon found Diane Brentari’s book *A Prosodic Model of Sign Language Phonology* (Brentari, 1998), which claimed to

Analyze the conventional sign language “parameters” of handshape, movement, orientation, and location... and demonstrate their relationship to more abstract units, specifically segments, syllables, and prosodic words...this analysis of sign language data offers a new perspective on the definition of these traditional abstract units: it suggests concrete ways of defining them so that they can encompass both spoken and signed languages. (Brentari, p. 1)

Before I could create an interface between the languages (the dictionary), I would need to learn about the structure of ASL itself.

I was intrigued by this scientific approach by an author who is not experienced with ASL, and has an outsider's perspective. The idea of analyzing the characteristics of ASL without understanding their meaning was a fresh and useful point of view. However, this particular book, and Ms. Brentari's research, were far too scientific for my project, and my potential audience.

Taking some inspiration from Brentari's approach, I decided to begin by trying to catalog all of the handshapes that should be in my database. Rather than basing the organization on alphabetical order, or academic qualities of signs/handshapes (meanings or similarity based on elements of ASL grammar), I tried to think about how a user would approach the database.

My user base would consist mostly of friends and family members of people who use ASL to communicate. I could assume no baseline of knowledge of ASL. The interface would have to be based on the users' common sense, not specific linguistic knowledge. Therefore, rather than expecting a user to remember specific details about a handshape or motion, I would base my choices on more general information. For instance, rather than asking a user to identify the "S" hand-shape, he or she could simply identify the shape as "fist-like."



Figure 14: The "S" Handshape

Developing a Visual Taxonomy of Handshapes

My advisor, Hu Hohn, suggested that I develop a specific taxonomy to sort through the handshapes in the database. I would observe the qualities of the shapes, and organize them into groupings based on yes/no choices which would be easy to navigate through, and would allow for both general and specific identification of signs.

This exercise forced me to look at ASL through the eyes of a person without extensive knowledge of the language.

To begin, I used the English alphabet handshapes as my collection of signs. I created a set of choices that would provide a path through the alphabet to each individual shape, based on elements like



Figure 15: Taxonomy for Alphabet Handshapes

number of fingers extended, direction of finger extension, which finger was extended, etc.—things that were easily observable even by people with no knowledge of ASL.

Based on what I was beginning to understand about ASL through my research, I realized that an interface based on a taxonomic structure would be inefficient because it would take at least 3 steps to narrow down to one handshape.

Working on this taxonomy had forced me to look at ASL and the signs through the eyes of a person without extensive knowledge of the language. This would become an integral element in the development of my database organization.

How a Precedent Led to a Tangent

One of the most influential precedents I found during my research was the MultiMedia Dictionary for American Sign Language, or MM-DASL. The project had been developed by ASL experts in 1993, but had not been completed. The only available information were online PDF documents about the project's goals and preliminary interface designs. (see "Precedents" section for more info on MM-DASL) Dennis Cokely, the head of the ASL department at Northeastern University was one of the principal creators of the project, so I set up a meeting with him to discuss MM-DASL, as well as my own thesis idea.

Mr. Cokely's insight into the challenges of creating a visual interface to American Sign Language consisted of telling me that the interface element of the project was "the easy part," and "had already been done." He went on to explain that the entire project was actually useless because there was no information to put in the database. The way he described it, this interface should give access to the ASL-equivalent of the Oxford English Dictionary (OED)—a source w/history, meaning, pronunciation, etc. for every sign in the database. However, for many reasons, including the relative age of ASL, and the ongoing challenges the Deaf community faces in even promoting education in ASL, there has been no such resource compiled for the language.

Initially, I was discouraged by this feedback, but soon realized that I had just been presented with a new design challenge. My hypothesis was that an OED-type resource for ASL hadn't been created because the nature of ASL made two-dimensional recording of the information difficult. It seemed like a great opportunity for New Media, and I decided to change the focus of my thesis project. My

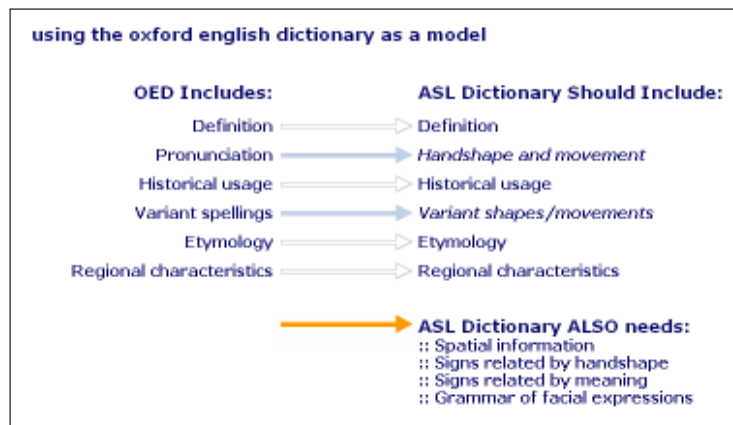


Figure 16: Screen of proposed relationship between Oxford English Dictionary and comprehensive ASL resource

new goal was to design the structure and functionality for a comprehensive dictionary for ASL—that would include the ASL-equivalents of the elements used in the OED, as well as additional information that could best be communicated through interactive media (*see Figure 16*).

Developing the Search Interface

Initial Ideas

After focusing on the “OED” tangent for a few months, I spent some more time reviewing the *MultiMedia Dictionary for American Sign Language* (MM-DASL). Despite Dennis Cokeley’s insistence that it was complete, I saw significant room for improvement. From the limited documentation available on the project, I was able to see that the interface for the MM-DASL was created with traditional interface tools, and used conventions such as drop-down menus and scroll-through filmstrips. It also used industry-specific and linguistic terminology that seemed inaccessible for a general audience. So I decided to go back to my original idea, and think of the MM-DASL as a precedent upon which I could improve. (see “Research” for more on MM-DASL.)

I happily returned to my original idea of creating an interface based on the nature of the language.

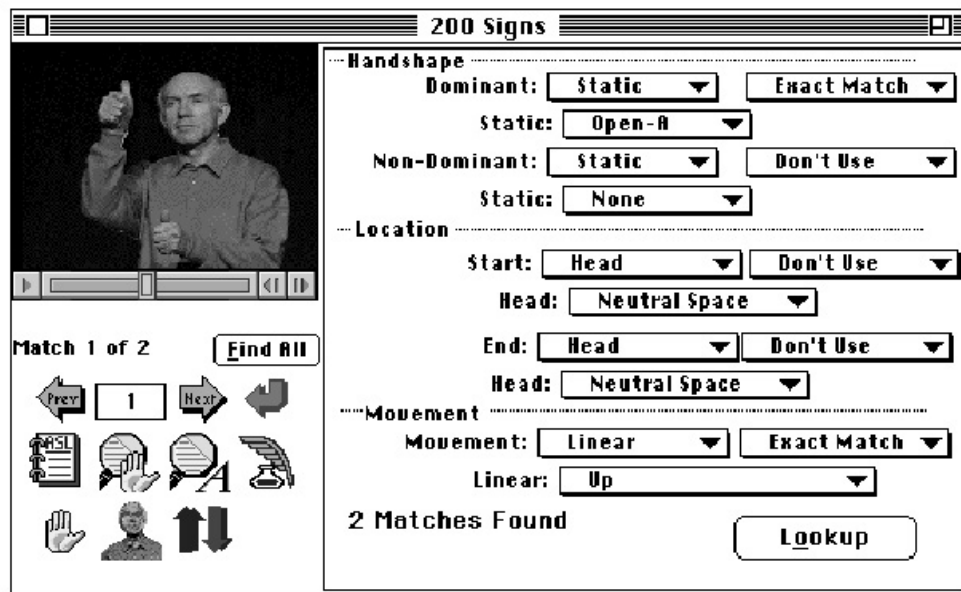


Figure 17: Main Search Interface for MM-DASL

I happily returned to my original idea of creating an interface for ASL that would be designed based on the nature of the language, not traditional interface standards.

First, I began to explore how a user would be able to interact with an on-screen image of a person (“model”). I thought about using the mouse to manipulate an image of a hand into a shape like the user had seen, and then “attach” that hand shape to the model’s image (see Figure 18). The user could then move or position the hand/arms around the body. By using the mouse to click, drag, etc., the user would indicate what parts of the hand or body were either positioned in certain places, or moved between places.

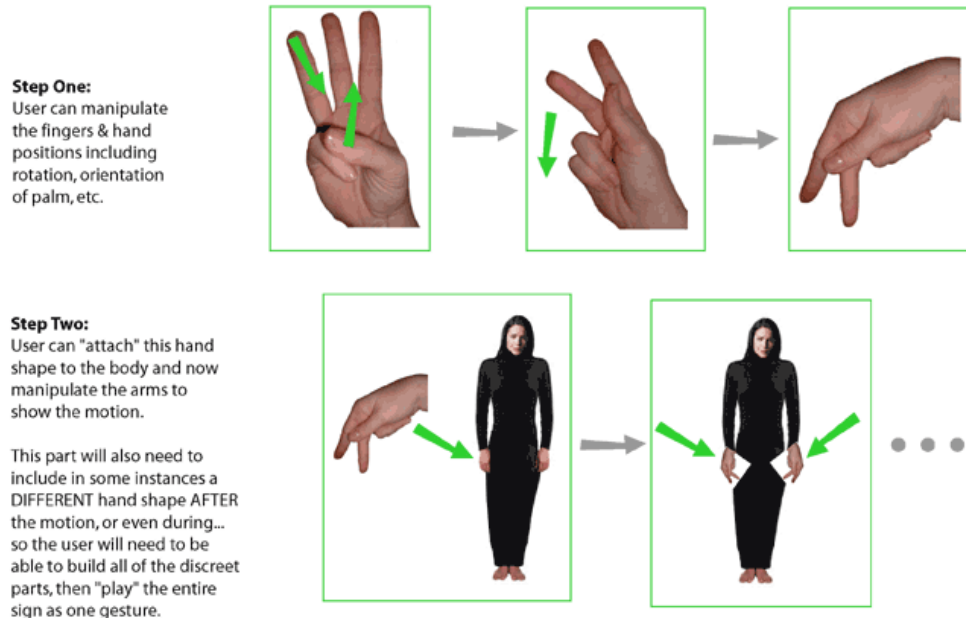


Figure 18: Sketches for possible interactivity with on-screen model

I also briefly explored the idea of creating an interface device in the shape of a life-size, moveable hand, that would allow a user to actually build the shape they had seen in physical space. The user would then move to the computer interface to add more information about movement, position, etc., and perform searches.

While reinforcing the physical reality of the signs’ shapes, I believed that this type of interface would be too cumbersome. Not only would it require extra equipment, but by splitting the interface into different types of interaction (manipulation of an object vs. on-screen), I believed this would create unnecessarily complicated usability issues.

Mapping the Space Around the Body

While I didn't want to create a new physical object as part of my interface, I did want to improve the sense of real space in my interface. So, I decided to embrace the three-dimensional nature of ASL in a way I hadn't yet explored.

I decided to embrace the three-dimensional nature of ASL in a way I hadn't yet explored.

To begin, I mapped out areas on and around the body where signs take place, or between which signs move. In order to specify three-dimensional areas, I had to map the space from the front and the sides.

After identifying these areas, I overlaid the points of view to create a three-dimensional grid around the body. I also identified (shown by intensity of red shading in Figure 19) the areas that were more or less frequently used.

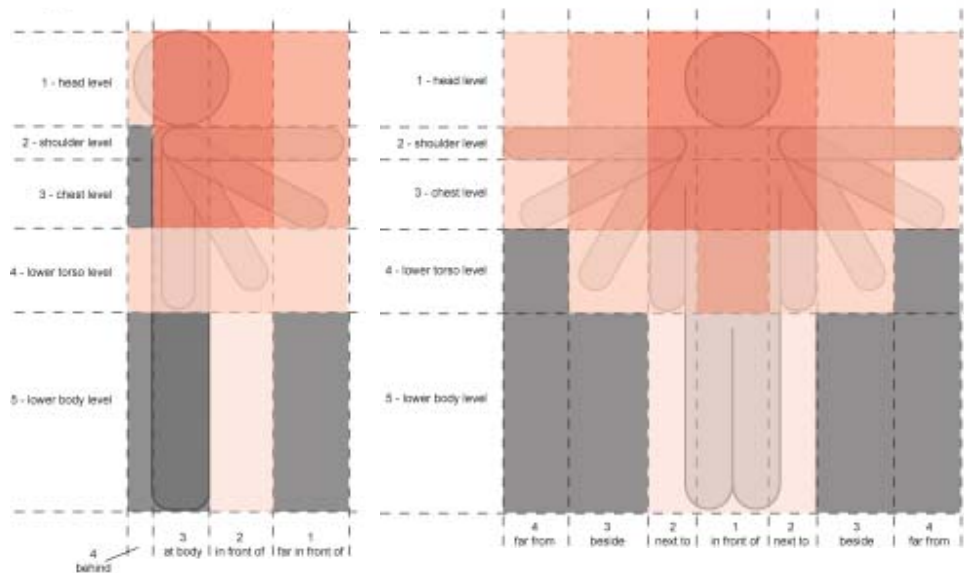


Figure 19: Vertical and horizontal mapping of space around the signer's body

In addition to the general areas around the body, there are also places where the location is more specific, and has more bearing on the meaning of a sign—in particular, the head. For instance, signs

made near the top half of the head refer to male people, and signs made near the lower part of the head refer to female people. So I created a more detailed map of the areas around the head, in

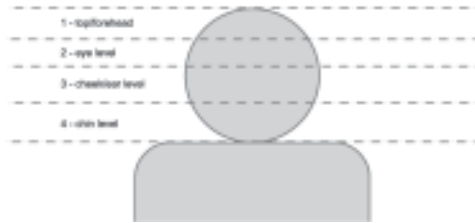


Figure 20: Break-down of vertical space around the head

order to allow for specific searching in this area. The male/female breakdown is not true of all signs made near the head, so the option to identify a more general space is also necessary.

Through this break-down of the space around the body and head, I created a limited number of discrete locations in which a sign could take place. They could be easily identified by a user, and would each correspond to a value in my database.

Identifying Motions

Most signs either move through space, or have a small motion in place, so I defined a limited number of types of motion, general directions, as well as shapes of motion through space. I also included types of motion in place, like back-and-forth rotation of the wrist. These motions would correspond to database values, and be easy to indicate through the interface.

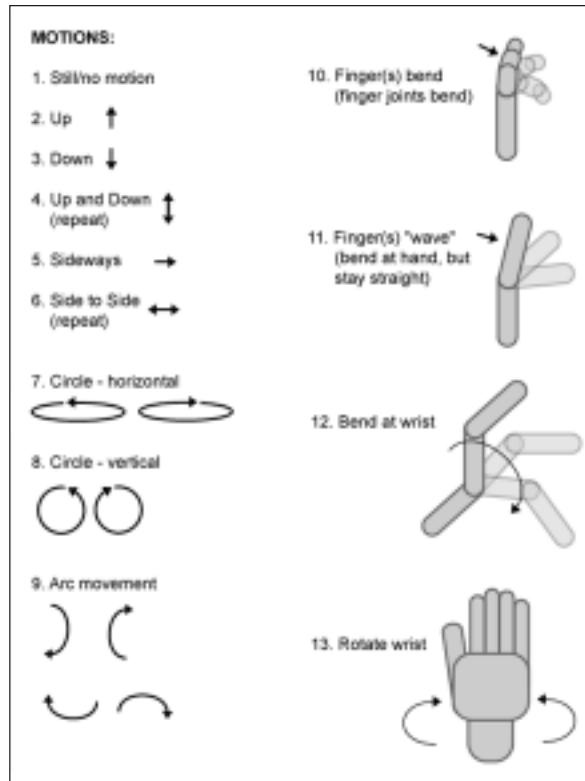


Figure 21: Motions to be included in database

I simplified how the movement categories related to the location interface. The user would not need to identify that a sign included "an arc-shaped movement beginning at the shoulder and ending near the opposite elbow, that included a rotation of the arm, which was bent at the elbow." All they would need to do is identify on the spatial interface the beginning- and end-points of the motion, and choose "arc" from a shape category. This would be enough information to narrow the search to only a few choices, from which the user could then choose the specific sign.

Choosing Hand Shapes

The third, and possibly most important, step of creating my database was to define a limited number of handshapes, and an easy way for users to identify them. Based on what I had learned in

Classifiers

ASL has a fairly large set of signs that are called classifiers. Linguists have found that there are at least two types of classifiers:

1. True Classifiers (CL) are signs in which a particular hand shape, with a particular palm orientation is used to represent a noun and can indicate the location of that noun and actions, if any. True CLs are real signs with all five parameters. Each parameter has its own meaning:
 - a. Hand shape - gives information regarding size and shape.
 - b. Palm Orientation - provides information on locale and angle.
 - c. Movement - gives the nature of the action (how fast, etc.).
 - d. Location - gives location and spatial orientation.
 - e. NMGS - show emphasis for size, action, locale, etc.
2. Size and Shape Specifiers (SASSes) are a special kind of CL that illustrate certain physical features of a noun as well as indicate its location in space. SASSes give a physical description. SASSes may occasionally be able to show movement (ie. 'button popping off shirt').

From: Mitch's ASL Teacher's Resource Web Site
<http://www.puyallup.k12.wa.us/aslteacher/index.htm>

ASL classes and from my research, I came up with 34 different shapes that would be included in the database (see *Figure 23, page 38*). These included the alphabet letter shapes, as well as common "classifiers." Classifiers are hand shapes that are used to represent objects, actions, or sign types. For instance, the "bent L" classifier (see "*CL:L*" in *Figure 23*) is most often used to represent something round and flat.

Once I had finalized this collection of shapes, I tried to divide the shapes into categories that would make searching through them as easy as possible. Rather than categorizing by meaning or alphabet letter, I approached from the users' point of view. Were there characteristics that a non-expert user would identify, like "fist-shaped" or "pointing up," that I could use to organize these shapes? I eventually came up with three categories—fist-shaped, vertical, and downward/sideways.

Some signs were hard to categorize, and for these, I devised an online survey to determine how potential users might categorize these signs (see *Figure 22, next page*). The feedback I received was very consistent on some shapes,

and very inconsistent on others. Based on this feedback, I put most of the shapes into one of the three categories, but included a few in more than one category, so that users with different impressions of the signs would still be able to find them.

SEJ Thesis Survey #1 - Hand Shapes

This survey is intended to help me categorize the handshapes used in my thesis interface. Please provide your name and email address, and complete the survey below.

Your name:

Your email address:

INSTRUCTIONS: Please look at each handshape below and indicate what type of handshape you think it is, based on these three categories, and the examples shown:



Closed/Fist-Like

This category is for hand shapes in which the fingers are bent or "closed," and give the overall impression of being like a fist.



Vertical/Finger(s) Up

This category is for hand shapes that give an overall vertical impression, and have one or more fingers sticking up.



Sideways or Downward

This category is for hand shapes in which the hand seems to point sideways or downward.

Which category of shapes would this sign fit in?

- closed, fist-like
- vertical/finger(s) up
- sideways/down



Which category of shapes would this sign fit in?

- closed, fist-like
- vertical/finger(s) up
- sideways/down



Figure 22: Screen shot of part of handshapes survey



Figure 23: Handshapes in the database

Now I had defined my three types of information—location, type of motion, and handshape—and methods to navigate through them. Using my organization of information, I believed that users could quickly narrow a search to a manageable number of results, from which they could easily find the particular sign(s) they were looking for.

Bringing the Information to Interface Design

Despite my focus on the visual qualities of ASL, my first attempts to bring these elements into an actual interface were still rooted in traditional/text-based layouts. The visual element of the figure was necessary for identifying a sign's location, but I was unsure how to communicate motion and shape. I relied on radio buttons and form buttons, and was hesitant to push the limits of visual interface, even though that was the premise of my project.

I was hesitant to push the limits of visual interface, even though that was the premise of my project.

The initial layouts included abstract drawings of a figure, and coded shapes to represent moving or still signs. Unlike the figure, handshapes were represented with actual photographs. I used photographs for this element because it was nearly impossible to approximate the complexity of each handshape in an abstract fashion, without losing some of the *gestalt* of the handshape. The

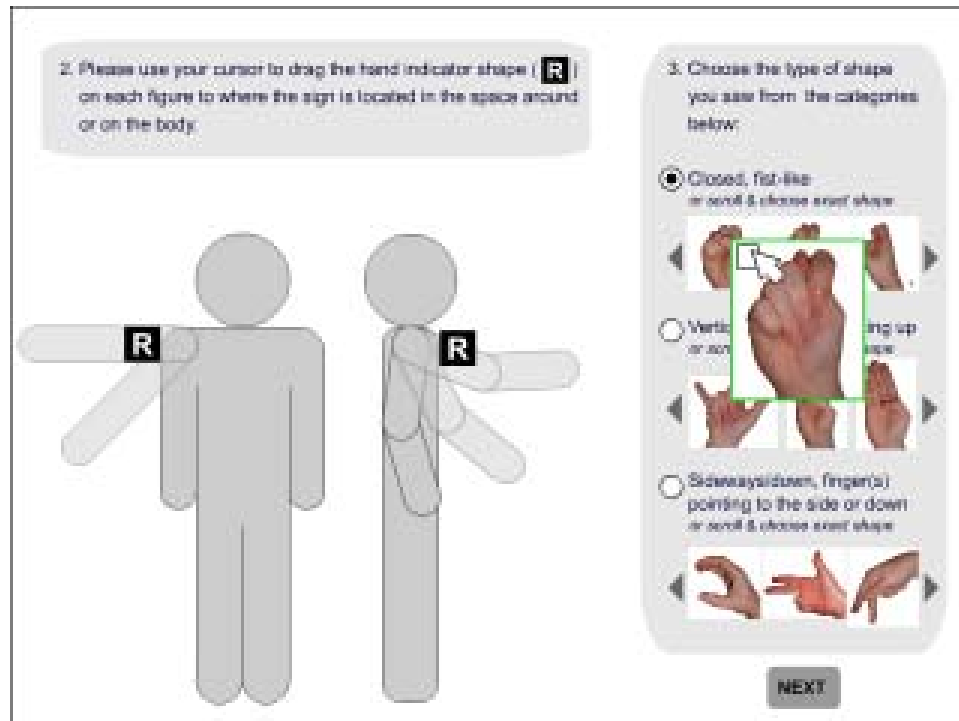


Figure 24: First attempt to organize information into an interface layout

elements were organized on screen so that a user would first “place” the hand in space, then choose one of three handshape categories, or scroll through each category to find a specific shape.

The use of photos for the hand shapes made me think more about the best way to represent the entire person. I realized that, just like with the hand shapes, when a person moves part of the body, there are changes in the rest of the body that add up to the entire shape/impression made by that motion. This would also be impossible to capture in abstracted shapes. So, I found some photos of people that I could make rough mock-ups for with their arms in various positions, to work through my interface ideas.

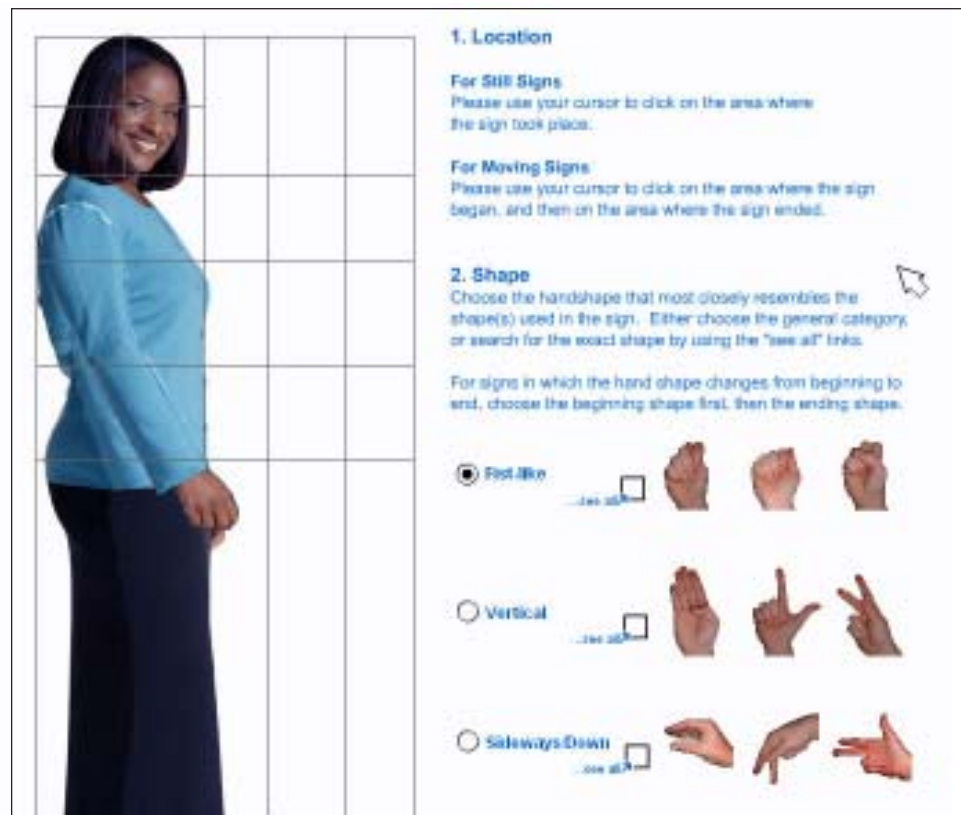


Figure 25: Second idea for interface layout

The size of the entire interface was increased to make room for a more usable-sized image of a person, in which the hands could easily be placed at different points on the “grid” of space around

the body. I also changed the way people accessed the specific hand-shapes. Instead of scrolling through the options on the main screen, the user could choose to view a smaller pop-up screen that would show all the options for each category in one view. This would make it much easier to compare all the shapes in a category at once, rather than trying to remember the differences between two similar shapes while scrolling back and forth between them.

I found that I could easily plot arm movements from the side view, through the various grid quadrants, but then realized that a front-view was also a necessary part of the interface. It would be more difficult to place the hands in the grid from the front view, and have it be obvious that they were in the same places that had been indicated in the side view, so I thought about how to combine them.

I then tried a page that was completely based on three views of the person—from each side, and from the front, and these views would be dynamically affected by the others. If the right hand was moved on the right-side view, the right hand would also move on the front-view model, and so on. This option seemed to be a huge waste of on-screen real estate, and I quickly moved on.

Improving the Grid

Deciding out how the grid structure would work from various points of view forced me to take a much closer look at how the grid was created. While the simple divisions I had created in the beginning were easy to map, they didn't correspond directly to the important differences in location of some signs. I fine-tuned the grid so that it was more appropriate to the actual spaces where signs take place. I also separated areas that are used to change meaning. For instance, rather than just having one quadrant near the head, I made 3 areas—the bottom of the head for female signs, the top of the head for male signs, and mid-range next to the head for signs that do not necessarily need differentiation between male and female.

The grid could help users understand how the physical location of a sign can change its meaning.

It soon became evident that the grid would be different from the side view vs. the front view. So instead of applying one grid to all views, I designed a specific grid for each view, which more closely reflected the actual differences in placement of signs. The grid itself could actually help users understand how the physical location of a sign can change its meaning.

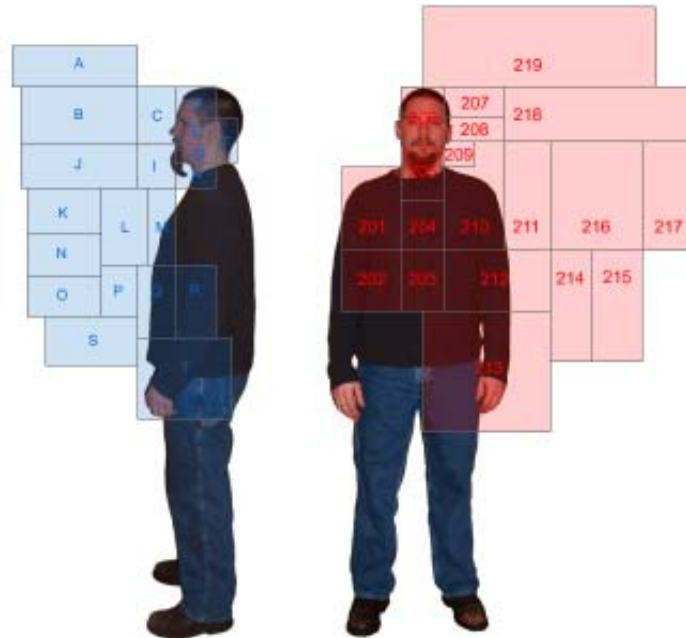


Figure 26: Different grids for the front and side views

Because ASL can be performed using either the right or left hand as the primary or “dominant” hand, the interface would have to support users searching for either hand in almost every area of the grid. This created the need for two overlapping grids—one to plot the right hand’s location, and one to plot the left—because the right hand touching the right shoulder has a very different meaning than the left hand touching the right shoulder. The database information contained in the grid, therefore, would need to be different for each combination of hand and location.

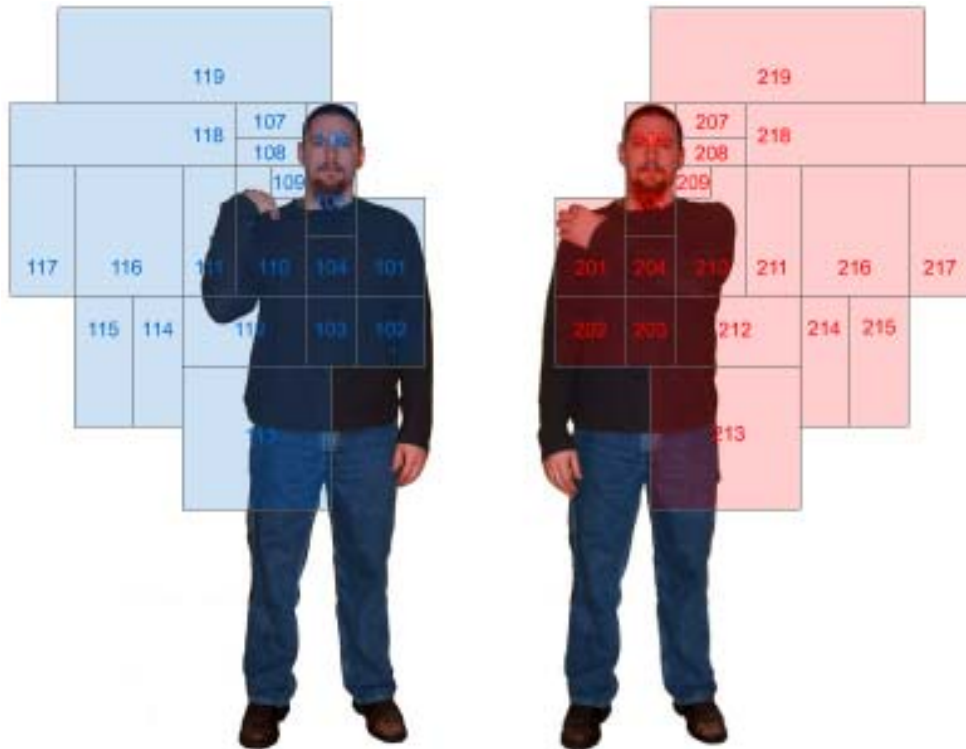


Figure 27: Two grids for mapping each hand around and across the body

Putting It All Together

Now it was time to put all the elements together and create one comprehensive search interface. I was still feeling a bit burdened by the amount of information I wanted to include, and created a system through which the user would identify discrete parts of the sign. Navigation was divided into “tabs” that held different information, like view of location from the front, view from the side, hand shape, and motion. I created a space in the interface where the elements that had been identified could be “saved” and would be accessible from any of the “tabs.”

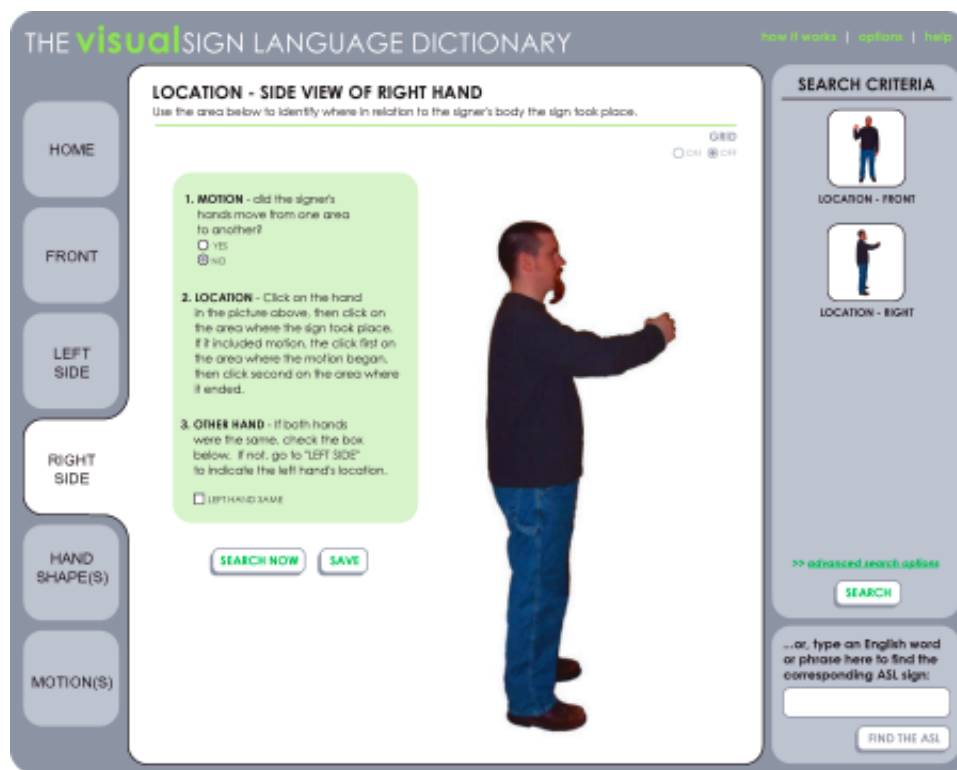


Figure 28: The first comprehensive interface layout

This was a very good exercise for me, to put all the pieces together and try to make a system that worked no matter what piece of information the user wanted to identify first. However, the overall feeling was still text-heavy and clunky, and didn't embrace the opportunities available to me through new media.

Diving Into Design/Stretching My Limits

After taking some time away from this interface, I came back with a fresh mind for my last semester. I started on my greatest challenge—exploring what technology could bring to my interface, beyond things I could build myself. It was time for me to design my ideal, not a pragmatic, buildable model, as I had been doing.

I intensified the focus of the interface on the three-dimensionality of the model. Instead of using separate still images to see the model from various points of view, the model itself would rotate, as would the hand shapes. Using the mouse, the user could actually “draw” through dragging, or indicate by clicking, the location, motion and shapes he or she had seen.

I started on my greatest challenge—exploring what technology could bring to my interface, beyond things I could build myself.



Figure 29: Main screen of first draft of improved interface

In addition to an overall view of the entire model, there would be areas devoted to detailed information about the handshapes and details of the head. These options would be smaller “pop-up” screens that would overlap the main screen. The information described through these details would be shown on the main screen, in a kind of summary.

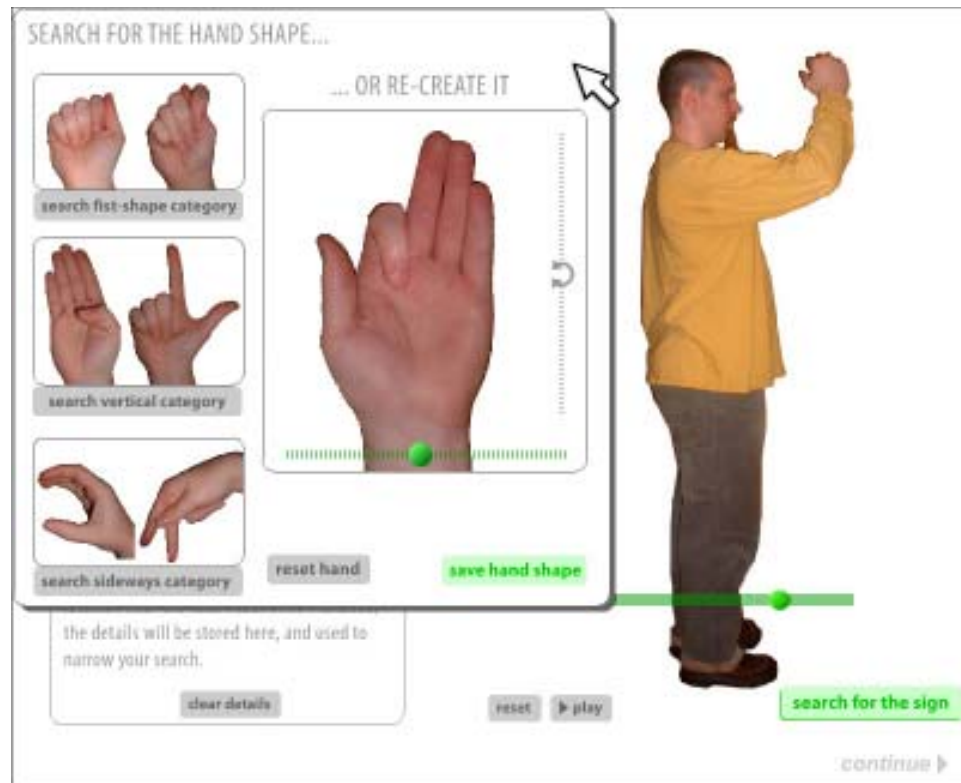


Figure 30: Hand detail

Interestingly, the feedback I received for this outline of the system’s functionality was mostly about wanting to bring back things like the grid of 3D space around the person, and the idea that even these small pop-up windows were taking the user “away” from the main focus of the interface, and should be more simplified.

I spent a few weeks trying to simplify the interface elements within the system I had built—to make the detail pop-ups more intuitive so they seemed more integrated with the main interface screen.

Then, one day I decided to take a different approach, and began to move in a new, simplified direction. I would still include all the information I had previously shown in the pop-ups, but now the information would live in a “tool bar” area of the main interface. The user could drag (or attach by clicking) various pieces of information onto the model, and build the sign that way, rather than ever needing to go “away” from the main model to identify sign elements.

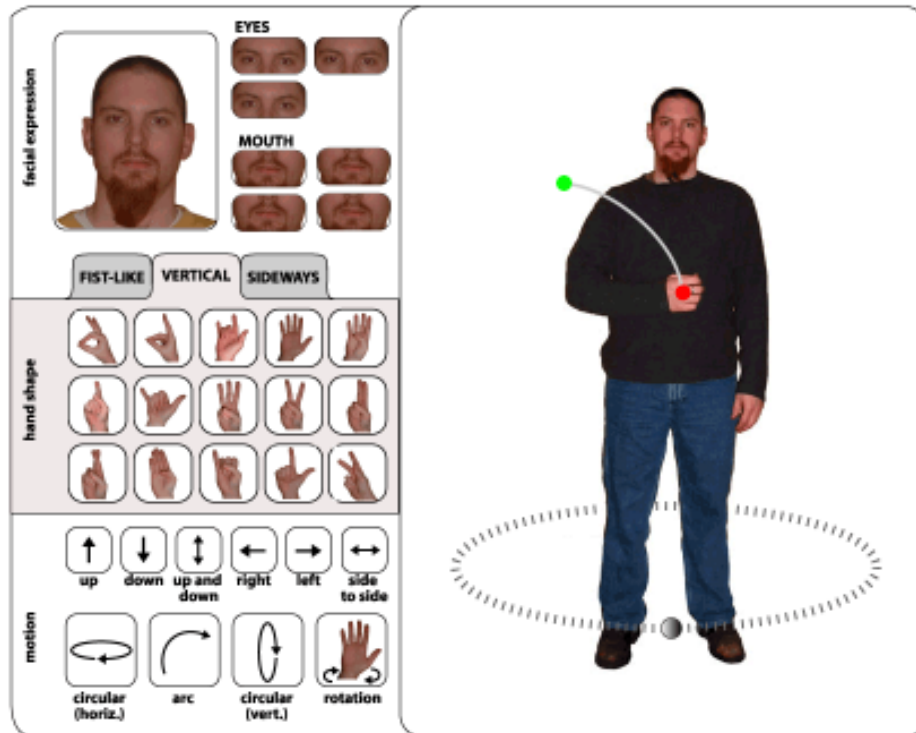


Figure 31: Rough “real estate” allotment for simplified layout

As I began to work through this simplified system, I thought about including even more information in the actual tasks the user performs, rather than taking up permanent space on the screen. For example, I considered moving the “facial expression” options to a menu that would open when the user clicked on the model’s head.

I realized that this would work well for hand motion, motion path, and facial expression, but would be unwieldy for choosing a hand-shape. A compromise between the two seemed to be creating “tool bars” for each type of information. These tool bars would occupy space next to the main model interface, never obscuring that part of the screen.



Figure 32: Draft sample of context-specific menu for detailed information

Finalizing the Search Functionality

Continuing with the toolbar concept, I had them share real estate, so that only the appropriate options would be available for the particular part of the model or motion the user was working with. Each characteristic would be accessible by clicking on its title, but for instance, if a user clicked on a hand, the hand-shape toolbar would open.



Figure 33: First layout of tool-bar based idea

I also decided to simplify the options for use of the mouse. Because people use computers differently, and PCs and Macs have some inherent differences (right-clicking on the PC requires a key-press on the Mac), I would make each option work via different methods.

Because people use computers differently, I would make each option work via different methods.

Users can access all the information directly through the toolbars, and either drag the options onto the model, where they will “snap” to the hands/head/paths, or click on the option, then click on the model (or vice-versa). They can also access all the information via the model. They can use the mouse to click and place hands, or drag motion paths, and when they perform these actions, the corresponding toolbars will come to the front, where the user can define more specific characteristics if they'd like. When they mouse-over parts of the model that can be modified, a shaded area will appear, and the cursor will change to indicate that it's clickable.

Instead of having an intermediate page between the “search” interface and the “definition” interface, I also decided to have the search results be dynamically generated to an area on the search interface. Each time the user specifies an option, the results will be narrowed and re-posted. These results will be shown by thumbnail images that, on mouse-over, will play the sign, and will have the title of the sign below the image.

When the user clicks on one of these results, a new window will open with the definition. The search interface will retain the state it was left in, and the user will have the option of returning to this interface and choosing another option from the search results (which will also open a new window, so it will be possible for a user to compare sign definitions while both are on screen), or creating new search criteria.

Designing the Final Prototype

After mapping out the functionality for both the search and definition interfaces, it was time for the final visual design. First, I wanted to make the interface pieces seem more like other computer-based tools—media players, CD-rom games and demos, and even Instant Messenger—by softening corners/edges, and giving some modularity. I also needed to define a consistent visual language for icons and information.

I began by dividing the toolbars into separate elements that would seem “stacked” on top of each other in the same screen space. Navigating between them would be the same as in previous iterations, but this entire block of toolbars would be moveable. I also started to separate the search results out as its own interface element a bit more than before.

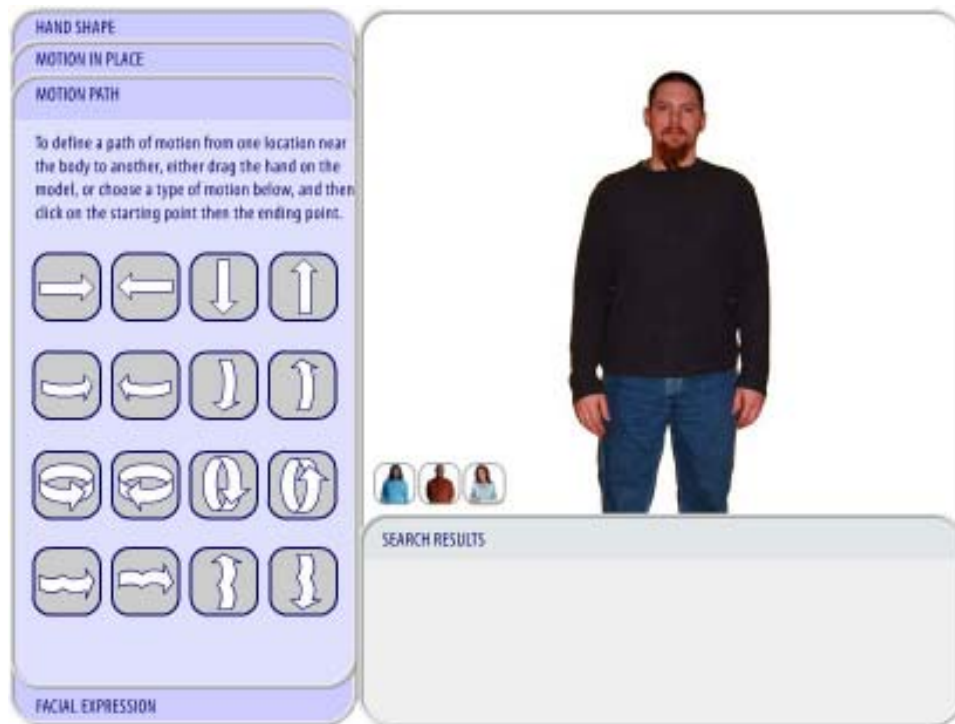


Figure 34: Beginning to hone the visual language and treatments

I worked on this interface for a few days, but started to feel like I was stuck in a bit of a rut with the layout. I decided to start over on a “blank slate” using all the elements and ideas I had developed through previous iterations. This time I wanted to stay focused on the idea that I was creating a computer-based *tool*. It should look and function like a utility, and should embrace the potential for modularity and flexibility. I began by creating the icons for the system that would identify categories of information as well as toolbar options. I then built a shell of the interface that would show that each section was a different piece. Having already defined how the different pieces would interact with each other, I then worked to fine-tune the functionality of each section separately.



Figure 35: Final Interface

The Main Interface Area

The main area with the model did not change significantly, aside from its position in the interface. Since it is the focal point of the system, I moved it to the top left, to indicate that the toolbars, etc. were supplemental to it. In this section, users can manipulate the model to recreate a sign, as well as choose which model to work with, and turn the grid on or off. The Reset button in this section will remove all changes that have been made in all toolbars and bring you back to the beginning of the search, unlike the buttons in each toolbar which only remove changes made from that toolbar .



Figure 36: Main search interface section

The Handshape Toolbar

The first toolbar I focused on was the Handshape toolbar. This toolbar is used to identify particular handshapes, or general categories of handshapes, that are used in signs. It can be used in different ways, depending on a user's preference. In all cases, when a user rests the mouse over a handshape icon, a larger image will appear to give the user a better view of the shape.

Once the user decides which shape is correct, there are 3 ways to indicate this choice. One way is to select a handshape icon from the toolbar and drag it onto the appropriate hand on the model, where it will “snap” into position. The model's image will then change to show the chosen handshape.



Figure 37: Different methods of indicating handshape

This method may also be used with a general category icon. When a general category icon is used, rather than the model's hand changing shape to reflect the choice, a small version of the icon will remain on the hand to indicate the category. The user may click on the hand to select it before dragging the icon (in which case the hand will be highlighted in green), but it is not necessary.

The other method is to click on a handshape icon and then click on the model's hand. The icon will then automatically move to the hand and snap into position. This option can be performed in reverse as well, by clicking first on the hand to select it, and then clicking on a handshape icon.

This toolbar contains 34 handshape options divided into three categories. To have all options visible at once would be an inefficient use of space, and could easily overwhelm the user with too many choices. Each category is therefore represented by just three samples, with an option to view all handshapes in each category as needed.



Figure 38: Handshape toolbar with all signs in one category showing

The Motion Path Toolbar

The purpose of the Motion Path toolbar is to identify the gesture of a sign—where the hands move in relation to the body as a sign is made. I have simplified the categories of motion from my original collection to a much shorter list—straight line, wavy line, arc and circle—that users can identify using icons in the toolbar. There are two ways to identify a motion path. First, the user can click on the type of motion in the toolbar, and then click once on the hand used, click again on/near the model where the path began, and click a third time where the path ended. The system will then draw the chosen type of path between those points. The starting point is represented by an open square, and the end point by a closed square.

Users may also “draw” motion paths using just the mouse. First, the user clicks on the appropriate hand, then clicks and drags the hand from the start to end points in space near the model, or click once at the start and once at the end points. By default, the system will draw a straight line between the points.

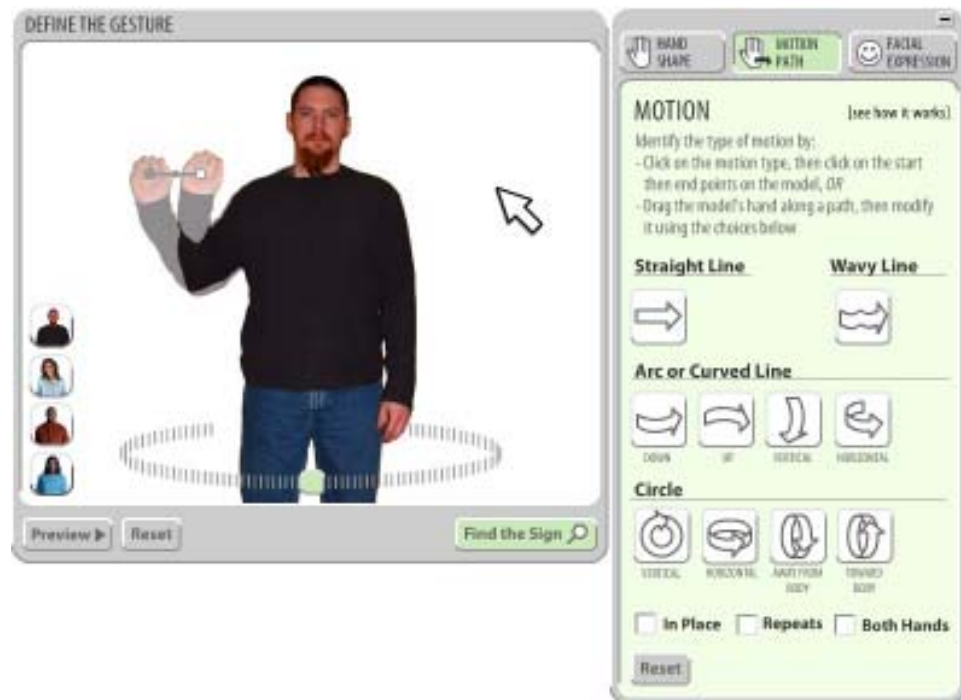


Figure 39: View of model with motion path

Once a path is drawn, the user may manipulate it using two methods. First, each path includes a small “handle” at its midpoint. Users can click and drag this handle in any direction, and the path will curve in response. If the desired path has more than one curve in it, the user can also rest the mouse near one half of the path (until a small curved-line icon appears at the top of the cursor), and then drag the section of the path into a curve. The midpoint stays in place, so the user can create a “wavy” or “bumpy” path.

One of my goals is to make the use of this system as intuitive and simple as possible, so at any point, no matter how a path was drawn or has been manipulated, any method can be used to edit it. For instance, a path that has been changed by using the “handle” could then be clicked on (selected and highlighted in green), and then the user could click on an icon in the toolbar to change the qualities of the path.



Figure 40: Moving the “handle” to change a path

As I thought about all the options to offer in this toolbar, I realized that I could include the “Motion in Place” option in this tool, rather than having two separate toolbars. “In place” is defined as moving within one section of the grid, rather than between two sections. The types and shapes of these motions are the same as for Motion Paths, the only difference being the amount of space across which they took place. I added an option to the Motion Path toolbar that a user can check if the motion happened in place. This option is included with options to identify whether the same motion is made by both hands, and whether or not the motion is repeated.

When a user selects “in place,” the grid will automatically be turned “on” and the path will shrink as necessary, to fit within the particular grid area. The grid area will be highlighted. A user may choose a different grid area by clicking and dragging the highlight to the new area, where it will “snap” into place.

The Facial Expression Toolbar

The third toolbar is used to indicate specific facial expressions made during the sign that contribute to its meaning. This toolbar contains options for the eyes and the mouth. It works in the same way as the handshape toolbar. Users can select options by dragging an icon onto the head, by clicking on an icon and then the head, or by clicking to select the head and then clicking on an icon. The only difference is that in the Facial Expression toolbar, more than one quality can be attributed to the head—one eye option and one mouth option.



Figure 41: Facial Expression toolbar

When the user has finished identifying sign characteristics, and clicks on the “Find the Sign” button at the bottom of the main interface window, a Search Results module will appear. This module will contain thumbnail images of the signs that fit the criteria specified by the user. When moused-over, these thumbnail images will play a previews of the signs. To see a full definition of one of the signs, the user will click on the thumbnail. This will open a definition screen on top of the search interface. The information in the search interface will not change when the definition opens, and so the user can go back and open definitions for more of the signs in the search results, or reset and start over, without losing the first definition.



Figure 42: Interface with Search Results

In addition to these visual tools I have developed, I have also included a small text-search option in my interface. This will allow my project to be a true “two-way dictionary” that users can also depend on when they simply want to know the sign for a particular English word or phrase.

To increase the flexibility of the interface, the sections (including the definition interface which is described in more detail in the following section) can be re-positioned in relation to each other, and some can be closed or minimized when not in use.

The functionality of this final design offers options for users with varying levels of comfort using a mouse (dragging and drawing paths with the mouse versus clicking on icons), and different preferences for the organization of information on their screens. These options, as well as the visual design, combine to provide a system that looks and functions like the computer-based utility I had envisioned.



Figure 43: Sample of two different organizations with minimized sections

The Definition Interface

Mapping out the Basics

When I started to create the interfaces for this project, in addition to the “search” interface, I also needed to map out what kind of information the user would be accessing, and how it would be displayed. It was clear that my “definition” interface could be as innovative as my search interface. The New Media elements of motion and interactivity could help to educate users about the nature of the language. There could be many paths to information through and from the definition interface, not just through the search interface.

My definition interface could use New Media to educate users about the nature of the language, and offer them many paths to information.

Based on my understanding of ASL from taking classes, reading, and speaking with experts (see “Research” section), I was able to identify a number of particular pieces of information that would combine to create a full “definition” or description of each sign. Each definition would include cross-references to other signs that were related by particular characteristics.

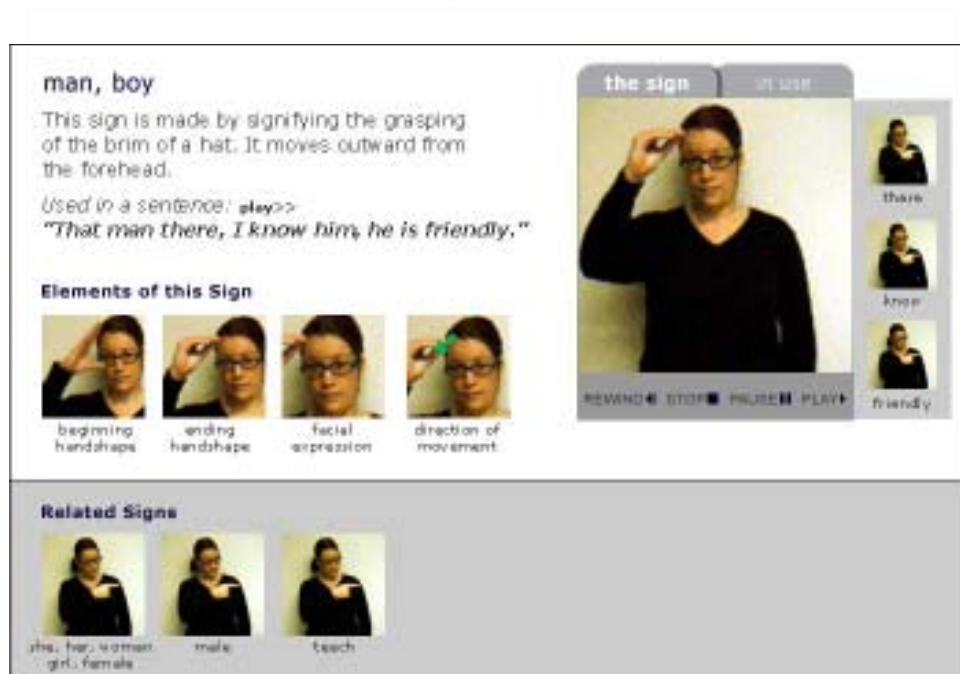


Figure 44: Sketch of elements for definition interface

My definition interface would include:

- ▶ The English word or phrase that corresponded to the sign
- ▶ A written description of how the sign was made
- ▶ An interactive motion graphic of a person making the sign – both alone and in the context of a sentence.
- ▶ Distinct images of the various parts of the motion or shape of the sign that go together to create the whole sign
- ▶ Links to definitions of the other signs used in the “context sentence” motion graphic.
- ▶ Links to definitions of other signs that are related to the sign being defined either by shape, motion, sign family, or meaning

I was relatively confident that these elements were correct, and set the definition interface aside so that I could spend the bulk of my time creating an innovative search interface, which I knew would be my greatest challenge.

Improving the Design

As I developed and simplified my search interface, my definition was also evolving. The motion graphic/video would now provide more more interactivity and detail. In addition to the user being able to view the video of the sign being made, they could view a zoomed-in detail video of the sign, as well as the sign in context. The user would be able to see each of these parts being performed by different people. A progress bar could also be dragged at a user's desired speed in order to focus attention on any part of the sign. Also, the sentence would be written in both ASL and English to reinforce the differences between the grammar of the two languages.

It also seemed that the connections between related signs might be an opportunity to reinforce the elements that make up my database. To do this, I created a "grid" that would show which of the related signs had various elements in common—so a user could see which signs were more closely related on what basis, and learn the differences between relation based on different characteristics.

Again I stepped away from the definition interface to think more about improving the search functionality, and the entire system overall.

The interface displays the sign 'teacher' in green. It includes a description, elements of the sign (Handshape: Letter 'O', Begins: at forehead, Ends: forward), and a table of related signs. A video player on the right shows a man performing the sign, with controls for play, pause, and volume, and a sentence in ASL and English.

teacher

DESCRIPTION OF THE SIGN

Both hands, starting with the hand in an "O" shape near the forehead, and ending with the hand moved out in front of the forehead, then both hands flat w/palms facing, moving in a straight line down in front of the body.

ELEMENTS OF THE SIGN

Handshape: Letter "O"
Begins: at forehead
Ends: forward

RELATED SIGNS

	SHAPE	MOTION	LOCATION	TOPIC
teach	closed "O"	outward	forehead	school
learn			forehead	school
student			forehead	school
man	closed "O"	outward	forehead	
give	closed "O"	outward		

video player: SIGN, DETAIL, SENTENCE
SENTENCE IN ASL: I teacher I. Teach Sign Language I.
ENGLISH: I am a teacher. I teach Sign Language.

Figure 45: Improved definition interface

The Final Definition Interface

The definition screen went through fewer iterations than the search screens because it is a different type of interface. For the search interface, the challenge was far greater—creating innovative ways for people to use their computers to identify visual characteristics of ASL signs. For the definition, I needed to create ways of displaying information from the database, and options for interaction with that information.

Based on the improvements I had made to this interface in my previous iteration, I was able to leave it intact during two more editing cycles of the search functionality. As the search interface became finalized, I then began to work on a final design for the definition interface that would best interact with the search elements.

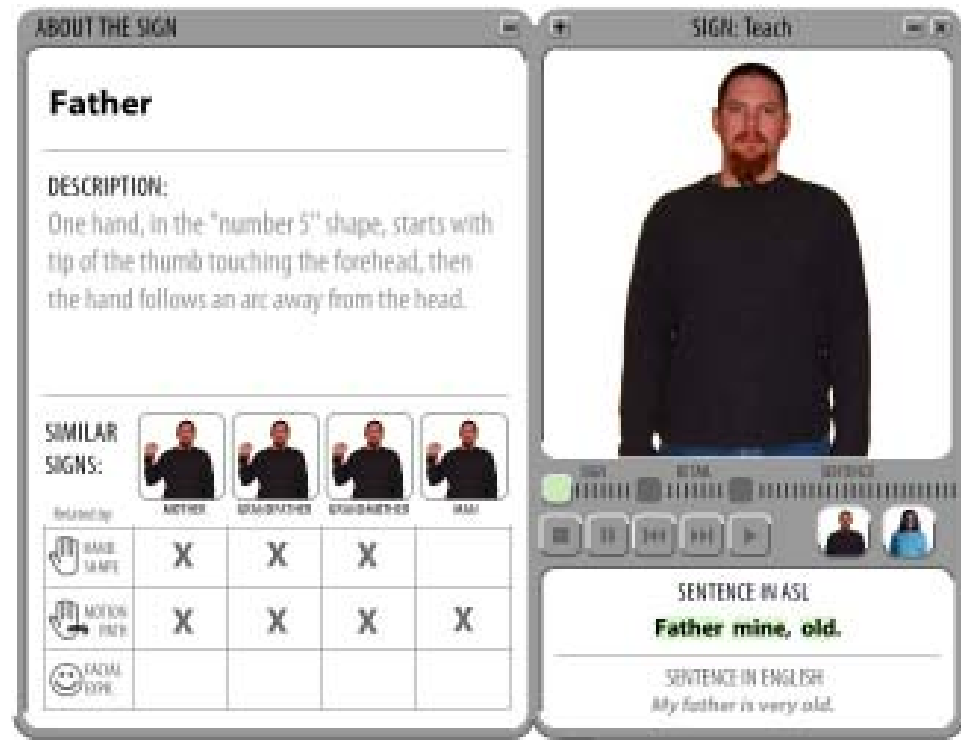


Figure 46: Final definition interface

First, because the interactivity of the video module included a detail view of the sign, and could be replayed at any speed by the user, I decided that the series of still images of the sign's component parts was unnecessary, and removed that information. I also updated the "Similar Signs" area. It would now correspond to the three types of information used in the search interface, and would include thumbnail images of the signs. Users could mouse-over these thumbnails to play previews, exactly like the search results section.

The final design of the entire project had become more modular, with each element becoming a separate entity that could be manipulated and moved as the user desired. This carried over to the definition interface in a few important ways. I had already decided that each time a user opened a definition, it would create a new window, so that a user could compare signs to each other easily by viewing them side by side on screen. To maximize use of space in these situations, I added an option to the definition screen. It would offer two views—the default view with all of the information, and a minimized view that would hide the textual and similar-sign information on the left side of the screen, showing only the interactive movie and sentences.

To give users even more flexibility for using space on screen, I also provided the option to minimize the entire definition for a sign. When a definition is minimized, it will show up as a small window header that snaps to the search results section of the interface, and can be maximized for viewing as desired.

By making these changes, I was able to integrate the definition interface much more seamlessly with the search, so that users could more quickly become comfortable with the entire system.

USER TESTING AND FEEDBACK

User Testing and Feedback

The target audience for my thesis work changed a few times during the initial development of my interface. As I became more confident about the functionality of the system, it became clear that it would be most appropriate for a specific audience—ASL students.

I had decided that my work should be for ASL and English what other two-way dictionaries are for other language pairs. This meant that the typical user would come to the interface with some basic knowledge of ASL, and possibly even be conversant in the language. This dictionary would offer them options to identify sign characteristics that they were already able to identify. Much like a student learning German might hear a new word and work out how it is spelled in order to look it up in a German/English dictionary, my user would see a new sign and be able to identify the component parts, in even the most general of ways, in order to look it up through this interface.

Having identified this user type, I asked for feedback from a few people who were currently or had been in that type of situation. In addition to generally positive remarks from local ASL interpreters about the potential usefulness of my idea, I was able to get more detailed feedback from two potential audience members. My first respondent is Farzaneh Behroozi, a Hearing woman whose best friend is Deaf. She and her friend mostly communicate through speaking and lip-reading, with some basic ASL at times. Because ASL is one of her friend's principle methods of communication, however, Farzaneh is slowly learning ASL. She was very excited to hear about my thesis project.

My second respondent is Farzaneh's friend, Jenna Beacom. Jenna was brought up Hearing, and became Deaf at the age of 13. It is because she spent the early part of her life communicating through spoken English that she can communicate in speech and lip-reading with Farzaneh. After years of learning ASL, she is now fluent, and has even brought her Hearing daughter up using ASL as her first language. Jenna has also taught beginning ASL. This dual perspective of a person who had to learn ASL out of necessity, as well as a teacher of ASL, brings valuable insight to my project.

Farzaneh's reaction to my project was overwhelmingly positive. Her characterization of my work was that it would be a "a huge contribution to people who speak ASL, their families and people who are learning ASL."

She identifies her relationship with ASL in the following way:

My best friend is deaf, and we met in college. We have communicated through speaking, as she lip-reads. Her husband has learned some sign language, and I've been wanting to

learn more ASL—I can fingerspell only when I’ve been practicing (otherwise it disappears). I’ve been trying different ways of learning sign language.

One of the tools Farzaneh has been using to help her with ASL is the *Gallaudet Survival Guide to Signing*. This book is produced by Gallaudet University Press, one of the premiere publishers of books about ASL, and is very highly recommended. Farzaneh describes the book as being organized in a non-standard way that is not based on the shapes and motions of the signs, but on particular topics or situations defined in the book. In her opinion it is “not helpful at all” as a dictionary-type reference tool, and it seemed to her that she “would need to read and learn the entire book for it to benefit” her.

In her experience, building vocabulary is the most difficult part of learning ASL, because “you need to see [the new sign] and a printed dictionary is really not that helpful.”

So, she is left to ask people to explain what they mean when they use a sign that she has not seen before, and says “it would be great to have a dictionary, so I can pick up more on my own...I speak French, and am learning Spanish, but ASL is a pretty difficult language, and anything that makes it easier is very welcome!”

As she walked through the demo of my interface, her reactions were very positive. Her first comment was that it seemed to make a lot of sense to have the model be the main part of the interface. She thought the division of sign information into the three sections—Handshape, Motion Path and Facial Expression—was intuitive, and that the tools offered for each section were appropriate and useful.

She noted that, although the information contained in the system is complex, the interface is “simple” and seemed “easy to manipulate.” She especially liked the way that motion paths could be changed with the mouse, and that the model could be rotated to see the signs from various points of view. She commented that the interface addressed the “specific need the user has” to identify visual elements he or she had seen.

After walking through the search interface, we moved on to the definition. She was very excited about the options offered for the movie of the sign. In particular she liked that the interface helped identify the particular parts of a sentence being signed, and that the user had so much control over viewing the different parts of the movie as needed.

At the end of our interview, she added that the inclusion of the search box for looking up words and phrases was a great idea, because it made the product work as a quick look-up for English words as well, which would also be useful.

The feedback I received from Jenna was different, but also mostly positive and helpful. I did not meet with Jenna in person, and so received her feedback via email. The first part of her message included a reference to a posting she had recently seen in a Yahoo! Group for Deaf people in Illinois (<http://groups.yahoo.com/group/DeafIllinois/message/6324>). The posting reads as follows:

Date: Sat May 8, 2004 10:00 pm

Subject: Reverse ASL Website?

Does anyone know of an ASL website in which you can describe a sign that you don't know the meaning of? It would be sort of like a reverse look up. I know the MSU website has an ASL Browser to look up the sign for the words you know, but I am looking for a reversal to that.

Can anyone help me out?

Thanks

Jenna suggested I post a response to this query with a link to my demo, in order to get feedback from a wider audience. Once I am closer to actually building the interface, I may do that. Right now, though, as the group has over 10,000 people, I didn't feel it appropriate to send them information until I was prepared to deal with the possible volume of response I could get, especially when I don't even have solid plans of actually creating the tool.

She then went on to give me her thoughts on the project itself, and its usefulness. Rather than paraphrase from my own notes, here is the response she sent me:

As a website, it rocks.

As a concept, I'm not sure of its utility.

I have taught ASL, and one of the earliest skills I emphasize is retention of visual movements. A specific exercise I do is to have students partner up with a barrier in between them, one partner with a paper that has a series of abstract shapes on it (a square on top of a circle on top of a...) and the other with a blank piece of paper and a pen. The partner with the

shapes then “draws” them in the air with his or her index fingers, and the partner with the pen has to replicate those shapes.

People who are new to ASL have a terrible time with this. They can retain some of it in their mind’s eye, but they can’t retain the whole thing. The longer it gets (square on top of a circle on top of a triangle on top of a square surrounded by a circle and topped with a crescent), the less they retain. (i.e. if it’s short they retain say half, if it’s long they retain nothing.)

My point here is that I suspect that people who would need this site would not be able to retain enough information about the sign to recreate the sign. A beginner, faced with an ASL sentence, would retain only a vague sense of whirling hands.

So it would be a pretty narrow audience (though that audience may in fact exist), ASL students who already know enough sign that they are able to follow whole sentences but get stuck on one or two signs, and have trained their brains well enough to remember the movements if not the meaning of the sign. It seems unlikely that people in this situation wouldn’t be able to simply ask someone for the meaning.

Again, though, someone spontaneously asked about whether there is a reverse ASL dictionary like the one you are working on, and a small audience is still an audience. And the specifics of how you set this up look really good.

Jenna’s perspective as a teacher is very valuable. Although my target audience is in fact closer to the group she describes later in her feedback (“ASL students who already know enough sign that they are able to follow sentences...”), the idea that the interface should support searches for very general motion descriptions is worth pursuing, and may be as simple as modifying the directions for the toolbars, or adding some general categories on top of those I have already identified.

I feel that the basic response to my project from both Farzaneh and Jenna was positive, given the parameters that I set out for myself at the beginning. Although Jenna’s feedback was less enthusiastic, the online posting she referred to, as well as Farzaneh’s excitement about the project, seem to suggest that there is real potential for this project—even if it is just for a “small audience.”

CONCLUSION

Summary/Final Remarks

The work I've done for my thesis over the past six semesters has been satisfying on many levels. As a designer, the unique challenges presented by ASL gave me the opportunity to push my abilities beyond where I am usually comfortable. Because of this, I have created a project that will become a high-point of my portfolio. As a person who's lived in the Boston area for over 10 years, this project has given me insight into an entirely new community, and the opportunity to explore a new industry. Having peeked into the world of ASL Interpreters, I am very interested in someday pursuing education and work in that industry. As a language enthusiast, all that I have learned about American Sign Language has also been quite engaging and enjoyable.

Apart from the personal satisfaction, I am left with the hope that some day I will be able to transform my prototype into a functioning tool.

Thesis Contribution/Significance

The potential contributions that my thesis project could make to the Deaf community are many. One of the most important applications of this tool could be to help the families and friends of people who communicate in ASL. In particular, this tool would help people who only occasionally come in contact with ASL in the same way a phrase book is used when traveling to foreign-speaking countries. For friends and family who are learning ASL, this tool could help to build vocabulary by giving them a resource other than ASL experts they know, where they could find the meanings of the new signs they see in conversation.

On a larger scale, I hope that, by providing a tool that has long been available for students of other languages, my project could play a role in the ongoing efforts to get ASL recognized as a “foreign language” in higher education. Currently, there are over a half million Deaf people in the United States and Canada who use ASL (gri.gallaudet.edu/Presentations), who must seek out education on ASL at specialized schools and programs, because it is not offered as part of mainstream education. This would not only benefit Deaf people, but would facilitate communication between the Deaf and Hearing worlds in a way that has not yet happened on a large scale. I would hope that a tool like mine could aid in this setting, in addition to helping families and small communities.

My work will also find a place in the New Media/Visual design industry. The use of motion graphics, non-text-centric database design, and interactivity in my project will provide access to ASL in a way that was not possible in traditional media. By approaching ASL from a beginner’s perspective, I was able to see opportunities that had not been addressed by traditional “experts” in the language. By breaking the language down based on visual information, and creating a unique database organization, I was able to make ASL more accessible to a general audience. Because I was continually learning about ASL during the entire design process, my designs were refined and reorganized many times. While it may have seemed that my work included many tangential efforts, it all came together to inform the final interface. What I have created is an interface that successfully addresses many complex issues about ASL because of all the wrong turns and incorrect assumptions I learned from along the way.

Based on the innovation that I was able to bring to this interaction with American Sign Language, I believe that there are many other opportunities for New Media to solve communication issues for other groups of people with particular needs, and that my project can serve as a precedent for such work.

Direction for Further Research

On a personal level, I have been intrigued by the exposure I had to the Deaf community and the job of ASL interpreter. After some time away from school, I think I might find myself investigating the possibility of studying to become an interpreter.

My future plans for this project are more concrete, and begin with conducting additional usability tests. I will need to add to this area of my research in order to continue to develop the design for a working prototype. I hope some day to have the opportunity to work with a team of database engineers and ASL experts to actually build a functioning version of my project. I believe that this tool could have a promising future.

RESOURCES

Annotated Bibliography

ASL & Deaf Culture Resources/Reference Books

Brentari, Diane. 1998. *A Prosodic Model of Sign Language Phonology*. Cambridge, MA: The MIT Press

This is a scientific approach to sign language based on its physical attributes and its spatial characteristics, which attempts to break down the language into a collection of motions made by various parts of the body. The author of this book is NOT experienced with ASL, and has an outsider's perspective, which I was intrigued by – hoping that seeing the language's characteristics without understanding the meaning could be a fresh point of view. It has been a helpful book in terms of this perspective, but is far too scientific.

Lane, H., R. Hoffmeister, and B. Bahan. 1996. *A Journey into the Deaf-World*. San Diego, CA: Dawn Sign Press

This is a great book about a hearing person's experiences with Deaf culture, as well as an easy-to-read history of ASL in the United States – where it came from, its roots in France and New England, as well as the challenges that the Deaf-World faces in the world even today.

Stokoe, W., D. Casterline, and C. Cronenberg. *A Dictionary of American Sign Language on Linguistic Principles*. 1976. Linstok Press

This was a ground-breaking book in the world of ASL linguistics in the 1970s, and is still the standard that experts (whom I've met) in the field refer to when you ask them about the possibilities of organizing ASL into a database of its movements. I have used the basic collection of handshapes defined by Stokoe et al in the 1970s as a basis for my database as well.

ASL Dictionaries/Workbooks/Precedents

American Sign Language Video Dictionary and Inflection Guide. 2000. National Institute for the Deaf, Rochester Institute of Technology, Rochester, NY.
(<http://www.rit.edu/~gspncm/files/CDProject.htm>)

I purchased this CD as an example of a precedent for my project. When I got the CD and tried to use it, however, I realized that it is in fact, one more in an enormous collection of “ASL Dictionaries” that only allow users to access meanings of signs through looking them up based on their english equivalents.

Costello, E. 1998. *American Sign Language Dictionary*. New York, NY: Random House

This is the “gold-standard” of ASL dictionaries that instructors I’ve learned ASL from have referred to in ASL classes. It is a typical ASL dictionary which is organized based on the english alphabet. It includes sketches of people making the signs, as well as written explanations. Movements are indicated by arrows on the sketches. I find it useful to know that this is the accepted standard.

Garcia, J. 1999. *Sign with your Baby: How to Communicate with Infants Before They Can Speak*. Seattle, WA: Sign2Me (imprint of Northlight LLC), and Bellingham, WA: Stratton-Kehl Publications

This is a system that has gained in popularity in the past few years through which parents can teach their infants to communicate with “sign language” long before verbal communication begins. It is not necessarily based on the true linguistics or grammar of ASL, but rather a collection of discrete signs that babies can learn. At one point I had thought to use the signs in this system to be the basic elements of my database.

Humphries, T., and C. Padden. 1992. *Learning American Sign Language*. Englewood Cliffs, NJ: Prentice Hall

This is the book that was used in an adult ed. ASL class that I took last year as part of an independent study. In addition to teaching vocabulary, this book also teaches ASL grammar – including “classifier” hand shapes as well as the order of signs in ASL sentences versus the order of words in english sentences.

Lewis, K., and R. Henderson. 1997. *Sign Language Made Simple*. New York, NY: Broadway Books (a division of Random House, Inc.)

This book is a basic ASL resource for beginners. It defines the idea of a “sign” as well as giving limited information about ASL. In the beginning of my thesis work, I was drawn to it because it organizes its data based not on alphabetical order, but by subject matter, and I thought that might be an avenue to explore for organization in my database.

Riekehof, L. Second Edition, 1987. *The Joy of Signing: Illustrated Guide for Mastering Sign Language and the Manual Alphabet*. Springfield, MO: Gospel Publishing House

This is another printed ASL reference that relies on the organization of signs by subject matter. In the definitions in this book are also included “origins” of the signs, which are actually brief descriptions of the action that is made in the sign, and what it represents. It also includes “usage” in sentences, however, the sentences are in printed English, and do not conform to the rules of ASL grammar, so it is not as much of a resource as it seems at first. At this point, I am simply including it in my collection of printed ASL dictionaries that my thesis aims to improve upon.

Smith, C., E.M. Lentz, and K. Mikos. 1998. *Signing Naturally: Student Workbook Level 1*. San Diego, CA: Dawn Sign Press

This is the workbook (and video) used in the ASL class that I took at Emerson college last fall. This system focuses on learning signs in groups based on certain life activities. It does not deal with grammar or the differences between ASL and English.

Tennant, R.A., and M. Gluszak Brown. 1998. *The American Sign Language Handshape Dictionary*. Washington, DC: Clerc Books (Gallaudet University Press)

I originally thought that this book would be an analog precedent for what I wanted to create with my thesis in a multimedia format. This is a book of signs that users access based on subject matter, so in a sense it is a departure from the typical “dictionary,” and does encourage people to use their memories of the visual presence of a sign in order to find its meaning. However, the signs are organized in a way that only makes sense within the various topics, which are organized based on English.

Web-Based Resources

Bell, T., and P. Willig. 2000. *Classifiers in American Sign Language*. from "ASL: It Can't Be Done on the Web... And How We Did It!" (<http://www.jal.cc.il.us/ipp/ASLonline/>) <http://www.jal.cc.il.us/ipp/Classifiers/>

Mandel, M., Draft, 1993. *ASCII-Stokoe Notation: A Computer-Writeable Transliteration System for Stokoe Notation of American Sign Language*.

<http://world.std.com/~mam/ASCII-Stokoe.html>

Noll, M., *Classifiers*. from "Mitch's ASL Teacher's Resource Web-Site" (also linked from <http://www.aslboardroom.com/Downloads/aslidiom.pdf> by James Womack.???)

<http://www.puyallup.k12.wa.us/aslteach/classifiers.htm>

Vicars, W. *ASL University* (online complement to book "Sign Me Up!") <http://www.lifeprint.com/asl101/index.htm>

(in particular, <http://www.lifeprint.com/asl101/pages-layout/signs.htm#C> – links to CL: A, etc. – classifiers info)

Wilcox, S., J. Scheibman, D. Wood, D. Cokely, and W. Stokoe. (1993?). *Multimedia Dictionary of American Sign Language*.

<http://www.unm.edu/~wilcox/research/MM-DASL/mmdasl.html>

<http://www.signwriting.org/forums/linguistics/ling006.html>