```
to   turn   the face or body in    a   specified   direction
 |     |     |   |   |   |   |      |        /\            |
 |     vb   art  n   |   n  prep   art      /  \           n
 |     |     |   |   |   |          |      /    \          |
 |     vb-   |   N   |   N          |   specify  +ed       N
 |    kernel |   |   |   |          |      |   vb-adj    N-set
 |     |     |   |   | N-set        |      vb    suffix    |
 |     |     |   |   |   /          |   \    \    /        /
 |     |     \   |   \  |  /        |    \    \  /        /
 |     |      \   \   \ | /         |     \    adj       /
 |     |       \   N-set |          |      \    |       /
 |     |        \     |  |          |       \ adj-set  /
 |     |         \    |  |          \        \   |    /
 |     |          \   |  |           \        \  |   /
 |     |           \  NP |            \        \ | /
 |     |            \  | |             \       NP2 /
 \     |             \ | |              \       /
  \    |              \| |               \   NP2-set
   \   |            NP-set                 \   /
    \   \              |                    \ /
     \   \             |                     PP
      \   \     vb-kernel-set               /
       \   \            |                  /
        \   \           |                 /
         \   \          |                /
          \   \         \               /
           \   \   vb-def-phrase       /
            \   \        /            /
             \   \      /            /
              \   \    /            /
               \   \  /            /
                \  vb-def
```

Figure 7-2 Parse of "face-2.7a – to turn the face or body in a
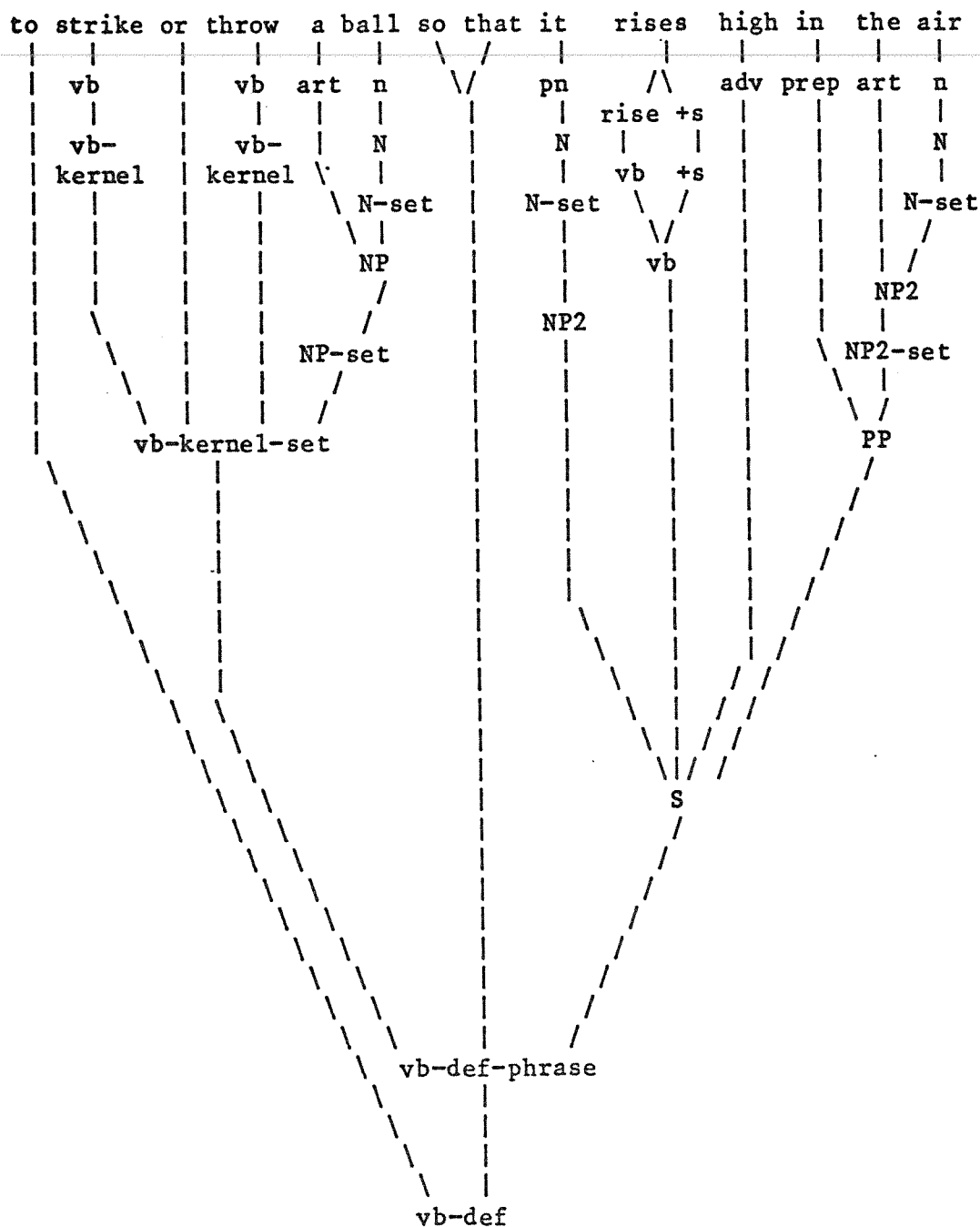   specified direction" using grammar of figure 7-1.

```
to strike or throw  a ball so that it   rises  high in  the air
 |    |      |   |     |   |    \  /    |      / \      |     |   |
 |   vb      |  vb   art  n     \/    pn      /   \   adv prep art n
 |    |      |   |    |   |      |      |    rise +s   |    |   |   |
 |   vb-     |  vb-   |   N      |      N     |    |   |    |   |   N
 | kernel    | kernel \   |      |      |     vb  +s   |    |   |   |
 |    |      |   |     \  N-set   |   N-set    \   /   |    |   |  N-set
 |    |      |   |      \ |       |     |       \ /    |    |   |  /
 |    |      |   |       NP       |     |        vb    |    |  NP2
 |    |      |   |       /        |     |        |     |    |   |
 |     \     |   |      /         |    NP2       |     |    \  NP2-set
 |      \    |   |    NP-set      |     |        |     |     \  /
 |       \   |   |    /           |     |        |     |      PP
 |        \  |   |   /            |     |        |     |      /
 |         \ |   |  /             |     |        |     |     /
 |          vb-kernel-set         |     |        |     |    /
  \          \                    |     |        |     |   /
   \          \                   |     |        |     |  /
    \          \                  |     |        |     | /
     \          \                 |     |        |     |/
      \          \                |      \       |    /|
       \          \               |       \      |   / |
        \          \              |        \     |  /  |
         \          \             |         \    | /   |
          \          \            |          \| / /
           \          \           |           \|/ /
            \          \          |            S
             \          \         |            /
              \          \        |           /
               \          \       |          /
                \          \  vb-def-phrase  /
                 \          \      |        /
                  \          \     |       /
                   \          \    |      /
                    \          \   |     /
                     \          vb-def
```

Figure 7-3 Parse of "loft-.0a - to strike or throw a ball so that it
rises high in the air" based upon grammar of Figure 7-1.

7.2 Morphological Parsing to Verb Normal Form (VNF)

> abatis — a defensive barrier of felled trees with sharpened
> branches turned outward.

This definition is an excellent example of how much information can be
contained within one noun phrase. To completely represent the content of
this definition it is necessary to do more than simply "parse" it. One
must undo the morphological transformations as well. A parsing of this
phrase into semantic relations might resemble the following:

```
(BARRIER DET A
         NBR S
         MOD DEFENSIVE
         SOURCE (TREE NBR PL
                      MOD FELLED)
         HASPART (BRANCH NBR PL
                         MOD SHARPENED
                         THM* (TURN MANNER OUTWARD)))
```

To see what a more complete representation should result in consider
the following:

defensive = (DEFEND INST ABATIS THM1 X THM2/from Y)

i.e. "abatis defends x from y"

barrier = (BAR INST ABATIS THM1 Y THM2/from Z)

i.e. "abatis bars y from z"

defensive barrier =
```
     (ENABLE ARG1 (BAR INST ABATIS THM1 Y THM2/from Z)
             ARG2 (DEFEND INST ABATIS THM1 X THM2/from Y))
```

or "factoring" INST ABATIS out,

```
         (ENABLE INST ABATIS ARG1 (BAR THM1 Y THM2/from  Z)
                              ARG2 (DEFEND THM1 X THM2/from Y))
```

i.e. "abatis barring y from z defends x from y."

Continuing with "of felled trees" we find "of" to be all that remains
of another event, the "making" of the abatis, i.e.,

of = (MAKE AGT X SOURCE W THM ABATIS)

felled trees = (FELL AGT X THM TREES)

of felled trees = (MAKE AGT X1 SOURCE (TREES THM* (FELL AGT X2)))

defensive barrier of felled trees =

```
   (MAKE AGT X1
          SOURCE (TREES THM* (FELL AGT X2))
          THM (ABATIS INST*
                       (ENABLE ARG1 (BAR THM1 Y THM2/from Z)
                               ARG2 (DEFEND THM1 X3 THM2/from Y))))
```


with = (TREES HASPART Z)

sharpened branches = (SHARPEN AGT X THM BRANCHES)

turned outward = (TURN AGT X PATH OUTWARD)

sharpened branches turned outward =
```
        (TURN AGT X1 THM (BRANCHES THM* (SHARPEN AGT X2)) PATH OUTWARD)
```

with sharpened branches turned outward =
```
        (TREES HASPART (BRANCHES THM* (SHARPEN AGT X1)
                                 THM* (TURN AGT X2 PATH OUTWARD)))
```

defensive barrier of felled trees
    with sharpened branches turned outward =

```
  (MAKE AGT X1
         SOURCE (TREES THM* (FELL AGT X2)
                        HASPART (BRANCHES THM* (SHARPEN AGT X3)
                                          THM* (TURN AGT X4
                                                     PATH OUTWARD)))
         THM (ABATIS INST* (ENABLE ARG1 (BAR THM1 Y THM2/from Z)
                                   ARG2 (DEFEND THM1 X5 THM2/from Y))))
```

Displaying these in a chronological order we have:

At t0 to tI,

   (GROW TEM1 TREES THM2 BRANCHES) ==> (HASPART TREE BRANCHES)

What is implied here is not that all trees have branches, which might very well be a property of trees in general, only that the trees which are under consideration here acquired branches as a result of growing them. "Branch" itself might be taken as a verb, which is the origin of the theme case argument "branches", i.e. "Branches branch from trees." I have also not explicitly dealt with the question of quantification, but what would also have to be represented here is that each tree has its own branches, rather than either one tree having all the branches or all trees sharing the same branches. These last possibilities might require pragmatic knowledge of plants to resolve.

At t2,

   (FELL AGT X1 THM TREES)

At t3,

   (SHARPEN AGT X2 THM BRANCHES) ==> (BRANCHES MOD SHARPENED)

At t4,

   (TURN AGT X3 THM BRANCHES PATH OUTWARD)

which satisfies the creation criterion for an abatis. i.e. "defensive barrier" is actually an intended function rather than an integral property of an abatis.

At t5,

   (BAR INST ABATIS THM Y)

thus,

   (DEFEND INST ABATIS THM X GOAL/FROM Y).

Thus we have a complex parsing process and a subsequent temporal ordering resulting in five events being involved in one noun phrase definition taken from the MPD. One advantage of using the MPD can now be demonstrated. Definitions in the Pocket Dictionary are closely related to their counterparts in the two larger Merriam-Webster dictionaries. Thus, if we decide to, we can elaborate upon the "abatis" definition by examining The Seventh Collegiate's definition,

> abatis - a defense formed of felled trees the sharpened ends of whose branches face the enemy

or continue upward to the unabridged Third International's definition,

> abatis - a defensive obstacle usu. formed by felled trees whose butts are secured towards the place defended with the often sharpened branches directed outwards against the enemy but sometimes made of live small trees bent down and often reinforced with barbed wire

This ability to consult a more detailed definition which can clearly be associated with the version in the Pocket Dictionary, and typically will include an example sentence for each sense meaning, permits the resolution of semantic problems that might otherwise prevent the Pocket Dictionary from being usable as a semantic data source.

7.3   Lexical Disambiguation by Computer

Lexical disambiguation may be defined as the process of determining which of a fixed set of sense meanings is assignable to a given lexical item in a given context. A simple example of this task, proposed by Bar-Hillel [1964], would be to be able to determine the correct sense of "pen" in the sentence "the pig is in the pen". If this task were undertaken in the context of the senses offered in the Pocket Dictionary, it would be to determine that "pen" meant "an enclosure for animals" rather than "a writing instrument". Automatic lexical disambiguation would thus be the process of performing such a task by means of a computer.

In addition to the necessary property of being able to tell which sense or senses from a fixed set are assignable to a lexical item in context, it would be desirable for all assignable sense meanings to be ranked in terms of their likelihood of assignment. All of these disambiguation tasks can be greatly facilitated by the use of dictionary definitions and in particular the hierarchical structure of the dictionary.

7.3.1 Automatic Disambiguation via Co-Occurrence of Words in Dictionary Definitions

The indexing and use of co-occurrences is traditionally a technique of information science used to process enormous volumes of text such as the titles of documents in a library collection. Within artificial intelligence such relations have not been extensively explored because AI has primarily dealt with small problems and domains in which the investigators have hand-coded all the knowledge the "intelligent" system will use. When one moves out of this area of hand-made tools one must resort to more automatic techniques such as those of information science. This however does not mean that one must stay confined to the concepts of statistical relatedness -- and here is where I believe AI and information science can combine to form a stronger investigative paradigm. Using the results of a co-occurrence system one can follow paths in a real network, that of dictionary definitions, and then name the arcs traversed to explain the co-occurrence relations with a cognitive AI basis. Thereafter one may implement computational rules and procedures to traverse similarly named arcs to solve analogous problems.

Within dictionary definitions words are not necessarily related because they are spelled the same. The meaning of a word extracted from context requires the addition of a disambiguation sense-number for reliable propagation. Since the only words which are unambiguous in the definitions of the current "processed" definitions are the kernel terms, there are typically several contending senses for each remaining spelling-form in a definition. Using the disambiguated kernel terms as the basis for traversing paths between definitions one can achieve a first order approximation to assuring that the co-occurring words one encounters will be in the same domain and hence reliably represent the same concept. This is perhaps clearer when discussed in the context of two examples.

Consider the definition of "abalone",

> abalone-.0a - a large edible sea mollusk-.0a with an ear-shaped shell

The disambiguated kernel term of this definition (i.e., "mollusk-.0a") and its definition are first looked up and listed as known data.

> mollusk-.0a - any of a large group-1.0a of mostly shelled and aquatic invertebrate animals-1.2a/! including snails, clams, and squids

Next, the possible senses of each of the other content words involved in the definition of "abalone" are also looked up and a search for matching spellings in their definitions is performed.

large-.1a - having more than usual power, capacity or scope
large-.2a - exceeding most other things of like kind in quantity
            or size

edible-.0a - fit or safe to be eaten

sea-.1a - a large body-.4a of salt water-1.1a/!
sea-.2a - OCEAN
sea-.3a - rough water-1.1a
sea-.3b - a heavy wave-2.1a
sea-.4a - something-.0a like or likened to a large body of water

ear-1.1a - the organ-.2a of hearing
ear-1.1b - the outer part-1.1a of this in a vertebrate
ear-1.2a - something-.0a resembling a mammal's ear in shape or
           position
ear-1.3a - sympathetic attention-.2a

shape-2.1a - APPEARANCE
shape-2.2a - surface configuration-.0a
shape-2.2b - FORM
shape-2.3a - bodily contour-.2a apart from the head and face
shape-2.3b - FIGURE
shape-2.4a - PHANTOM
shape-2.5a - CONDITION <he's in pretty good shape>

shell-1.1a - a hard or tough outer covering of an animal (as a
             beetle, turtle or mollusk) or of an egg or a seed
             fruit (as a nut)
shell-1.1b - something-.0a that resembles a shell <a pastry
             shell>
shell-1.2a - a case-2.1a holding an explosive and designed to be
             fired from a cannon
shell-1.2b - a case-2.1a holding the charge of powder and shot
             or bullet for small-arms
shell-1.3a - a light narrow racing boat-.0a propelled by oarsmen

It should be mentioned here that because at this stage I have no information about which of these senses is appropriate in this context I must list all of the senses. The task of determining which of the above senses are (and are not) appropriate constitutes a longer range goal for the dictionary.

In the case of "shell", which has several rather distinctive meanings relating to "biological organisms", "ammunition", and "racing boats", the need for disambiguation becomes acute. Also in this case, the dictionary definition itself provides the clue needed to distinguish "abalone" as having a "shell" of the biological organism type.

This is done by noting that "shell-1.1a" contains the word "mollusk" in its definition. Since "mollusk" is unambiguously "mollusk-.0a", there is circumstantial evidence for a computer co-occurrence program and positive proof for a human for the disambiguation of "shell" to "shell-1.1a." I regard this as more than pure chance, for there are reasons that some sense of "shell" should mention "mollusk" in its definition. The dictionary deals with a concept's defining traits and words co-occurring in definitions are likely to be parts of each other's semantic domains. This contrasts with co-occurrence in ordinary descriptive text, where words may be present for numerous other reasons unrelated to their definitions.

For the second example I will choose a more complex disambiguating context. Consider the definition of "abatis":

> abatis-.0a - a defensive barrier-.0a of felled trees with
>   sharpened branches turned outward.

The work done in building the noun taxonomy has given the disambiguation of "barrier" as the kernel term of the definition, but nothing is known of the senses of "defensive", "felled", "trees", "sharpened", "branches" and "outward". Despite the fact that these words appear unambiguous to the knowledgeable speaker of English, they cannot be so readily dismissed computationally. This reflects the psychological bias that humans bring with them when reading textual material, i.e., they do not see ambiguity because they have drawn upon their immense background of knowledge to eliminate the ambiguity almost as soon as they read the text.

Thus, "defensive" relating to "the answer made by the defendant in a legal action" or, "an argument in support or justification" is not considered by the human reader; nor is "fell" meaning "to sew (a seam) by folding one raw edge under the other" considered. "Tree" in the sense of "a piece of wood adapted to a particular use <a shoe tree>" or, "something in the form of or felt to resemble a tree <a genealogical tree>" is not considered. Nor are any of the numerous alternative senses of "sharp", such as "irritable", "higher than the true pitch", "involving an abrupt or extreme change", "clear, distinct". "Branch" as "a division of a family descended from a particular ancestor" or "a discrete unit or element of a complex system (as of knowledge, people, or business)" is not considered; and "turn" as "to revolve mentally", "to shape by means of a lathe", "to gain by passing in trade <turn a profit>", etc., are not considered; "outward" alone, of the above words in the definition of "abatis", has a single sense meaning, "toward the outside".

Some of the above senses could be eliminated by using standard selectional features of "human", "abstract vs. concrete", etc., and these could be made available with further augmentation of the dictionary; but many other senses cannot be so resolved. What is most interesting, however, is that once again co-occurrence would appear to offer some help

in disambiguation of definitions such as that of "abatis".

If one considers the definitions of "tree", "branch" and "fell" the following interesting phenomenon appears:

tree-1.1a - a woody perennial <u>plant-2.1a</u> usu. with a single main <u>stem</u> and a head of <u>branches</u> and leaves at the top.

branch-1.1a - a natural subdivision\Rv.0a (as a bough or twig) of a <u>plant</u> <u>stem</u>.

fell-2.1a - to cut-1.3a, beat-1.1a, or knock-1.1a down <fell <u>trees</u>>

No other sense of "tree" uses the spelling-forms "plant", "stem" or "branches" in its definition; no other sense of "fell" uses "trees" in its definition; and only one other sense of "branch" uses "plant" and "stem" in its definition, that of,

branch-1.2a - a division-.2a (as of an antler or a river) related to a whole like a plant branch to its stem.

Thus the structure of figure 7-4 exists.
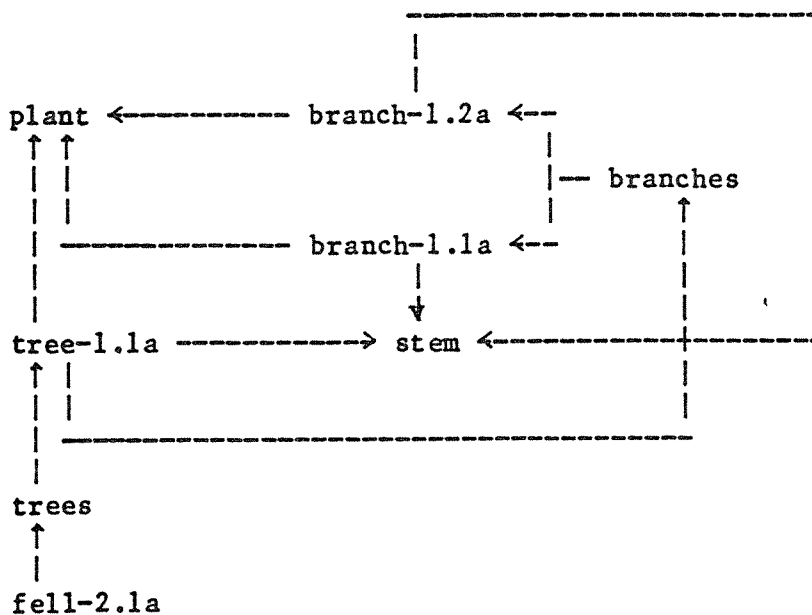
Figure 7-4 Co-Occurrence Relations Disambiguating "abatis"
Definition Words

This implies that "tree-1.1a" has a co-occurrence relationship with both "branch-1.1a" or "branch-1.2a" and that "fell-2.1a" has a co-occurrence relationship with "tree". Thus "fell" in the definition of "abatis" is disambiguated to "fell-2.1a" by the co-occurrence of "trees" in its example usage; "trees" in the definition of "abatis" is disambiguated to "tree-1.1a" by the co-occurrence of "plant" and "stem" in its definition and that of "branches"; and "branch" is disambiguated to either "branch-1.1a" or "branch-1.2a" by the same co-occurrence relationships.

The procedures followed may be enumerated as in figure 7-5.

Technique V

Steps: (1) For each word in the text determine its part of speech.

(2) For each noun, verb, or adjective determine from its dictionary taxonomy the ISA link for each sense.

(3) For each sense, add to the ISA link all content words in the definition of that sense.

(4) Intersect the sets of words formed for each sense in steps 2-3 above with the sets of words formed for the other words in the text.

(5) For all non-null intersections formed create a set containing the disambiguated words in that intersection.

(6) Repeat steps 1-5 for each ISA link found in 2, keeping the intersections found in ranked order of occurrence until either:

    (a) a root node is reached for a sense

or

    (b) all words in the text have been disambiguated taking the additional words accompanying each successively more general ISA link and adding them to that sense's intersection set.

(7) When no further connections can be formed take the ranked set of connections and substitute the disambiguated senses for the undisambiguated words of the text.

Figure 7-5 Co-Occurrence Disambiguation of Words in a Text

7.3.2 Automatic Disambiguation via Natural Language Meta-Rules

The phenomenon of co-occurring spelling-forms clarifying which sense of a word is being used in a definition occurs again and again in the dictionary. It is not, however, an infallible disambiguation technique. It is basically just statistical evidence of a deeper cognitive basis for disambiguation. The number of cases in which definitions without previously disambiguated content words will reliably yield disambiguations solely via co-occurrence relationships may be only a fraction of the existing vocabulary (though totaling several thousand words). But, when considering the magnitude of the task of disambiguating the text of the entire dictionary, co-occurrence disambiguation "guesses" would probably prove very useful in an interactive disambiguation environment, much the way current interactive computer spelling correctors provide a powerful aid to text users seeking a correct spelling of a word from their list of "guesses" and their stored lexicon of forms.

The co-occurrence phenomenon does suggest that a true natural language processing technique could be developed by determining the cognitive basis for each of the co-occurrence disambiguations and then modeling that basis with disambiguation meta-rules, or statements about how to use the arcs of a very large taxonomic semantic network to arrive at disambiguations.

For instance, in the "abalone" example of section 7.3.1 it can be seen that a part/whole relationship exists between "shell-1.1a" and "abalone-.0a" by virtue of the part/whole relationship between "mollusk-.0a" and "shell-1.1a" and the transitivity of the ISA relationship between "abalone-.0a" and "mollusk-.0a". This is illustrated in the figure 7-6.

```
MOLLUSK-.0A  <---/ISPART/--- SHELL-1.1A
     ↑
     |
     | ISA
     |
     |
ABALONE-.0A ---/HASPART/---> SHELL-?
```
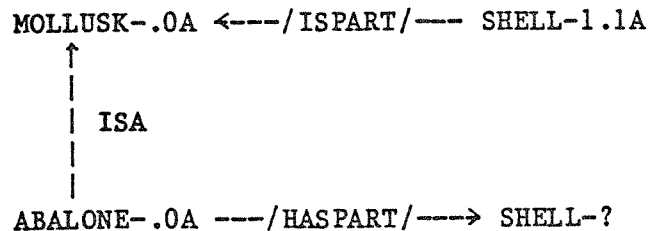
Figure 7-6 Part/Whole Relationship between Abalone-.0a and Shell-1.1a

Using this diagram I can state a simple "meta-rule" for disambiguating "shell?", namely:

If   (Y-# ISPART X-#)
and (Z-#   ISA   X-#)
and (Z-# HASPART Y)
then (Y is disambiguated to Y-#)

Likewise in the "abatis" example, "branch" and "tree" have a part/whole relationship (and interestingly enough in two senses of each, hence the minor ambiguity of "branch" remaining unresolved); "tree-1.1a" and "plant-.0a" have an ISA relationship; "branch-1.1a" and "stem" have a prototypical example relationship; and "fell" and "tree" have a case-argument relationship, with "tree" as the prototypical theme (direct object) of a "felling" event. This may be illustrated as in figure 7-7.


```
PLANT-.0A  <----/ISPART/---- BRANCH-1.1A ---/TYPICAL --> STEM
    ↑                             ↑          E.G./
    |                             |
  /ISA/                           |
    |                             |
    |                             |
TREE-1.1A -----/HASPART/---------
    ↑
    |
/TYPICAL
 THEME/
    |
    |
FELL-2.1A
```
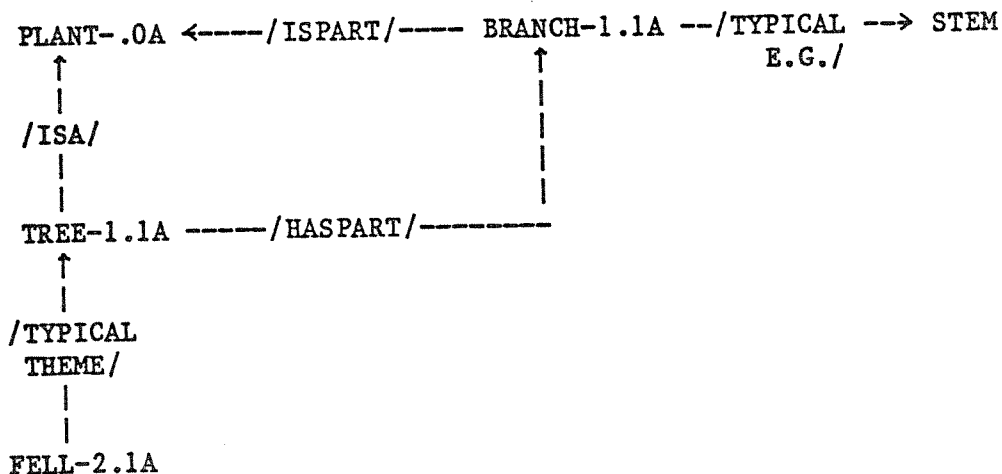
Figure 7-7   Relationships of FELL-2.1A, TREE-1.1A, PLANT-.0A and BRANCH-1.1A derived from definitions related to "abatis".

Thus for "abalone" the relationships of SIZE "large", ATTRIBUTE "edible", HABITAT "sea", and HASPART "shell" could be added when the definition was disambiguated. For "abatis" the relationships of ATTRIBUTE "defensive", HASPART "trees" (with "trees" HASPART "branches") would likewise be added.

The reason for this relationship network is that I expect to be able to write meta-rules for successful disambiguation which will wholly encompass the statistical co-occurrence phenomenon that performs disambiguation. Stated in other terms, this means that I believe every

successful co-occurrence disambiguation has an underlying rule-based statement that will potentially be more powerful and more accurate in performing automatic disambiguation than the observed co-occurrence relationship itself.

Further, the development of a rule-based disambiguation program offers the additional benefit of an explanation to accompany each disambiguation. Thus, the proposed disambiguation procedure would perform a disambiguation-finding and disambiguation-explaining process within the existing structure of the lexicon.

7.3.3 Lexical Disambiguation in Non-Dictionary Text

Although the dictionary constitutes a form of natural language somewhat different from that of other types of prose, its definitions are reasonable targets for extended efforts at disambiguation because they constitute a body of knowledge which itself may help to disambiguate ordinary text. If the text of the dictionary were being disambiguated it would also be useful as a "boot-strap" to the completion of its own disambiguation. This is so because every definition which is completely disambiguated may then be used as the basis of accurate co-occurrence relationships between word senses rather than word spelling-forms. Thus, for example, once the definition of "abalone" were completely disambiguated, there would be a definite link between "sea-.la" and "shell-1.la". Likewise, in the case of "abatis", the disambiguation of its definition would provide positive knowledge that "tree-1.la", "fell-2.la", and "branch-1.la" co-occur, indicating that the reciprocal problem of which sense of "tree" occurs in the definition of "fell-2.la" would not exist when that definition was reached.

Thus, dictionary definitions can assist in the further disambiguation of their own text. It therefore is reasonable to expect that a fully disambiguated dictionary could form the basis for a disambiguation procedure useful on any text. Numerous examples of this could be provided, but the classic one proposed by Bar-Hillel, namely the sense of "pen" in the sentence, "The pig is in the pen", was selected for illustration here because it cannot be disambiguated by any syntactic information present in the sentence.

Disambiguation in this instance can be performed by knowledge of the meanings of the words "pig" and "pen". Such knowledge is contained in the definitions of the words "pig" and "pen" as presented in the dictionary after these definitions are fully disambiguated.

In order to illustrate the computational procedure I intend to develop, it is useful to first describe in words what I believe would have to occur for the definitions in the MPD to produce the desired disambiguation. It is important here to note that I am insisting on solely using the existing text of the dictionary. I cannot add words or

alter the contents of the definitions, because in a real-world situation I would not have known beforehand that the system would be asked to disambiguate these words. Hence if this example works it would have worked without my having intervened to pre-arrange the information such that the program would then have conveniently found it. This is a significant departure from most of natural language processing, and I think a considerable improvement in generality.

The judgement of native listeners that the sentence "the pig is in the pen" is unambiguous (it actually has several ranked interpretations), is based upon the most likely interpretation of "pig" being "a swine", and "pen" as being "a small enclosure for animals". The reason this joint interpretation "makes sense" is that a "pig" is immediately accepted as being an "animal" and the appropriateness of the "pen" is recognizable by its "for animals" defining phrase.

How would this recognition occur computationally? First, the noun taxonomy would be employed to transitively connect "pig" to "swine", "mammal", and then "animal". Let me refer to such an upward taxonomic path as a "trace". Next, the same procedure would be applied to "pen". The traces associated with "pen" involve, for the dictionary, two alternatives, one being a path through "enclosure" to "thing"; the other, through "writing instrument", and "instrument" to "thing". Neither trace for "pen" would yield the necessary connection to "animal" however, as the "animal" portion of the appropriate definition of "pen" is not part of the taxonomy. Thus, a connection between "pen" and "animal" is required. This is provided if I include the words accompanying the kernel of the definition as part of the context acquired while traversing the taxonomy. Thus, because "for animals" is part of the full definition of "pen", the term "animals" (or its easily derived singular, "animal") is included in what I may call the "trace context". The intersection of the words of the definitions in the trace contexts of "pig", "swine", "mammal", "animal"; and "pen", "enclosure(animal)", "thing" thus yields "animal" as a connecting link (figure 7-8).

```
enclosure(animal)
     ↑          ↑
    pen       mammal
                ↑
              swine
                ↑
               pig
```
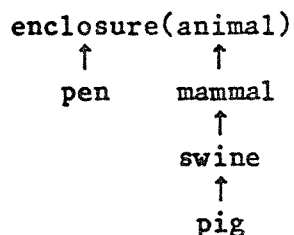
Figure 7-8 Taxonomic Relations between "pen" and "pig"

Now that this simple view of what is being sought in the dictionary has been stated, I will show what complicates the process (and would be required for it to actually be performed by a computer). First, while the "naive listener" above might only have two senses of "pen" the dictionary actually has four:

    pen-1.1A - a small enclosure for animals
    pen-1.2A - a small place of confinement or storage
    pen-3.1A - an instrument with a split point to hold ink used for
               writing
    pen-3.1B - a fluid-using writing instrument

What is more surprising is that "pig" has five senses even in a pocket dictionary, namely:

    pig-.1A - SWINE
    pig-.1B - a young swine
    pig-.2A - PORK
    pig-.3A - one resembling a pig (as in dirtiness or greed)
    pig-.4A - a casting of metal (as iron or lead) run directly from
              a smelting furnace into a mold

The existence of these senses means that far more than the simple ambiguity perceived by naive speakers would be considered, which is not necessarily a handicap in light of the other possible contexts. For example, if I chose "pig-.4A", then I am likely to want "pen-.2A". What is desired is a set of ranked alternatives from which a selection might be made on the basis of other higher-order context variables. If one were discussing the operation of a steel mill, then "iron" would already be highly likely to provide a context for "pig-.4A" being selected.

The most common interpretation of "pen" would be as "pen-1.1A", "a small enclosure for animals", with "pig" being either "pig-.1A" or "pig-.1B". This interpretation is capable of automatic computational selection because of the linkages between "pig-.1A" (or "pig-.1B"), "animal(s)" and "pen-1.1A".

To see how this computation would be performed it is necessary to examine the appropriate data in the noun taxonomy. Extracting from this data a "trace" of taxonomically linked noun kernels for each sense of "pig" one gets the tree-like structures of figure 7-9.

```
[ THING-.5A
    ( CASTING-.1A
        ( PIG-.4A ))
    ( BEING-.3A
        ( PERSON-.1A
            ( PIG-.3A ))
        ( ANIMAL-.2A <== WHOLE/PART ==> (FLESH-.2A/MEAT-.2A
            ( MAMMAL-.0A                    ( PORK-.2A
                ( SWINE-1.0A                   ( PIG-.2A )))
                    ( PIG-.1A
                    ( PIG-.1B
                    ( SWINE-1.0B
                        ( PIG-.1A
                        ( PIG-.1B ]


[ PLACE-1.3A
    ( PEN-1.2A )
    ( ENCLOSURE
        ( PEN 1.1A ]


[ INSTRUMENT-.2A
    ( PEN-3.0A )
    ( PEN-3.0B ]
```

Figure 7-9 All Noun Taxonomies of PIG and PEN

If ISA+ is the transitive ISA relationship, then X ISA+ Z implies that for some set of nodes,

$$\{Y1, Y2, Y3, \ldots Yn-1, Yn\}$$

there is a set of ISA arcs such that,

```
X ISA Y1
Y1 ISA Y2
Y2 ISA Y3
    ...
Yn-1 ISA Yn
Yn ISA Z
```

is true.

I may then define a transitive THEME relationship, THEME+, as implying that if X THEME+ Y, then either,

(X THEME Y)

or

(X THEME W) and (Y ISA+ W).

If "pen-1.1A – a small enclosure for animals" is analyzed into a Verb Normal Form (section 7.2), i.e., the "enclosure" kernel noun is transformed into an instrument argument to an "enclose" (vb.) event, then it may be represented as:

If   (X SIZE SMALL)
and (X INST* (ENCLOSE THEME (ANIMAL NBR PL)))
then (X ISA PEN-1.1A)

If now an inference rule for the verb "enclose" is added introducing the preposition "in", i.e.,

If (ENCLOSE INST Y THEME Z) then (Z IN Y)

Then a rule for determining that "pen" in "the pig is in the pen" is "pen-1.la" may be stated as:

If   (Z ISA+ ANIMAL-.0A)
and (Z IN Y) equivalent to (ENCLOSE INST Y THEME+ Z)
and (Y ISA+ PEN)
then PEN is disambiguated to PEN-1.1A

There are two senses of PIG which will satisfy the value of Z in the above rule, namely "pig-.la – SWINE" and "pig-.lb – a young swine".

This rule for disambiguating "pig" in "the pig is in the pen" is of course very limited in its range of application, requiring constants such as ANIMAL-.0A, ENCLOSE, and PEN in its statement. However, from collections of such rules one might determine more extensive "meta-rules" which would have only variables or variables with feature restrictions in their statements.

CHAPTER VIII   CONCLUSIONS

This dissertation has shown that the machine-readable text of an ordinary dictionary can be computationally analyzed to provide a wide variety of syntactic and semantic information about a language. Specifically:

1) A concordance of dictionary definition texts can be used as data in a componential analysis of the case argument patterns of high-level verbs and nouns.

2) The structure of dictionary definitions provides a basis for constructing taxonomies of both verbs and nouns, but requires semantic disambiguation of the "genus" terms of each definition when alternate senses exist.

3) Taxonomies created by computationally connecting the paired main entries and semantically disambiguated genus terms of definitions form "tangled hierarchies" [Fahlman 1975; 1977] or semi-lattices. These taxonomies are rooted in clusters of circular definitions or semantic relations to other nodes (word-senses) in the taxonomy. They are acyclic except for these primitive root clusters. The existence of these terminating clusters causes the dictionary to be a forest of tangled trees rather than a single tangled tree.

4) Two common types of terminating relations are those defining nodes of the ISA-hierarchy as nodes in the part-whole hierarchy (e.g. leaf IS-PART plant), and those defining nouns as the case arguments of verbs (e.g. vehicle INSTRUMENT-OF carry; worker AGENT-OF work; etc.)

5) Numerous statistics provided by counting the frequencies of definitions by parts-of-speech, numbers of senses, sizes of defined vs. defining vocabulary, frequency of disambiguated genus terms, and the sizes and depths of computationally grown tangled trees provide new information for future research and further semantic hypotheses about the language.

   These reveal, for instance, that basically nouns, verbs and adjectives account for 98% of all definitions, with nouns overwhelmingly superior in in numbers to verbs or adjectives. There are approximately 3 times as many nouns as there are verbs or adjectives.

6) The dictionary, being a closed definitional system, uses circularity in definitions when primitive concepts are being defined. Knowing this one can thus use the circularity of sets of high-level definitions to identify, describe, and study the semantically primitive concepts of the language.

7) Using knowledge of the structure of the dictionary gained through study of concordances and augmented by human identification and disambiguation of definition genus terms, a complete taxonomy of the noun and verb definitions of the Merriam-Webster Pocket Dictionary (27,000 nodes for nouns; 12,000 nodes for verbs) was computationally constructed. This tool provides the capability for numerous further studies of semantic domains and language primitives. Extraction tasks for componential analyses which required months of hand-labor at the beginning of this project can now be performed in hours.

8) Interactions between the ISA-hierarchy and the part/whole hierarchy can be used as the basis for inductive reasoning and analogy discovery (e.g. LEAF:PLANT::FROND:FERN).

9) A large number of defining words, termed "partitives" and "collectives", exist in an ISA-hierarchy (e.g. the terms under GROUP) as well as being used to define words via quantificational relationships to other words.

10) A preliminary phrase-structure grammar for verb definitions shows dictionary defining syntax to be dominated by the conjunctions AND and OR and highly structured to use parallel constructions involving these conjunctions. Such grammars may automatically identify the genus terms of definitions.

11) A deep semantic analysis technique (parsing to verb normal form (VNF)) involving morphologically decomposing nouns and other syntactic forms into their underlying verbs and supplying deleted verbs is proposed. Using this technique it is believed that a greatly enriched knowledge base representing the content of definitions (and text) can be produced from the elliptical form of such text.

12) The controlled use of co-occurrence of words within taxonomically linked definition texts is proposed as a potentially useful technique for the discovery of underlying semantic bases for lexical disambiguation. Capable of automatic computation, the technique provides ranked candidate disambiguations of numerous other words in the dictionary. It is minimally seen as a useful augmentation of human disambiguation decision-making for definitions and believed to be a valuable tool for discovering cognitively-based semantic "meta-rules" which could be computationally stated and applied to perform fully-automatic lexical disambiguation.

RULES FOR PLURAL-TO-SINGULAR SUFFIX-ANALYSIS BASED UPON THE MERRIAM-WEBSTER THIRD INTERNATIONAL DICTIONARY

Rule	Examples and Comments
S E S -2 * I S * .	theses, analyses, crises
S E Z -2 * .	buzzes
S E X -2 * I S * .	axes → ax / axes → axis
S E H C -2 * .	torches
S E H S -2 * .	dashes
S E I -2 Y * .	armies, soliloquies, skies
S E V -3 F * E * .	leaves / knives
S E G -3 X * .	larynges → larynx, spinges → sphinx
S E C I -3 X * .	matrices
S E C I -4 E X * .	indices
S E C U -3 X * .	cruces
S E D -3 S * .	aphides, probosides, ephemerides
S E -2 * .	+es
S I E -3 I S *	necropoleis → necropolis
S -1 * .	+s
N E X -2 * .	oxen
N E M -2 A N * .	men, women, Englishmen
M I -2 * .	cherubim, seraphim
E A -1 * .	formulae
E C I -3 O U S E * .	mice, lice
E S E E -4 O O S E * .	geese → goose
I R -1 * .	monsignori → monsignor
I O -1 S * .	logoi → logos
I -1 U S * .	foci → focus, radii → radius
A R O _ E -3 U R * .	femora → femur
A R O -3 U S * .	corpora → corpus
A R E M -1 O N * .	ephemera → ephemeron
A R E -3 U S * .	genera → genus
A N I -3 E N * .	nomina → nomen, gravamina → gravamem
A N -1 O N * .	phenomena
A T A M -2 * T O N * .	schemata → schema vs. automata → automaton
A I L -1 O N * .	ganglia
A -1 U M * .	emporia → emporium
X -1 * .	beaux → beau, adieux → adieu

Example: KNIVES

Using the rule: S E V -3 F * E * .

We would first match S E and V to the last three letters of KNIVES, starting from the end. Next we would remove (-3) three letters, leaving KNI. Then we would add an F, yielding KNIF and look this word up (unsuccessfully). Then we would add an E, forming KNIFE, looking this word up successfully.

With this same rule,

        LEAVES ==> LEA +F ==> LEAF (lookup successful).

APPENDIX II

DEFINITIONS OF "MOVE" VERBS

AGITATE 1.1 - MOVE WITH AN IRREGULAR RAPID MOTION
APPROACH 1.1 - MOVE NEARER TO
ASCEND 1.1 - MOVE UPWARD ; /MOUNT/ , /CLIMB/
BARGE 2.2 - MOVE OR THRUST ONESELF CLUMSILY OR RUDELY
BLOW 1.1 - MOVE FORCIBLY
BLUNDER 1.1 - TO MOVE CLUMSILY OR UNSTEADILY
BOB 1.1 - MOVE UP AND DOWN JERKILY OR REPEATEDLY
BOLT 1.1 - MOVE SUDDENLY (AS IN FRIGHT OR HURRY) ; /START/ , /DASH/
BULLDOZE 1.1 - TO MOVE , CLEAR , GOUGE OUT , OR LEVEL OFF WITH A
      TRACTOR-DRIVEN MACHINE (BULLDOZER)
BUMP 1.1 - TO MOVE OR ALTER BY BUMPING
BUSTLE 1.1 - TO MOVE OR WORK IN A BRISK FUSSY WAY
CARRY 1.1 - MOVE WHILE SUPPORTING : /TRANSPORT/, /CONVEY/, /TAKE/
CHUG 1 - TO MOVE OR GO WITH CHUGS < A LOCOMOTIVE CHUGGING ALONG >
CIRCLE 2.2 - TO MOVE OR REVOLVE AROUND ; <ALSO> : TO MOVE IN A CIRCLE
CIRCULATE 1.1 - TO MOVE OR CAUSE TO MOVE IN A CIRCLE, CIRCUIT, OR ORBIT
COAST 2.2 - TO MOVE (AS DOWNHILL ON A SLED OR AS ON A BICYCLE WHILE NOT
      PEDALING) WITHOUT EFFORT
CRAWL 1.1 - TO MOVE SLOWLY BY DRAWING THE BODY LONG THE GROUND
DANCE 2 - TO MOVE QUICKLY UP AND DOWN OR ABOUT
DANDLE 1 - TO MOVE UP AND DOWN IN ONE'S ARMS OR ON ONE'S KNEE IN
      AFFECTIONATE PLAY
DASH 7 - TO MOVE WITH SUDDEN SPEED
DELAY 3 - TO MOVE OR ACT SLOWLY
DIVERGE 1 - TO MOVE OR EXTEND IN DIFFERENT DIRECTIONS FROM A COMMON
      POINT
DODGE 1 - TO MOVE SUDDENLY ASIDE
DRAG 2 - TO MOVE WITH PAINFUL SLOWNESS OR DIFFICULTY
DRAW 1.3A - TO MOVE OR GO STEADILY OR GRADUALLY < NIGHT DRAWS NEAR >
DROP 9 - TO MOVE DOWNWARD OR WITH A CURRENT
EDGE 2 - TO MOVE OR FORCE GRADUALLY < EDGE INTO A CROWD >
FALL 1.12 - TO MOVE OR EXTEND IN A DOWNWARD DIRECTION
FALTER 1 - TO MOVE UNSTEADILY : /STUMBLE/ , /TOTTER/
FAN 2 - TO MOVE (AIR) WITH OR AS IF WITH A FAN
FIDDLE 2 - MOVE THE HANDS OR FINGERS RESTLESSLY
FIDGET 2.1 - TO MOVE OR CAUSE TO MOVE OR ACT RESTLESSLY OR NERVOUSLY
FLAP 3 - TO MOVE (AS WINGS) WITH A BEATING MOTION
FLING 1 - TO MOVE HASTILY , BRUSQUELY , OR VIOLENTLY
FLIRT 1 - TO MOVE ERRATICALLY : /FLIT/
FLOAT 2 - TO MOVE GENTLY OR THROUGH A FLUID
FLOUNCE 1 - TO MOVE WITH EXAGGERATED JERKY MOTIONS
FLUCTUATE 1 - TO MOVE UP AND DOWN OR BACK AND FORTH LIKE A WAVE
FLUTTER 2 - TO MOVE WITH QUICK WAVERING OR FLAPPING MOTIONS

FLUTTER 4 - TO MOVE ABOUT OR BEHAVE IN AN AGITATED AIMLESS MANNER
FLY 1 - TO MOVE IN OR PASS THROUGH THE AIR WITH WINGS
FLY 2 - TO MOVE THROUGH THE AIR OR BEFORE THE WIND
FLY 6 - TO MOVE OR PASS SWIFTLY
FORGE 1 - TO MOVE AHEAD STEADILY BUT GRADUALLY
FREEWHEEL 1 - TO MOVE , LIVE , OR DRIFT ALONG FREELY OR IRRESPONSIBLY
FUNNEL 2 - TO MOVE TO A CENTRAL POINT OR INTO A CENTRAL CHANNEL
GLIDE 1 - TO MOVE SMOOTHLY AND EFFORTLESSLY
GO 1.1A - TO MOVE ON A COURSE : /PROCEED/
GRAVITATE 1 - TO MOVE OR TEND TO MOVE UNDER THE INFLUENCE OF GRAVITATION
GRAVITATE 2 - TO MOVE TOWARD SOMETHING
GRIND 6 - TO MOVE WITH DIFFICULTY OR FRICTION
HASTEN 2 - TO MOVE OR ACT QUICKLY : /HURRY/
HIKE 1 - TO MOVE OR RAISE WITH A SUDDEN EFFORT
HITCH 1 - TO MOVE BY JERKS
HOP 1 - TO MOVE BY QUICK SPRINGY LEAPS
HOVER 1 - /FLUTTER/ ; <ALSO> : TO MOVE TO AND FRO
HURL 1 - TO MOVE OR CAUSE TO MOVE VIGOROUSLY
HURRY 3 - TO MOVE OR ACT WITH HASTE
HURTLE 1 - TO MOVE WITH A RUSHING SOUND
INCH 2.1B - TO MOVE SLOWLY < CARS INCHING ALONG THE SLIPPERY ROAD >
JERK 2 - TO MOVE IN SHORT ABRUPT MOTIONS
JIGGLE 1 - TO MOVE WITH QUICK LITTLE JERKS
JOLT 1 - TO MOVE WITH A SUDDEN JERKY MOTION
KEDGE 1 - TO MOVE A SHIP BY HAULING ON A LINE ATTACHED TO A SMALL ANCHOR
        DROPPED AT THE DISTANCE AND IN THE DIRECTION DESIRED
LASH 1 - TO MOVE VIGOROUSLY
LABOR 2 - TO MOVE WITH GREAT EFFORT
LUMBER 1 - TO MOVE HEAVILY OR CLUMSILY
LURK 1 - TO MOVE FURTIVELY : /SNEAK/
MARCH 1 - TO MOVE ALONG IN OR AS IF IN MILITARY FORMATION
MIGRATE 1 - TO MOVE FROM ONE COUNTRY, PLACE, OR LOCALITY TO ANOTHER
MILL 2 - TO MOVE IN A CIRCLE OR IN AN EDDYING MASS
NOD 2 - TO MOVE UP AND DOWN < THE TULIPS NODDED IN THE BREEZE >
NOSE 2 - TO PUSH OR MOVE WITH THE NOSE
NOSE 6 - TO MOVE AHEAD SLOWLY < THE SHIP NOSED INTO HER BERTH >
PADDLE 2.1 - TO MOVE THE HANDS AND FEET ABOUT IN SHALLOW WATER
PADDLE 2.1.1 TO- TO MOVE ON OR THROUGH WATER BY OR AS IF BY USING A
        PADDLE
PASS 1.3 - TO MOVE PAST, BEYOND, OR OVER
PLAY 2.2 - TO MOVE AIMLESSLY ABOUT : /TRIFLE/ < PLAYS WITH A RING
        NERVOUSLY >
PLAY 2.6 - TO MOVE OR OPERATE IN A BRISK, IRREGULAR, OR ALTERNATING
MANNER < A FLASHLIGHT PLAYED OVER THE WALL >
POUND 4 - TO MOVE OR MOVE ALONG HEAVILY
PROGRESS 1 - TO MOVE FORWARD : /PROCEED/
PUTTER 1 - TO MOVE OR ACT AIMLESSLY OR IDLY
RATTLE 2 - TO MOVE WITH A CLATTERING SOUND < RATTLE DOWN THE ROAD >
RECEDE 1 - TO MOVE BACK OR AWAY : /WITHDRAW/
RECIPROCATE 1 - TO MOVE BACKWARD AND FORWARD ALTERNATELY < A
        RECIPROCATING MECHANICAL PART >

REMOVE 1.1 - TO MOVE FROM ONE PLACE TO ANOTHER : /TRANSFER/
REMOVE 1.2 - TO MOVE BY LIFTING OR TAKING OFF OR AWAY
REVOLVE 12 - TO MOVE OR CAUSE TO MOVE IN AN ORBIT ; <ALSO> : /ROTATE/
RIDE 2 - TO FLOAT OR MOVE ON WATER < RIDE AT ANCHOR > ; <ALSO> : TO
    MOVE LIKE A FLOATING OBJECT
RING 2.2 - TO MOVE IN A RING OR SPIRALLY
RISE 7 - TO MOVE UPWARD : /ASCEND/
ROCK 1 - TO MOVE BACK AND FORTH IN OR AS IF IN A CRADLE
ROLL 1 - TO MOVE BY TURNING OVER AND OVER
ROLL 2 - TO MOVE ON WHEELS
ROLL 3 - TO MOVE ONWARD AS IF BY COMPLETING A REVOLUTION < YEARS ROLLED
    BY >
RUN 15 - TO MOVE IN SCHOOLS ESP. TO A SPAWNING GROUND < SHAD ARE
    RUNNING >
RUN 7 - TO MOVE ON OR AS IF ON WHEELS : PASS FREELY
RUSH 1 - TO MOVE FORWARD OR ACT WITH TOO GREAT HASTE OR EAGERNESS OR
    WITHOUT PREPARATION
SCOUR 1 - TO MOVE RAPIDLY THROUGH : /RUSH/
SCREW 3 - TO MOVE OR CAUSE TO MOVE SPIRALLY ; <ALSO>: TO CLOSE OR SET
    IN POSITION BY SUCH AN ACTION
SCUD 1 - TO MOVE SPEEDILY
SHAKE 1 - TO MOVE OR CAUSE TO MOVE JERKILY OR IRREGULARLY : /QUIVER/
    < THE EXPLOSION SHOOK THE HOUSE >
SHUFFLE 3 - TO MOVE WITH A SLIDING OR DRAGGING GAIT
SHUTTLE 1 - TO MOVE BACK AND FORTH RAPIDLY OR FREQUENTLY
SIDLE -1 - TO MOVE SIDEWAYS OR SIDE FOREMOST
SKIP 1 - TO MOVE WITH LEAPS AND BOUNDS
SKULK 1 - TO MOVE FURTIVELY : /SNEAK/ , /LURK/
SLIDE 1 - TO MOVE OR CAUSE TO MOVE SMOOTHLY ALONG A SURFACE
SLINK 1 - TO MOVE STEALTHILY OR FURTIVELY
SMACK 1 - TO MOVE (THE THE LIPS) SO AS TO MAKE A SHARP NOISE
SMASH 2 - TO MOVE FORWARD WITH FORCE AND SHATTERING EFFECT
SNEAK 1 - TO MOVE, ACT , OT TAKE IN A FURTIVE MANNER
SPIN 6 - TO MOVE RAPIDLY ALONG
SPIRAL 1 - TO MOVE IN A SPIRAL COURSE
SPRING 1 - TO MOVE SUDDENLY UPWARD OR FORWARD : /LEAP/ , /BOUND/
SPRING 3 - TO MOVE QUICKLY BY ELASTIC FORCE
SQUELCH 2 - TO MOVE IN SOFT MUD
STEAM 3 - TO MOVE BY OR AS IF BY THE AGENCY OF STEAM
SURGE 2 - TO MOVE IN WAVES
SWASH 1 - TO MOVE ABOUT WITH A SPLASHING SOUND : /SPLASH/
SWEEP 4 - TO MOVE OVER WITH SPEED AND FORCE < THE TIDE SWEPT OVER THE
    SHORE >
SWEEP 6 - TO MOVE OR EXTEND IN A WIDE CURVE
SWERVE 1 - TO MOVE ABRUPTLY ASIDE FROM A STRAIGHT LINE OR COURSE
SWING 1 - TO MOVE RAPIDLY IN AN ARC
SWING 5 - TO MOVE OR TURN ON A HINGE OR PIVOT
TEAR5 5 - TO MOVE OR ACT WITH VIOLENCE, HASTE OR FORCE
TEETER 1 - TO MOVE UNSTEADILY : /WOBBLE/
THRASH 3 - TO MOVE ABOUT VIOLENTLY : TOSS ABOUT
THROW 1.7A - TO MOVE (A LEVER) SO AS TO CONNECT (AS A CLUTCH OR
    SWITCH)

THUD 1 - TO MOVE OR STRIKE SO AS TO MAKE A THUD
TILT 1 - TO MOVE OR SHIFT SO AS TO INCLINE : /TIP/
TOSS 4 - TO MOVE RESTLESSLY OR TURBULENTLY < TOSSES ON THE WAVES >
TRAVEL 2 - TO MOVE AS IF BY TRAVELING (I.E. TRAVEL 1 - TO GO ON A TRIP
      OR TOUR) : /PASS/
TRAVEL 5 - TO MOVE FROM POINT TO POINT < LIGHT WAVES TRAVEL VERY FAST >
TREAD 2 - TO MOVE ON FOOT : /WALK/ ; <ALSO> : /DANCE/
TREMBLE 2 - TO MOVE, SOUND, PASS, OR COME TO PASS AS IF SHAKEN OR
      TREMULOUS
TRIP 1 - TO MOVE WITH QUICK LIGHT STEPS
TROOP 1 - TO MOVE OR GATHER IN CROWDS OR GROUPS
TUG 3 - TO MOVE BY PULLING HARD : /HAUL/
TURN 1.1A - TO MOVE OR CAUSE TO MOVE AROUND AN AXIS OR CENTER :
      /ROTATE/ , /REVOLVE/ < TURN A WHEEL >
TWITCH 1 - TO MOVE OR PULL WITH A SUDDEN MOTION : /JERK/
TWITCH 2 - TO MOVE JERKILY : /QUIVER/
UNSETTLE 1 - TO MOVE OR LOOSEN FROM A SETTLED POSITION : /DISPLACE/,
      /DISTURB/
UP 3.3A - TO MOVE OR CAUSE TO MOVE UPWARD : /ASCEND/
VERGE 3.2 - TO MOVE OR INCLINE IN A PARTICULAR DIRECTION
WADE 2 - TO MOVE OR GO WITH DIFFICULTY OR LABOR AND OFTEN WITH
      DETERMINED VIGOR < WADE THROUGH A DULL BOOK >
WAGGLE 1 - TO MOVE BACKWARD AND FORWARD OR FROM SIDE TO SIDE : /WAG/
WALK 1 - TO MOVE OR CAUSE TO MOVE ALONG ON FOOT USU. AT A NATURAL
      UNHURRIED GAIT < WALK TO TOWN > < WALK A HORSE >
WALTZ 2 - TO MOVE OR ADVANCE EASILY, SUCCESSFULLY, OR CONSPICUOUSLY < HE
      WALTZED THROUGH CUSTOMS >
WANDER 1 - TO MOVE ABOUT AIMLESSLY OR WITHOUT A FIXED COURSE OR GOAL :
      /RAMBLE/
WARP 3 - TO MOVE (A SHIP) BY HAULING ON A LINE ATTACHED TO SOME FIXED
      OBJECT (AS A BUOY, ANCHOR, OR DOCK)
WASH 6 - TO MOVE OR REMOVE BY OR AS IF BY THE ACTION OF WATER
WAVE 4 - TO MOVE BEFORE THE WIND WITH A WAVELIKE MOTION < FIELDS OF
      WAVING GRAIN >
WHIP 10 - TO MOVE NIMBLY OR BRISKLY ; <ALSO> : TO THRASH ABOUT LIKE A
      WHIPLASH
WHIP 1 - TO MOVE, SNATCH, OR JERK QUICKLY OR FORCEFULLY
      < WHIP OUT A GUN >
WHIRL 1 - TO MOVE OR DRIVE IN A CIRCLE OR SIMILAR CURVE ESP. WITH FORCE
      OR SPEED
WHIRL 4 - TO PASS, MOVE, OR GO QUICKLY
WHIR 1 - TO MOVE, FLY, OR REVOLVE WITH A WHIZZING SOUND : /WHIZ/
WHISH 1 - TO MOVE WITH A WHIZZING OR SWISHING SOUND
WHISK 1 - TO MOVE NIMBLY AND QUICKLY
WHISK 2 - TO MOVE OR CONVEY BRISKLY < WHISK OUT A KNIFE >< WHISKED THE
      CHILDREN OFF TO BED >
WIGGLE 1 - TO MOVE TO AND FRO WITH QUICK JERKY OR SHAKING MOVEMENTS :
      /JIGGLE/
WIND 4.2 - TO MOVE OR LIE SO AS TO ENCIRCLE
WOBBLE 1 - TO MOVE OR CAUSE TO MOVE WITH AN IRREGULAR ROCKING OR
      SIDE-TO-SIDE MOTION

WORK 3.19A - TO MOVE SLIGHTLY IN RELATION TO ANOTHER PART
WORM 1 - TO MOVE OR CAUSE TO MOVE OR PROCEED SLOWLY AND DEVIOUSLY
WREATHE 1.2B - TO MOVE OR EXTEND IN CIRCLES OR SPIRALS
WRENCH 1 - TO MOVE WITH A VIOLENT TWIST
WRIGGLE 1C - TO MOVE OR ADVANCE BY TWISTING AND TURNING < A SNAKE
        WRIGGLED ALONG THE PATH >
WRITHE 1 - TO MOVE OR PROCEED WITH TWISTS AND TURNS < WRITHE IN PAIN >
ZIP 1.1 - TO MOVE OR ACT WITH SPEED OR VIGOR
ZOOM 1 - TO MOVE WITH A LOUD HUM OR BUZZ

SAMPLE OF MPD PART-OF-SPEECH CATEGORY CONTENTS

Full List of Main Entry Non -LY Adverbs

aback	evermore	passim
abaft	everywhere	pell-mell
abeam	ex officio	peradventure
abed	extempore	per annum
aboard	extra	per capita
aborning	facedown	percent
about	fain	perchance
above	fair	per contra
aboveboard	far	per diem
abreast	farther	perforce
abroad	farthest	perhaps
a cappella	fast	per se
accelerando	fine	pianissimo
across	first	piecemeal
adagio	flat	piggyback
ad infinitum	fleet	pit-a-pat
ad interim	flush	plumb
ad lib	fore	plump
ad nauseam	forever	poco a poco
adrift	forevermore	presto
afar	forte	pretty
afield	forth	pro
afloat	forthwith	pronto
afoot	forward	pro rata
a fortiori	forwards	pro tempore
afresh	foul	quasi
aft	free	quite
after	fro	rather
afterward	full	rearward
again	full tilt	red-handed
aground	further	right
ahead	furthermore	roughshod
ajar	furthest	running
akimbo	gratis	same
a la carte	headfirst	seaward
alee	headlong	seldom
alfresco	helter-skelter	sharp
alias	hence	short
alike	henceforth	sidelong
all	henceforward	sideways

139

allegro	here	since
all over	hereabout	sine die
all right	hereafter	skyward
all told	hereby	so
almost	herein	soever
aloft	hereof	solo
along	hereon	someday
alongshore	hereto	somehow
alongside	heretofore	sometime
aloud	hereunder	sometimes
already	hereunto	somewhat
also	hereupon	somewhere
altogether	herewith	soon
always	higgledy-piggle	so-so
amain	high	south
amidships	hither	still
amiss	hitherto	straight
amok	homeward	straightway
andante	hors de combat	sub judice
anew	horseback	such
anno domini	how	sure
anon	howbeit	tandem
any	however	tete-a-tete
anyhow	howsoever	that
anymore	ibidem	the
anyplace	ill	then
anyway	in	thence
anywhere	in absentia	thenceforth
anywise	inboard	thenceforward
apace	incognito	there
apart	incommunicado	thereabouts
apeak	indeed	thereafter
apiece	indoors	thereat
aport	in extremis	thereby
apropos	inland	therefor
aright	in medias res	therefore
around	in petto	therefrom
as	inshore	therein
ashore	inside	thereof
aside	in situ	thereon
askance	insomuch	thereto
askew	instanter	thereunto
aslant	instead	thereupon
asleep	inter alia	therewith
astern	in toto	therewithal
astraddle	in vacuo	this
astray	inward	thither
astride	ipso facto	thitherward
asunder	just	though
as well	largo	thrice
as yet	last	through

at all
athwart
avaunt
awash
away
awhile
awhirl
awry
aye
back
backward
bang
bareback
barefoot
bare-handed
bareheaded
before
beforehand
behindhand
belike
below
beneath
beside
besides
best
betimes
better
between
betwixt
beyond
bias
by
cantabile
cap-a-pie
catercorner
clockwise
collect
con
con brio
contrariwise
counter
counterclockwise
crescendo
crisscross
crosswise
darkling
dead
deep
double
doubtless
down

late
least
leastwise
lengthwise
less
lickety-split
lief
likewise
literatim
little
long
loose
malapropos
manyfold
maybe
meantime
meanwhile
midships
midway
nay
near
nearby
needs
ne'er
never
nevermore
nevertheless
new
next
nigh
nix
no
none
nonetheless
north
not
nothing
notwithstanding
now
nowadays
noway
nowhere
nowhere near
nowise
o'clock
o'er
off
offhand
offshore
offstage
oft

throughout
thus
thwart
tight
tiptoe
to
today
together
tomorrow
tonight
too
topsy-turvy
to wit
true
twice
ultra vires
unaware
unawares
under
underfoot
underground
underhand
underneath
undersea
under way
up
uphill
uppermost
upside down
upstage
upstairs
upstream
uptown
upward
upwards of
upwind
verbatim
very
vice versa
videlicet
vis-a-vis
vivace
well
well-nigh
west
what
when
whence
where
whereabouts
whereby

downhill	often	wherefore
downrange	oftentimes	wherein
downright	OK	whereon
downstage	on	whereupon
downstairs	once	wherever
downstream	onshore	wherewith
downwind	onward	whilom
due	opposite	whither
each	otherwise	why
east	out	wide
edgeways	outboard	wild
else	outdoors	withal
elsewhere	out-of-bounds	within
en bloc	outright	without
endways	outside	worse
en masse	outward	worst
enough	over	wrong
en route	overboard	yes
erelong	overhead	yesterday
erst	overland	yet
erstwhile	overnight	yon
even	overseas	yonder
ever	par excellence	zigzag

Full List of Main Entry -LY Adverbs

accordingly	fully	partly
awfully	gaily	primarily
barely	haply	quarterly
busily	happily	really
capitally	hardly	reportedly
civilly	ideally	rightly
confessedly	instantly	scarcely
deadly	inwardly	severally
deservedly	kindly	shortly
diametrically	likely	unduly
doubly	manly	unnecessarily
duly	mostly	untimely
early	namely	verily
exceedingly	naturally	warily
fairly	newly	wholly
famously	only	willy-nilly
firstly	outwardly	wrongly
formerly	overly	yearly

Full List of Main Entry Prepositions

abaft	between	out of
aboard	beyond	outside

about	but	outside of
above	by	over
according to	circa	owing to
across	concerning	pace
afoul of	considering	past
after	despite	pending
against	down	per
ahead of	during	plus
along	ere	pursuant to
alongside	except	regarding
alongside of	exclusive of	regardless of
amid	failing	respecting
among	following	round
anent	for	sans
apropos of	from	save
around	in	since
as	in memoriam	through
as for	in re	throughout
aside from	inside	till
aslant	inside of	times
as of	instead of	to
as regards	into	toward
as to	irrespective of	under
astraddle	less	underneath
astride	like	unlike
as well as	midst	until
at	minus	unto
athwart	near	up
atop	neath	upon
back of	next	versus
bar	nigh	via
because of	notwithstanding	vice
before	of	vis-a-vis
behind	off	wanting
below	on	with
beneath	onto	within
beside	opposite	without
besides	out	worth

Full List of Main Entry Pronouns

all	myself	thine
another	neither	this
any	nobody	thou
anybody	none	thyself
anyone	no one	us
anything	nothing	we
as	one	what
both	oneself	whatever

each	other	whatsoever
either	ours	when
everybody	ourselves	where
everyone	own	which
everything	same	whichever
few	she	whichsoever
he	so	who
her	some	whoever
hers	somebody	whom
herself	someone	whomever
him	something	whomsoever
himself	somewhat	whose
his	such	whoso
I	that	whosoever
idem	thee	ye
it	theirs	you
itself	them	yours
many	themselves	yourself
me	there	
mine	they	

Full List of Main Entry Conjunctions

after	if	until
albeit	inasmuch as	when
although	insofar as	whenever
and	lest	whensoever
and134or	like	where
as	neither	whereas
as if	nor	whereat
as long as	notwithstanding	whereof
as soon as	now	wheresoever
as though	only	whereto
because	or	whereupon
before	save	wherever
both	since	whether
but	so	while
either	supposing	whilst
except	than	whithersoever
for	that	yet
howbeit	though	
however	unless	

Full List of Main Entry Interjections

adios	fore	lo
ahoy	gesundheit	prithee

alleluia	hail	roger
aloha	hallelujah	viva
amen	hollo	why
auf wiedersehen	hosanna	zounds
eureka	hurrah	
fie	huzzah	

Full List of Main Entry Suffixes

-able	-er	-ize
-ade	-ery	-less
-age	-es	-let
-al	-ess	-like
-ally	-est	-ly
-an	-eth	-ment
-ance	-ful	-most
-ancy	-fy	-ness
-ant	-hood	-or
-ar	-ic	-ous
-ard	-ical	-ry
-ary	-ify	-s
-ate	-ing	-ship
-cy	-ish	-some
-dom	-ism	-th
-ed	-ist	-ty
-en	-istic	-ward
-ence	-ite	-ways
-ency	-ity	-y
-ent	-ive	

Full List of Main Entry Prefixes

anti-	over-	sub-
in-	re-	super-
non-	semi-	un-

Partial Listings of Multi-Part-of-Speech Category Contents

Category: "pure" NOUN   Frequency: 12466

aardvark, abacus, abalone, abatement, abatis, abattoir, abbacy,
abbess, abbey, abbe, abbot, abbreviation, abdomen, abecedarian,
....
zucchetto, zwieback, zwinglian, zygote, zymase

Category: "pure" VERB   Frequency: 2779

     abase, abash, abate, abbbreviate, abdicate, abduct, abet, abhor,
     abide, abjure, ablate, abnegate, abolish, abominate, abound,
     ....
     wreathe, wring, write, writhe, yean, yearn

Category: "pure" ADJECTIVE   Frequency: 3805

     abandoned, abhorent, abject, ablative, ablaze, able-bodied, able,
     abloom, abominable, aboriginal, abrupt, absentminded, absorbent,
     ....
     youngish, youthful, yummy, zealous, zippy, zonal

Category: NOUN-VERB   Frequency: 1941

     abandon, abuse, accent, accord, account, addict, address,
     adventure, affiliate, affix, age, aid, aim, air, alarm, alibi,
     ....
     yank, yap, yawn, yell, yield, yoke, zero, zip, zone

Category: NOUN-ADJECTIVE   Frequency: 458

     accidental, accordion, acid, adamant, adept, adhesive, adjuvant,
     adult, aerial, affirmative, agape, alien, ambulatory, ancient,
     ....
     woolen, working, worthy, yea, young, zany

Category: "pure" ADVERB   Frequency: 332

     aback, abeam, abed, aborning, aboveboard, abreast, abroad,
     accelerando, accordingly, adrift, ad infinitum, ad interim, ad lib,
     ....
     whither, wholly, willy-nilly, withal, wrongly

Category: NOUN-VERB-ADJECTIVE   Frequency: 166

     abstract, ace, advance, aggregate, alert, alternate, arch, average,
     base, bay, black, blanket, blank, blind, bluff, bound, brave,
     ....
     wholesale, wildcat, winter, wood, work, yellow

Category: VERB-ADJECTIVE   Frequency: 87

     absent, alight, animate, appropriate, approximate, articulate,
     awake, bandy, bare, blunt, busy, callous, clean, complete,
     ....
     tame, tarry, thin, truncate, utter, warm, weary

Category: "pure" PREPOSITION   Frequency: 51

    according to, afoul of, against, ahead of, alongside of, amid,
among, anent, apropos of, aside from, as for, as of, as regards, as
....
to, toward, unto, upon, versus, via, with

Category: ADJECTIVE-ADVERB   Frequency: 49

    alike, amiss, apropos, away, backward, deadly, doubtless,
downright, early, else, fain, farther, farthest, far, headlong,
....
upward, very, whilom, wide, yearly, yonder, yon

Category: "pure" PRONOUN   Frequency: 45

    anybody, anyone, anything, everybody, everyone, everything,
herself, hers, he, himself, him, idem, itself, I, me, myself, no
....
whosoever, whoso, who, yourself, yourrs, you

Category: NOUN-ADVERB   Frequency: 30

    adagio, alias, allegro, andante, aside, aye, forte, hereafter,
here, horseback, incognito, largo, meantime, meanwhile, midway,
nay, outdoors, peradventure, percent, pro, seaward, solo, tandem,
tete-a-tete, today, tonight, whereabouts, wherefore, yesterday, yes

Category: "pure" CONJUNCTION   Frequency: 28

    albeit, although, and/or, and, as if, as long as, as soon as, as
though, because, if, inasmuch as, insofar as, lest, nor, or,
supposing, than, unless, whenever, whensoever, whereas, whereat,
whereof, wheresoever, whereto, whether, whilst, whithersoever

Category: NOUN-ADJECTIVE-ADVERB   Frequency: 26

    dead, deep, due, east, enough, extra, fair, first, high, ill,
inland, least, little, north, no, overhead, quarterly, short,
south, straight, then underground, upstairs, west, wild, worse

Category: NOUN-ADJECTIVE-VERB-ADVERB   Frequency: 25

    back, best, better, counter, double, fast, fine, flat, flush,
forward, foul, full, last, long, plumb, plump, right, sharp, still,
thwart, true, well, worst, wrong, zigzag

Category: ADVERB-PREPOSITION   Frequency: 23

    abaft, aboard, about, above, across, alongside, along, around,
aslant, astraddle, athwart, below, beneath, besides, beside,
between, beyond, by, throughout, to, underneath, within, without

Category: "pure" INTERJECTION   Frequency: 19

    adios, ahoy, alleluia, aloha, amen, auf wiedersehen, eureka, fie,
gesundheit, hallelujah, hollo, hosanna, hurrah, huzzah, lo,
prithee, roger, viva, zounds

    The remaining parts of speech are all mixed categories with frequency
less than ten. They include the following:

Category: ADJECTIVE-PRONOUN   Frequency: 9

    another, her, his, other, some, whatever, whichever, which, whose

Category: NOUN-VERB-ADVERB   Frequency: 8

    bang, bias, collect, con, crisscross, fleet, nix, tiptoe

Category: ADJECTIVE-ADVERB-PRONOUN   Frequency: 8

    all, any, each, none, same, such, this, what

Category: ADJECTIVE-ADVERB-PREPOSITION   Frequency: 7

    next, nigh, off, on, over, through, under

Category: ADVERB-CONJUNCTION   Frequency: 6

    howbeit, however, though, whereupon, wherever, yet

Category: VERB-ADJECTIVE-ADVERB   Frequency: 5

    even, free, further, loose, pretty

Category: NOUN-PREPOSITION   Frequency: 5

    at, failing, midst, vice, worth

Category: NOUN-ADJECTIVE-ADVERB-PREPOSITION   Frequency: 5

    astride, in, less, opposite, outside

Category: ADJECTIVE-PREPOSITION   Frequency: 4

     behind, pending, unlike, wanting

Category: NOUN-ADJECTIVE-PREPOSITION   Frequency: 4

     following, minus, past, plus

Category: ADVERB-PREPOSITION-CONJUNCTION   Frequency: 3

     before, notwithstanding, since

Category: NOUN-VERB-PREPOSITION   Frequency: 3

     bar, pace, till

Category: ADJECTIVE-PRONOUN-CONJUNCTION   Frequency: 3

     both, either, neither

Category: PREPOSITION-CONJUNCTION   Frequency: 3

     but, for, until

Category: NOUN-VERB-ADJECTIVE-ADVERB-PREPOSITION   Frequency: 3

     down, out, up

Category: NOUN-PRONOUN   Frequency: 3

     it, nobody, somebody

Category: NOUN-ADJECTIVE-PRONOUN   Frequency: 3

     few, many, one

Category: VERB-ADVERB   Frequency: 2

     OK, upstage

Category: NOUN-ADVERB-PREPOSITION   Frequency: 2

     inside, vis-a-vis

Category: NOUN-ADVERB-PRONOUN-CONJUNCTION   Frequency: 2
     when, where

Category: NOUN-PRONOUN-ADVERB   Frequency: 2

     nothing, there

All of the remaining categories have a single occurrence and shall hence be only listed with POS categories and the word.

```
ADJECTIVE-ADVERB-CONJUNCTION...................only
ADJECTIVE-ADVERB-PREPOSITION-CONJUNCTION......after
ADJECTIVE-ADVERB-PRONOUN-CONJUNCTION..........that
ADVERB-DEFINITE+ARTICLE.......................the
ADVERB-PREPOSITION-PRONOUN-CONJUNCTION........as
ADVERB-PRONOUN-CONJUNCTION....................so
ADVERB-PRONOUN................................somewhat
NOUN-ADJECTIVE-ADVERB-INTERJECTION............fore
NOUN-ADVERB-CONJUNCTION.......................while
NOUN-ADVERB-INTERJECTION......................why
NOUN-INDEFINITE+ARTICLE.......................a
NOUN-VERB-ADJECTIVE-PREPOSITION-CONJUNCTION...like
NOUN-VERB-ADJECTIVE-PREPOSITION...............round
NOUN-VERB-CONJUNCTION.........................while
NOUN-VERB-INTERJECTION........................hail
NOUN-VERB-PREPOSITION-CONJUNCTION.............save
NOUN-VERB-PRONOUN.............................mine
PRONOUN-DEFINITE+ARTICLE......................ye
VERB-ADJECTIVE-ADVERB-PREPOSITION.............near
VERB-ADJECTIVE-PRONOUN........................own
VERB-PREPOSITION-CONJUNCTION..................except
```

DISAMBIGUATION PROTOCOL TRANSCRIPT

Transcribed Tape Recorded Protocol of the Disambiguation Procedure

This session was recorded on April 26, 1979, well after the completion
of the actual disambiguation phase. Thus, this present task provides both
data on intuitive criteria as well as a consistency comparison with the
scores assigned to the kernal terms in the actual procedure. The
disambiguator, GAH, was provided a blank coding form consisting of noun
main entries with sense definitions and kernel candidate terms beginning
with the letter M; as well as a copy of the MPD for reference. Presented
here are excerpts of the session, for the kernel candidate term MARK.
Also present at the session was project supervisor RA.

The text is extracted verbatim from the transcribed tape recording
with <,> text added to show what portion of the coding form or dictionary
was being examined. Centered text segments contained within ==='s are
boundaries of extracts. [,]'s contain scores entered during the session,
separated by a semicolon from the original score entered several months
ago. Horizontal spacing is indicative of short pauses, vertical spacing
represents longer pauses. The ... segments do not represent omitted
material, but are used for speech which trailed off into a pause. {,}'s
represent non-text exclamations. Asterisks within <,>'s mark where
material was obscured on the coding form.

=== BEGINNING OF KERNEL CANDIDATE TERM "MARK" ===

<PATHFINDER .OB....... = MARK............ ONE THAT EXPLORES UNTRAVELED
                                          REGIONS TO MARK OUT A NEW
                                          ROUTE>

GAH: pathfinder - the one that explores untraveled regions
to mark out   a new route

verb
[X ; X]

<PERIOD 1.3A.......... = MARK............ A PUNCTUATION MARK $161$1
                                          USED ESP. TO MARK THE END OF
                                          A DECLARATIVE SENTENCE OR A*
                                          *BBREVIATION>

a punctuation mark , period

[Note: $161$1 is a symbol code for a non-ASCII character]

[turning pages in dictionary]

<1 mark <n> 1 : TARGET; also : GOAL, OBJECT 2 :
something (as a line or fixed object) designed to
record position; also : the starting line or
position in a track event 3 : BUTT 4 : the
question under discussion 5 : NORM <not up to the
~> 6 : a visible sign : INDICATION; also :
CHARACTERISTIC 7 : a written or printed symbol
8 : GRADE < a ~ of B+> 9 : IMPORTANCE, DISTINCTION
10 : a lasting impression>

OooK
[Clears throat] Target
something designed to record,   position
the starting line

question, norm, a visible sign, indication or characteristic
a written or printed symbol
here we go, that's probably it
grade, importance, distinction
a lasting impression

OK, it's 1.7A
{tch}
[1.7A ; 1.7A]

<POINT 1.7A........... = MARK............. A PUNCTUATION MARK ; ESP>

point

a punctuation mark ... the same thing
[1.7A ; 1.7A]

<POINT 1.8A........... = MARK............. A DECIMAL MARK>

point   a decimal mark

is a written symbol
[1.7A ; 1.7A]

<POST 1.2A............ = MARK............. A POLE OR STAKE SET UP AS A
                                           MARK OR INDICATOR>

post - a poll or stake set up As a mark
OK, this is set up As a visible sign

that's 1.6   A

slash plus since it is not in the kernel
[1.6A/+ ; X]

<POSTMARK .OB......... = MARK.............. THE MARK CANCELING THE
                                           POSTAGE STAMP>

postmark - the mark   canceling the postage stamp

{tch} well, now this is very interesting

{tch} postmark is a visible sign
it is also a printed sym... no its not a symbol

something designed to record position   no
no
a visible sign
{tch} {sigh} {tch-tch tch-tch}
well, it's not the same kind of visible sign that
a pole or stake is

{?? Oh ??}, but I'd still 1.6A
{tch}, alright
[1.6A (later changed to 1.7A - see ahead) ; 1.7A]

<PRICK 1.1A........... = MARK............. A MARK OR SMALL WOUND MADE BY
                                          A POINTED INSTRUMENT>

prick - a mark or small wound

not a target, not designed to record, not the starting line
not the butt, not a question under discussion or a norm

again this is a visible sign
[1.6A ; 1.6A]

<PRINT 1.1A........... = MARK............. A MARK MADE BY PRESSURE>

print - a mark made,   by pressure
{tch} a visible sign
[1.6A ; 1.6A]

<PROFESSIONALISM .1A.. = MARK............. THE CONDUCT , AIMS , OR
                                          QUALITIES THAT CHARACTERIZE OR
                                          MARK A PROFESSION OR A PROF*
                                          *IONAL PERSON>

professionalism - the conduct, aims or qualities that
characterize or mark,

verb,

[X ; X]

<QUESTION MARK .0A.... = MARK............ A PUNCTUATION MARK $18$1 USED
                                         ESP. AT THE END OF A SENTENCE
                                         TO INDICATE A DIRECT Q* *TION>

a question-mark, a punctuation mark is 1.7 A
[1.7A ; 1.7A]

<SCAR .0A............ = MARK............ A MARK LEFT AFTER INJURED
                                        TISSUE HAS HEALED>

scar - a mark left after injured tissue has healed

Ah HA - a visible sign? Yes
[1.6A ; 1.6A]

<SCRATCH 2.1A......... = MARK............ A MARK MADE AS OR AS IF BY
                                         SCRATCHING ; ALSO>

scratch - a mark made by or as if by scratching

a visible sign
[1.6A ; 1.6A]

<SEAL 3.3A............ = MARK............ A MARK ACCEPTABLE AS HAVING
                                         THE LEGAL EFFECT OF AN
                                         OFFICIAL SEAL>

seal - a mark acceptable as having the legal effect of an
official seal

a mark?

I think that this is a written or printed symbol

yes
[1.7A ; 1.7A]

{tch}
which makes me want to go back and reconsider postmark
  again

and I'm going to change that one
to 7A   as a written symbol

[erases 6 in score for MARK in POSTMARK .0B
  and enters 7 in its place]

<SEMICOLON .0A........ = MARK............. A PUNCTUATION MARK $167$1
                                          USED ESP. IN A COORDESP.
                                          INATESP. ING FUNCTION BETW*
                                          MAJOR SENTENCE ELEMENTS>

{tch} semicolon, a punctuation mark   is 1.7A
[1.7A ; 1.7A]

<STAMP 2.2A........... = MARK............. THE MARK MADE BY STAMPING ;
                                          ALSO>

stamp - the mark made by stamping   1.7A
[1.7A ; 1.7A]

=== END OF SESSION ===

BIBLIOGRAPHY

Abelson, R.P. (1974). Utterance headers: How to almost understand almost anything. Paper presented at the Carbonell Memorial Conference, Pajaro Dunes, Calif., May, 1974.

Abelson, R.P. (1975). "Concepts for representing mundane reality in plans." Pp. 273-309 in [Bobrow & Collins 1973].

Abrahamson, Adele A. (1975). "Experimental Analysis of the Semantics of Movement." Pp. 248-276 in [Norman & Rumelhart 1975].

Alinei, Mario. (1974). La struttura del lessico. Bologna: Il Mulino.

Amsler, Robert A. (1969). Semantic Space: A Computer Technique for Modeling Word Meanings. M.S. Thesis, N.Y.U.

Amsler, Robert A. and John S. White. (1979). Final Report for NSF Project MCS77-01315, Development of a Computational Methodology for Deriving Natural Language Semantic Structures via Analysis of Machine-Readable Dictionaries. Linguistics Research Center, University of Texas at Austin.

Bar-Hillel, J. (1964). Language and Information. Reading: Addison-Wesley.

Bendix, E.H. (1966). Componential Analysis of General Vocabulary: The Semantic Structure of a Set of Verbs in English, Hindi, and Japanese. The Hague, Netherlands: Mouton.

Berlin, Brent, Dennis E. Breedlove, and Peter H. Raven. (1974). "General principles of Tzeltal plant classification and nomenclature." Pp. 25-45 in their Principles of Tzeltal Plant Classification. New York: Academic Press.

Berlin, Brent, Dennis E. Breedlove, and Peter H. Raven "Covert Categories and Folk Taxonomies." in American Anthropologist. Vol. 70, no. 2.

Bobrow, Daniel G. and Allen Collins, (eds.) (1975). Representation

and Understanding: Studies in Cognitive Science. New York:
    Academic Press.

Bolinger, Dwight. (1970). "Getting the words in." American Speech
    45,i/ii: Pp 78-84. Also pp. 8-13 in [McDavid & Duckert 1973].

Browse, Roger. (1978). "Knowledge Identification and Metaphor." Pp.
    48-54 in Proceedings of the Second National Conference of the
    Canadian Society for Computational Studies of Intelligence, July
    19-21, 1978, Toronto, Ontario, Canada.

Calzolari, N. (1977). "An Empirical Approach to Circularity in
    Dictionary Definitions," Pp. 118-128 in Cahiers de Lexicologie,
    Vol 31, no. 2.

Canadian Society for Computational Studies of Intelligence.   (1978).
    Proceedings of the Second National Conference. July 19-21,
    1978, Toronto, Ontario, Canada. Toronto: Univ. Toronto.
    Dept. of Computer Science.

Conklin, Harold C. (1962). "Lexicographic treatment of folk
    taxonomies." Pp. 41-59 in [Tyler 1969].

Deo, Narsingh. (1974). Graph Theory with Applications to Engineering
    and Computer Science. Englewood Cliffs, N.J.: Prentice-Hall.

Diller, Timothy. (1975). User's guide to the SOLAR bibliography
    file. (TM-5292/002/00). Santa Monica, Calif.: System
    Development Corp.

Duda, Richard O., Peter E. Hart, Nils J. Nilsson, Rene Reboh,
    Jonathan Slocum, and George L. Sutherland. (1977).
    Development of a Computer-Based Consultant for Mineral
    Exploration. Menlo Park, Calif.: SRI International.

Educational Resources Information Center (ERIC). (1978). Thesaurus
    of ERIC Descriptors. Seventh Edition. Washington: U.S.
    Government Printing Office.

Evens, Martha, Bonnie Litowitz, Judith Markowitz, Raoul Smith and
    Oswald Werner. (1976). Lexical- Semantic Relations: A
    Comparative Survey. Illinois Inst. of Technology, Dept. of
    Computer Science.

Evens, Martha and Raoul Smith. (1977). A Lexicon for a Computer
    Question-Answering System. (Report no. 77-14). Illinois Inst.
    of Technology, Dept. of Computer Science.

Fahlman, Scott E. (1975). Thesis progress report: A system for
    representing and using real-world knowledge. (AI-Memo 331).
    Cambridge, Mass.: M.I.T. Artificial Intelligence Lab.

Fahlman, Scott E. (1977). A System for Representing and Using Real-World Knowledge. Ph.D. diss., M.I.T.

Fahlman, Scott E. (1978). (Personal Communication, 21 May 1978, 1611 EDT, via ARPANET msg.).

Fillenbaum, Samuel and Amnon Rapoport. (1971). Structures in the Subjective Lexicon. New York: Academic Press.

Findler, N.V. and H. Viil (1974). "A few steps toward computer lexicometry." American Jour. of Computational Linguistics, (Microfiche 4).

G. & C. Merriam Co., eds. (1966). Webster's Third New International Dictionary. Chicago: Encyclopedia Britannica, Inc.

G. & C. Merriam Co., eds. (1967). Webster's Seventh New Collegiate Dictionary. Springfield, Mass.: G. & C. Merriam Co.

G. & C. Merriam Co., eds. (1971). The New Merriam-Webster Pocket Dictionary. New York: Pocket Books.

Gentner, Dedre. (1975). "Evidence for the Psychological Reality of Semantic Components: The Verbs of Possession." Pp. 211-246 in [Norman & Rumelhart 1975].

Gerbner, George; Holsti, Ole R.; Krippendorff, Klaus; Paisley, William J.; and Stone, Philip J. (1969). The Analysis of Communication Content. New York: John Wiley & Sons, Inc.

Gershuny, H.L. (1973). Sexist semantics: An investigation of masculine and feminine nouns and pronouns in dictionary sentences that illustrate word usage as a reflector of sex role. Ph.D. diss., N.Y.U.

Goldman, N.M. (1974). Computer generation of natural language from a deep conceptual base. Ph.D. diss., Stanford Univ.

Granger, R. H. (1977). "FOUL-UP: A Program that Figures Out Meanings of Words from Context." Pp. 172-178 in Proceedings of the 5th International Joint Conference on Artificial Intelligence. August 22-25, 1977. Cambrigde, Mass.:M.I.T.

Haralick, Robert M. and Knut Ripken. (1975). "An Associative-Categorical Model of Word Meaning." Artificial Intelligence. 6: Pp. 75-99.

Hayes, Philip J. (1975). A Process to Implement Some Word-Sense Disambiguation. (TR6). Rochester, N.Y.: Univ. Rochester

Dept. of Computer Science.

Hayes, Philip J. (1977a). On Semantic Nets, Frames and Association. (TR 19). Rochester, N.Y.: Univ. Rochester Dept. of Computer Science.

Hayes, Philip J. (1977b). Some Association-Based Techniques for Lexical Disambiguation by Machine. Ph.D. diss., Univ. Rochester.

Hunn, Eugene S. (1977). Tzeltal Folk Zoology. New York: Academic Press.

Katz, Jerrold J. and Jerry A. Fodor. (1964). "The Structure of a Semantic Theory," Pp. 479-518 in The Structure of Language: Readings in the Philosophy of Language, ed. by Jerry A. Fodor and Jerrold J. Katz. Englewood Cliffs, N.J.: Prentice-Hall.

Kay, Paul. (1969). "Comments on Colby." Pp. 78-90 in [Tyler 1969].

Kay, Paul. (1971). Taxonomy and Semantic Contrast. Language. Vol. 47, no. 4.

Kelly, Edward Francis, and Philip J. Stone. (1975). Computer Recognition of English Word Senses. Amsterdam: North-Holland.

Lee, Charmaine. (1977). Review of La struttura del lessico by Mario Alinei. Pp. 474-477 in Language, Vol. 53, no. 2.

Lehrer, Adrienne. (1975a). Semantic Fields and Lexical Structures. Amsterdam: North-Holland.

Lehrer, Adrienne. (1975b). "Talking about wine." In Language. Vol. 51, no. 4.

Levelt, W. J. M., R. Schreuder, and E. Hoenkamp. (1976). "Structure and Use of Verbs of Motion," Pp. 137-161 in Recent Advances in the Psychology of Language, ed. by Robin Campbell and Philip T. Smith. New York: Plenum Press.

MRI Systems Corp. (1972). System 2000 Reference Manual, Level 2.03. Austin, Texas: MRI Systems Corporation.

Machina, K. (1968). Obtaining a Set of Semantic Functions from Webster's Seventh New Collegiate Dictionary by Analysis of Defining Formulas. SDC Document TM-4095.

Martin, William A. (1978). Descriptions and the Specialization of Concepts. (MIT/LCS/TM-101). Cambridge: M.I.T. Lab. for Computer Science.

McDavid, Raven I., Jr., and Audrey R. Duckert, eds. (1973) Lexicography in English. Vol. 211 of Annals of the New York Academy of Sciences.

Miller, G. (1972). "English verbs of motion: A case study in semantic and lexical memory." In Coding Processes in Human Memory ed. by A.W. Melton and E. Martins. Washington, D.C.: Winston.

Miller, George A. (1975). "Comments on lexical analysis." Pp. 30-33 in [Schank & Nash-Webber 1975].

Minsky, Marvin. (1968). Semantic Information Processing. Cambridge, Mass.: M.I.T. Press.

Minsky, Marvin. (1974). A framework for representing knowledge. (AI-Memo-306). Cambridge, Mass.: M.I.T. Artificial Intelligence Lab. Also pp. 211-77 in The Psychology of Computer Vision, ed. by P.H. Winston. New York: McGraw Hill.

Minsky, Marvin. (1975). "Minsky's Frame System Theory." Pp. 104-116 in [Schank & Nash-Webber 1975].

Moon, David A. (1974). The MACLISP Reference Manual. Cambridge, Mass.: M.I.T., Project MAC.

Munro, Allen. (1975). "Linguistic Theory and the LNR Structural Representation." Pp. 88-113 in [Norman & Rumelhart 1975].

Mylopoulos, John, Harry K.T. Wong, and Philip A. Bernstein. (1978). "Semantic Networks and the Design of Interactive Information Systems." Pp. 74-80 in Proceedings of the Second National Conference of the Canadian Society for Computational Studies of Intelligence. July 19-21, 1978, Toronto, Ontario, Canada.

Nida, Eugene. (1975a). Componential Analysis of Meaning: An Introduction to Semantic Structures. The Hague: Mouton.

Nida, Eugene A. (1975b). Exploring Semantic Structures. Munich: Wilhelm Fink Verlag.

Nilsen, Don L.F. and Alleen Pace Nilsen. (1975). Semantic Theory: A Linguistic Perspective. Rowley, Mass.: Newbury House Publishers, Inc.

Norman, Donald A., and David E. Rumelhart. (1975). Explorations in Cognition. San Francisco: W.H.Freeman.

Olney, John, et al. (1967). Toward the development of computational aids for obtaining a formal semantic description of English.

Paper presented at the International Conference on Computational Linguistics, Grenoble, France, August 23-25, 1967. Also SP-2766. Santa Monica, Calif.: System Development Corp.

Olney, John. (1968). "To: All Interested in the Merriam-Webster Transcripts and Data derived from them." Document L-13579. Santa Monica, Calif: System Development Corporation.

Osgood, Charles E., George J. Suci, and Percy H. Tannenbaum. (1957). The Measurement of Meaning. Urbana: University of Illinois Press.

Pacak, M. G., A. W. Pratt and W. C. White (1976). "Automated Morphosyntactic Analysis of Medical Language." Information Processing & Management. 12: Pp. 71-76.

Padoa, A. (1900). "Essai d´une théorie algébrique des nombres entiers, précédé d´une introduction logique à une théorie déductive quelconque," Bibliothèque du Congrès International de Phil., vol. 3.

Quillian, Ross M. (1968). "Semantic Memory." Pp. 227-270 in Semantic Information Processing, ed. by Marvin Minsky. Cambridge: M.I.T. Press.

Raphael, Bertram. (1968). SIR: A Computer Program for Semantic Information Retrieval. Ph.D. Dissertation, M.I.T. also in [Minsky 1968].

Read, A.W. (1973). "The segmenting of meaning in lexicographical practice." Linguistics 105:106-13.

Revard, Carter C. (1968). "On the Computability of Certain Monsters in Noah´s Ark: Using Computers to Study Webster´s Seventh New Collegiate Dictionary and The New Merriam Webster Pocket Dictionary." SP-3165/001/00. Santa Monica, Calif.: System Development Corporation.

Rhyne, James R. (1975). Lexical rules and structures in a computer model of nominal compounding. Ph.D. diss., University of Texas, Austin.

Rumelhart, David E. and James A. Levin. (1975). "A Language Comprehension System." Pp. 179-208 in [Norman & Rumelhart 1975].

Salton, G. (1968). Automatic Information Organization and Retrieval. New York: McGraw Hill.

Salton, G. and Lesk, M.E. (1971). "Information analysis and

dictionary construction." Pp. 115-142 in The SMART System: Experiments in Automatic Document Processing, ed. by G. Salton. Englewood Cliffs, N.J.: Prentice-Hall.

Schank, Roger C. (1973). The fourteen primitive actions and their inferences. (AIM-183). Stanford, Calif.: Stanford Artificial Intelligence Project.

Schank, Roger C. and Kenneth Mark Colby, (eds.) (1973). Computer Models of Thought and Language. San Francisco: W. H. Freeman and Co.

Schank, Roger C. (1975). Conceptual Information Processing. Amsterdam: North-Holland.

Schank, Roger C., and B.L. Nash-Webber, eds. (1975). Proceedings of the Workshop on Theoretical Issues in Natural Language Processing. June 10-13, 1975, Cambridge, Mass. Arlington: Assoc. for Comp. Ling.

Schank, Roger C. (1975). "The Structure of Episodes in Memory." Pp. 237-272 in [Bobrow and Collins 1975].

Schank, Roger C., and R.P. Abelson. (1976). Knowledge Structures. New Haven, Conn.: Yale Univ. Press.

Schank, Roger and Robert Abelson. (1977). Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Schneider, Peter F. (1978). "Organization of Knowledge for a Procedural Semantic Network Formalism." Pp. 81-89 in Proceedings of the Second National Conference of the Canadian Society for Computational Studies of Intelligence, July 19-21, 1978, Toronto, Ontario, Canada.

Sedelow, Sally Yeates. (1974). Automated Language Analysis 1973-1974. Lawrence: Univ. of Kansas, Depts. of Computer Science and Linguistics.

Sedelow, Sally Yeates. (1976). "Analysis of ´natural´ language discourse." Pp. 1027-34 in AFIPS National Conference Proceedings, Vol. 45.

Sherman, Donald. (1979). A Semantic Index to Verb Definitions in Webster´s Seventh New Collegiate Dictionary. Research Report, Computer Archive of Language Materials, Linguistics Dept., Stanford University.

Shortliffe, E. H. (1976). Computer-Based Medical Consultations: MYCIN. New York: American Elsevier.

Simmons, Robert F. (1973). "Semantic Networks: Their Computation and Use for Understanding English Sentences." Pp. 63-113 in [Schank & Colby 1973].

Simmons, Robert F., and Robert A. Amsler (1975). "Modeling dictionary data." Pp. 1-26 in Directions in Artificial Intelligence, Natural Language Processing, ed. by Ralph Grishman. (Computer Science Report 7). New York: Courant Institute of Mathematical Sciences, C.S. Dept., N.Y.U.

Slocum, Jonathan. (1979). ARPANET Personal Communication regarding INTERLISP 'virtual atom package' in use at SRI International.

Small, Stephen. (1979). "Word Expert Parsing," pp. 9-13 in Proceedings of the 17th Annual Meeting of the Association for Computational Linguistics, August 11-12, 1979. La Jolla, Calif.: University of California at San Diego.

Sparck Jones, Karen. (1967). Dictionary Circles. SDC document TM-3304, January 1, 1967.

Sparck Jones, Karen. (1971). Automatic Keyword Classification for Information Retrieval. London: Butterworths.

Sparck Jones, Karen and Martin Kay. (1973). Linguistics and Information Science. New York: Academic Press.

Tyler, Stephen A., ed. (1969). Cognitive Anthropology. New York: Holt, Rinehart and Winston.

Walpole, Hugh R. (1941). Semantics: The Nature of Words and Their Meanings. New York: W.W. Norton & Co.

West, Michael. (1953). A General Service List of English Words with Semantic Frequencies. London: Longmans, Green and Co., Ltd.

Wilder, Raymond L. (1965). Introduction to the Foundations of Mathematics. New York: John Wiley & Sons, Inc.

Winograd, Terry. (1978). "On Primitives, prototypes, and other semantic anomalies." Pp. 25-32 in [Schank & Nash-Webber 1975].

Woods, William A. (1978). "Taxonomic Lattice Structures for Situation Recognition." Pp. 33-41 in [Schank & Nash-Webber 1975].

Zgusta, Ladislav. (1971). Manual of Lexicography. (Janua linguarum, series maior, 39). The Hague: Mouton; Prague: Academia.