A corpus-based study of metaphor in information technology

Sattar Izwaini
Centre for Computational Linguistics, UMIST, PO Box 88,
Manchester M60 1QD, UK
Sattar.Izwaini@student.umist.ac.uk

Key words: Metaphor, Information Technology, Corpus Linguistics, English.

Abstract

To cater for reference purposes and term creation, the language of information technology (LIT) has made use of items in our surroundings and borrowed them figuratively into its own domain. The present paper is based on a specialised corpus of English IT texts of more than 7 million words, built mainly from online help files of computer systems and software. First, metaphors are outlined for two fundamental elements in IT: *the computer* and *the Internet* by proposing conceptual categories of metaphoric words used in IT. Then, words that are used metaphorically in this field are accounted for by using statistical methods. Metaphoric words are found to be persistent in LIT. Most of the words in those categories are found to be key words in the corpus.[1]

1. Metaphor in information technology

Metaphor is generally known as being used in reflecting and developing scientific ideas (see Gross 1990, Rothbart 1984, Hesse, 1980). According to Richards "Literal language is rare outside the central parts of sciences" (1936). Dirven (1985) demonstrates the role of metaphor in extending the lexicon. The linguistic potential of metaphor has rendered it a very useful tool in providing description and clarification in various scientific domains. In scientific and technical vocabulary, lexical items of general language are figuratively used to form a special language vocabulary. Metaphor plays a significant role in scientific discourse and terminology and in transmitting scientific concepts especially in new fields. It is widely used in Information Technology. The type of metaphor and the tasks assigned to it in science and technology are fundamentally different from its role in literature. The figurative aspect of metaphor is utilized to forward a model to understand scientific facts, theories and concepts. At this point, metaphor in science and technology moves rather into terminology and specialised language.

Metaphor in the world of computers has attracted the attention of researchers in the fields of technical writing and human-computer interaction. The first group discussed how metaphor is used to present this field and what the criteria are to choose metaphor (e.g. Chisholm 1986; Johnson 1991; Beck 1991; Mulder 1996). The second group discussed the use and significance of metaphorical representations in the graphical user interface (e.g. Constantine 2001; Coyne 1995; Microsoft 1993; Apple 1987). Other studies investigated the use of metaphor in different fields of information technology from a cognitive/linguistic perspective (e.g. Grevy 1999; Meyer et al. 1997; Öberg 1989).

Chisholm (1986: 198) calls computer terminology used metaphorically *metaphoric terminology*. He maintains that metaphoric terminology is a special kind of metaphor and a sub-category of *catachersis*, a term used by Max Black and Colin Turbayne after Stanford to give a name to something that lacks a designation by borrowing it from another (ibid: 1986).

Johnson (1991) presents metaphors used in computer science as having paradigms: *Agent Paradigm* (the doer metaphor), *Engine Paradigm*, *Traffic Paradigm*, *Structure Paradigm* (e.g. *architecture*), and *Illusion Paradigm* (e.g. *virtual*). These are categorised on semantic sets of words used metaphorically in this field.

Grevy (1999) studied metaphors in the computer domain in Danish. He found that one sixth of those he collected (3000 metaphors) are *highway* metaphors. He also introduced the term *integrated metaphor* (*integrerede metafor*) to describe the way those metaphors work: 'they are integrated with other metaphors in the same semantic field' (ibid, 173, 199). His main categories are *Guest and Visit*, *PC Driving* which includes *kør* (to run/drive), and *Highway and Travel*.

Meyer et al. (1997) studied metaphors of the Internet from a conceptual and structural point of view. They looked at English books and magazines as well as online and hard copy dictionaries and glossaries. They classify Internet metaphors into two main groups: fully metaphorical and partly metaphorical, where members of the latter have either a metaphorical modifier or a metaphorical base, e.g. *kill file* and *electronic mail* respectively (1997:14). Actually the metaphoric aspect does not lie in

[1] I would like to thank Carlo Grevy for his comments on an earlier version of this paper. However, any shortcomings that remain are my own.

one element of these terms but rather from the combination of both. The constituent elements of these metaphorical expressions are not metaphorical when used on their own. Only when combined together do they give rise to the figurative meaning.

Metaphoric designations facilitate communication among field experts as well as presenting the components of the fields of computer and the Internet to the ordinary user. IT makes use of metaphor by having a mental model for the user through linguistic representations. In addition to vocabulary innovation, e.g. *byte*, and derivation, e.g. *computer* and *server*, metaphor is the most used method of creating new vocabulary in the language of information technology (LIT). Instead of trying to create new coinage, language users tend to make use of what is already available in the language by making figurative use of it. Metaphorical designations are based on the correspondence to items that are found in the real world and have some other nature; most IT entities are of electronic or magnetic nature. This takes us to the basic definition of metaphor: to describe one entity by the qualities of another. The difference in the material and nature of items is the basis on which this metaphor is created.

Metaphor is used in LIT in single words, e.g. *mouse*, *chip, card* (depending on the shape), *file*, *hardware*, *traffic*, *surf*, *page* and *port*, and in compounds, e.g. *search engine*. LIT vocabulary draws its metaphoric character from general language and everyday experience. LIT uses metaphor and assimilates its shaping boundaries in the terminology in that the figurative aspect is no longer felt.

2. Data and methodology

This paper is based on a specialised corpus of English IT texts of more than 7 million words built mainly from online help files of computer systems and software as well as diverse IT material such as manuals, tutorials, software reviews and IT journalistic items. The corpus also includes IT-specialised web sites (see Izwaini 2003).

The methodology is to classify metaphoric vocabulary within categories as well as to account for words of very high frequency that are used metaphorically in this field to create its terminology. The starting point is the conceptual categories of metaphors in LIT. First, conceptual metaphors are outlined for two fundamental elements in IT: *the computer* and *the Internet* (see *3. Conceptual Framework* below). Words that are used metaphorically in this field to create its terminology are accounted for by using statistical methods. I used the Wordsmith tools package (Scott 1997), which produces frequency and key word lists. A key word is a word that has unusual frequency in a text in comparison to a reference corpus. The key word list is generated by comparing the word list of the corpus with the BNC as a reference corpus. The level of keyness and frequency are taken as criteria of the usage of metaphor in LIT. Different word forms or *lemmas* of metaphoric words outlined in the categories are accounted for as well, e.g. *bug*, *debug*, *debugging* etc. including compounds such as *toolbox*, *toolkit*. In calculating lemmas, acronyms and abbreviations are considered one word form of the head noun, e.g. *RAM* and *ROM* of *memory*, and *http* of *protocol*.

Statistics took into consideration the syntagmatic and semantic relations of key words. Lemmas are looked at to see whether they collocate with *computer* and *Internet*. Metaphor is sometimes manifested in having one collocate changed or in having a new collocation that gives rise to figurative usage (Izwaini 2000: 24-25).

3. Conceptual framework

Metaphor is used to express different aspects of life and everyday activities in a systematic way. Lakoff and Johnson (1980) present a conceptual account of the metaphoric system and how is that embodied in language. However, this is not based on comprehensive empirical data and might not lead to conclusive results. Furthermore, linguistic factors play a role in creating metaphor; changing collocations or even violating them produce metaphors (Izwaini 2000: 24-25), e.g. *I've invested a lot of time in her*, where *invest* is a typical collocate of *money* not *time*.

Here, the conceptual framework is based on our classification of words used in IT, which results in categories or themes of metaphors. Taking two main components of information technology, i.e. *the computer* and *the internet*, we can see them metaphorically by grouping LIT vocabulary in categories of a cognitive character. Words that are used metaphorically and now are part and parcel of LIT are organised in semantic sets that result in principal LIT metaphors. The two main categories of *computer* and *internet* are as follows:

The Computer

- THE COMPUTER IS A LIVING BEING: *client*, *conflict*, *dialogue* (conversation between the computer and the user), *generation*, *language*, *memory*, *protocol*, *syntax*, *widow*/*orphan*, and *virus* and *bug* (it can get ill);
- THE COMPUTER IS A WORKSHOP: *download*, *equipment*, *hardware*, *install*, *load*, *template*, and *tools*;
- THE COMPUTER IS AN OFFICE: *attachment*, *desktop*, *directory*, *document*, *file*, *folder*, *mail*, *trash can*, and *wastebasket*;

- THE COMPUTER IS A BUILDING/PLACE: *architecture*, *library*, *sign in*/*log in*, *sign out*/*log out*, *platform*, *port*, *window*, and *workstation*;
- THE COMPUTER IS A SOLDIER: *combat*, *command*, and *instructions*.

The Internet

- THE INTERNET IS IN A STATE OF WAR: *password*, *security*, *war*, and *warfare*;
- THE INTERNET IS A ROAD: *bus*, *highway*, *map*, *path*, and *traffic*;
- THE INTERNET IS A BUILDING/PLACE: *access*, *address*, *firewall*, *gateway*, *sign in*/*log in*, *sign out*/*log out*, *site*, *visit*, and *wallpaper*;
- THE INTERNET IS A BOOK: *bookmark*, *browse, browser*, and *page*;
- THE INTERNET IS A SEA: *navigate*, *pirates*, and *surf*;
- THE INTERNET IS A MARKETPLACE: *ecommerce*, *emarketing*, and *eshopping*.

Although the categorisation is different, some of these metaphors correspond to categories suggested in other studies, e.g. THE INTERNET IS A ROAD corresponds to Grevy's *Highway and Travel* (Grevy 1999), and to Johnson's *Traffic Paradigm (*Johnson 1991).

4. Statistics

Two word lists are produced to reflect the make-up of LIT vocabulary: a key word list and frequency list. The first is more significant in that it includes the words that have an unusual frequency in comparison with general language and thus have an important status. The key word list includes 500 key words. We looked first at the constituents of the metaphor categories, e.g. *language* and *war*, to see what level of keyness they have. The constituents here are looked at as words first and then as lemmas to see what percentage they have. The next step is to look at other constituents that are not present in the key word list. The frequency of those words and their lemmas is calculated to see what percentage they have and to be added in the end to the percentage of the other constituents of the same category.

There are some factors that can affect the results. First, keyness of some IT words, e.g. *virus*, is negatively affected by their non-IT meanings found in the reference corpus. Second, some words are also present in a non-metaphorical sense in the corpus, e.g. *language* and thus they can make the frequency higher. However, their frequency is rather marginal. Third, regional variants cause the word to have a different format, and according to the software calculation the word can lose or get the status of being a key word, e.g. *dialogue* and *dialog* (see 4.1.1 below).

4.1 The Computer

Computer is a key word ranking 129 in the list. Many of the constituents of the suggested categories are key words. *Computer* collocates within a short span and with different degrees of collocation with the lemmas of most of the constituents of all the categories suggested. This will be presented after the statistics of every constituent being presented. On the other hand, other words that are used for the computer such as *PC* and *machine* were also looked at.

4.1.1 THE COMPUTER IS A LIVING BEING

Taking the first theme, we find that the key words are as follows with their order of keyness in brackets: *dialog* (26), *syntax* (64), *client* (365), and *protocol* (500). Another key word, *debug*, is present under *bug* which is suggested to be a constituent. *Debug* is 345 in order of keyness. *Dialog* is a key word because the reference corpus is of British English. It occurs in BNC 66 times only. The percentage of these key words to the total frequency of key words in computer metaphor categories is 15.38%. By including lemmas of non-key words such as *language*, *conflict*, *memory*, *widow*, *orphan*, *virus*, *hibernation*, *freeze*, *life*, *assistant*, and *proxy* the percentage of the total frequency of constituents of this category is 0.51% of the whole corpus.

Words such as *sleep, awake, freeze*, *client*, *protocol, virus*, *communicate*, and *proxy* collocate with *computer* and thus support this theme. For example: *sleep* occurs 82 times, 53% of them have *computer* in the L2 slot, e.g.

… put your computer to sleep and wake it up…

Sleeps occurs three times, in two of them its subject is *computer and PowerBook* (a brand name of a portable computer). *Re-awaken* occurs once with *computer* as its object. *Computer* makes 64% of the collocates of *wake* as its direct object. *Freezes* occurs 22 times, in 50% of them it has *computer* as its subject.

Proxy is an adjective collocate of *server* which is a computer. *Server* is also one of the R1 top collocates of *client*. On the other hand, *protocol* does not collocate with *computer*, but rather with *Internet*. *www* which is an acronym with *web* as the head noun is the first top collocate of *http*

(hypertext transfer protocol) which is the key word no. 156. This is due to the fact that this is the structure of internet addresses via the World Wide Web. One top R1 collocate of *http* is *server* making the metaphor to have a double function. One acronym, *httpd* (hypertext transfer protocol daemon) was found to incorporate *protocol* and *daemon*. The latter is a server.

Virus was found to collocate with *computer* in R1 but with a low frequency. *Communicate* has also low figure collocations with *computer,* but see below:

A device that enables your computer to communicate with another computer…
…speed indicates the speed at which the computer communicates with the modem.

Machine was found to have the following adjective collocates: *host*, *partner* and *single*.

4.1.2 THE COMPUTER IS A WORKSHOP

Not only one word form of the elements of this category are key words, but also other word forms as well: *install* (113), *installed* (194), *installation* (218), and *installing*, (354). Other key words are *toolbar* (46), *wizard* (155), *device* (220), *download* (230)*, template* (269), *toolbars* (296), *utility* (425), and *task* (457). Their percentage to the total frequency of key words in the computer metaphor categories is 23.85%. By including lemmas of non-key words such as *load*, *hardware* and *equipment*, the percentage of the constituents of this category is 0.83% of the whole corpus.

Installed, *devices*, *hardware* and *downloaded* are found to collocate with *computer*, which supports this theme.

4.1.3 THE COMPUTER IS AN OFFICE

The key word *file* occupies the 2nd position in the list. Other key words include *document* (28), *folder* (34), *mail* (68), and *directory* (173). Their percentage of the total frequency of key words in the computer metaphor categories is 43.51%. By including lemmas of non-key words such as *desktop*, *attachment*, *archive*, *wastebasket*, *trash can*, *recycle bin* and *equipment*, the percentage of the constituents of this category is 1.2% of the whole corpus.

Collocates such as *file*, *documents*, *documentation*, and *desktop* support this theme. It is worth mentioning that the desktop metaphor is the most known metaphor which is often referred to because of the iconic metaphor used in the software design.

4.1.4 THE COMPUTER IS A BUILDING/PLACE

Key words include *window* (104) and *login* (148). Their percentage to the total frequency of key words in computer metaphor categories is 7.28%. By including lemmas of non-key words such as *sign in/out*, *firewall*, *workstation*, *platform*, *architecture*, *port*, and *gateway*, the percentage of the constituents of this category is 0.22% of the whole corpus.

Collocations are found to include *window* only. However, it was found that *server*, which is a kind of a computer named after its function, collocates with *log*, *port*, *platform* and *storage*. Both *server* and *pc* collocate with *architecture*. *Computer* collocates with *platform* and its plural form. *Machine* was found to collocate with *architecture*, *local*, *remote*, and *firewall*. *PC* has the collocates *remote*, *client*, *host* in L1 slot. In R1 slot it has *location*.

4.1.5 THE COMPUTER IS A SOLDIER

We have two key words which are both of the same lemma *command* (39) and *commands* (146). Their percentage of the total frequency of key words in computer metaphor categories is 9.97%. By including the lemmas of the non-key word *instruction*, the percentage of the constituents of this category is 0.21% of the whole corpus. As a soldier, *computer* collocates with *instructions*.

4.1.6 Discussion

Level of keyness is the first criterion to be taken for the presence of metaphor. Secondly, the frequency and its percentage of lemmas need to be taken into account as well, whether of key words or non-key words. In Table 1 we can see that the key words of the *Office* category are the highest in keyness with four constituents in the first 100, and the fourth in the first 200. The most comprehensive one is the *Workshop* metaphor. However, it has only one constituent in the first 100. It has three constituents in the first 200 and five in the first 300. *Living Being* metaphor comes third. It has five key words with two in the first 100, two in the first 400 and one is the last in the list. The *Soldier* metaphor has two key words only with one in the first 50 and the second in the first 150. The *Place/Building* metaphor occupies the bottom of the list with two key words in the first part of the first 200.

Out of the total key words of this category, the *Office* metaphor is the highest (43.51%), followed by the *Workshop* metaphor (23.85%). At the same time, the *Office* metaphor has the highest percentage of the whole corpus (1.2%) in comparison to other metaphors in this category. The computer metaphors constitute 3% of the whole corpus.

	Living Being	Workshop		Office	Place/Building	Soldier	Total
Order of KWs	26 64 365 345 500	46 113 155 194 218 220	230 269 296 354 425 457	2 28 34 68 173	104 148	39 146	
Frequency of KWs	20855	32342		58997	9875	13523	135592
Percentage of this category KWs to all *Computer* KWs	15.38	23.85		43.51	7.28	9.97	
KW Lemmas	25471	55039		82045	10698	13812	
Frequency of non-KW Lemmas	12561	5901		4098	5505	1277	
Total of Lemmas	38032	60940		86143	16203	15089	216407
Percentage of these lemmas to the whole Corpus	0.53	0.85		1.2	0.22	0.21	3

Table 1: Statistics of the *computer* metaphors

4.2 The Internet

Internet is a key word (38) ranking much higher than the *computer* (129). *Internet* collocates with most of the category constituents. Another name that is used for *Internet* is *web*. We will also look at this word.

4.2.1 THE INTERNET IS IN A STATE OF WAR

In this category we have two key words: *password* (84) and *security* (327). Their percentage to the total frequency of key words in the Internet metaphor categories is 13.34%. By including lemmas of non-key words such as *war*, *crack* and *bomb*, the percentage of the constituents of this category is 0.47% of the whole corpus. *Internet* collocates with *warfare, security* and *cracking*. *Bombed* occurs three times with *Internet* as its object in one of them. *Web* was found to collocate with *secure*.

4.2.2 THE INTERNET IS A ROAD

We have one key word *path* (346). Its percentage to the total frequency of key words in the Internet metaphor categories is 4.3%. By including lemmas of non-key words such as *road*, *traffic*, *highway*, *bus*, and *map*, the percentage of the constituents of this category is 0.06% of the whole corpus. *Internet* collocates with *traffic, shortcut, speed* and *transport*. *Web* was found to collocate with *traffic*. On the other hand, we have collocations such as *data transport*, *data highway*, and *information superhighway* that imply the metaphor.

4.2.3 THE INTERNET IS A BUILDING/PLACE:

Here we have two key words: *access* (32), *address* (157) and *site* (426). Their percentage to the total frequency of key words in the Internet metaphor categories is 36%. By including lemmas of non-key words such as, *visit*, *go*, *firewall*, *architecture*, *portal*, *gateway*, *home* and *wallpaper*, the percentage of the constituents of this category is 0.49% of the whole corpus.

Collocations are found to support this category. *Internet* collocates with *access*, *address*, *local*, *location* and *site*. A top collocate of *site* is *web*. *Visit* has *web*, *site* and *internet* as well as many *URLs* as object collocates. When checking the collocation pattern of *http*, which is a part of internet addresses, it was found collocating with location words such as *here*, *located at*, *available at,* and *found at*. *URL* has *address* and *destination* as top collocates. Here are some examples of the verb collocates *go* and *visit*:

Click the http://www.3com.com to go to 3Com's World Wide Web site.

Go to any website anywhere…

… the objects you encounter as you visit Internet sites…

Internet collocates with *access* in the L1 slot. All top L1 verb collocates of *access* imply permission: *gain*, *grant*, *delegate*, *restrict*, *allow*, *control*, *prevent*, and *provide Unauthorized* is a top L1 collocate as well.

4.2.4 THE INTERNET IS A BOOK

Key words include *page* (19), *pages* (87), *browser* (100), *browse* (429) and *bookmark* (471). Their percentage to the total frequency of key words in the Internet metaphor categories is 46.3%. By including lemmas of the non-key word *publish*, the percentage of the constituents of this category is 0.43% of the whole corpus.

Page and its plural form have both *web* and *Internet* as collocates in the L1 slot, though the collocation is much more frequent with the first. *Browse* has both *web* and *Internet* as object collocates. Both *web* and *Internet* co-occur with *browser* in the L1 slot. Other collocations that were found to support this category are: *Internet publishing*, *publishing Web pages*, *To publish Web pages* and *Republish web pages*.

4.2.5 THE INTERNET IS A SEA

No constituent of this category was found to be a key word. *Navigator* was found to be a key word, but has been excluded because it is a part of a brand name of the program *Netscape Navigator*. However, the name implies the metaphor. Non-key words are *navigate*, *pirate* and *surf*. These make 0.014% of the whole corpus. *Internet* was found to be an object collocate of *navigate*. One collocation that was found to imply the metaphor is *data stream*.

4.2.6 THE INTERNET IS A MARKETPLACE

For this category no key words was found. Percentage of non-key word lemmas to the whole corpus is 0.01%. *Internet* collocates with *marketing*, *commerce*, *e-commerce* and *e-marketing*.

4.2.7 Discussion

To summarize the statistics of the Internet metaphors, we can see in the table below that the *Book* metaphor is the most prominent one in terms of keyness followed by the *Building/Place* metaphor. In terms of percentage of the corpus, the *Building/Place* metaphor is the highest followed by the *War* metaphor and the *Book* metaphor. The *Marketplace*, *Sea* and *Road* metaphors are marginal although the latter has one key word. The first two has no key words.

	State of War	**Road**	**Building/Place**	**Book**	**Sea**	**Marketplace**	**Total**
Order of KWs	84 327	346	32 157 426	19 87 100 429 471	----	----	
Frequency of KWs	8591	2774	23203	29821	-----	----	64389
Percentage of this category KWs to all *Internet* KWs	13.34	4.3	36	46.3	----	----	
KW Lemmas	32972	3275	26874	30782	-----	----	
Frequency of non-KW Lemmas	1326	1342	8644	731	1009	756	
Total of Lemmas	34298	4617	35518	31513	1009	756	107711
Percentage of these lemmas to the whole Corpus	0.47	0.06	0.49	0.43	0.014	0.01	1.5

Table 2: Statistics of the Internet metaphors

The figures in tables 1 and 2 show that the *computer* metaphors are more common in LIT than *Internet* metaphors. Key words of the *computer* metaphors make 67.8% of the total frequency of key words of both the *computer* and the *Internet* metaphors, whereas those of the *Internet* metaphors are

32.19%. On the other hand, both categories of the *computer* metaphors and the *Internet* metaphors make 4.5% of the whole corpus, of which the *computer* metaphors make 3% and the *Internet* metaphors make only 1.5%. The *Office* metaphor is the highest in the whole corpus.

5. Conclusion

In using corpora in the study of figurative language, key word and frequency lists help in mapping out the use of metaphor, especially in a special variety of language. This has to be based on our conceptual perspective of the language use. Hence an interaction between the two approaches is important to have an overview of how the figurative use is organised. However, the same words can be found in the reference corpus in their literal meaning and thus affect the level of keyness negatively. On the other hand, results from a corpus-based study help in adjusting our conceptual metaphors or adding constituents to the categories, e.g. *sleep* which was not included in the initial stage of research.

Metaphor is highly used in LIT. Having key words of a metaphoric profile is an evidence from a fairly large corpus that metaphor is persistent in IT. At the same time the principal elements of IT, i. e. *computer* and *Internet* have metaphorical collocates. Collocation is an important indicator when key words collocate with words that denote the category or imply the metaphor.

References

Apple 1987 *Human interface guidelines: the Apple desktop interface*. Reading, Massachusetts, Addison–Wesley.

Beck C 1991 Implications of metaphors in defining technical communication. *Technical Writing and Communication* 21(1) 3-15.

Black M 1962 *Models and metaphors*: *studies in language and philosophy*. Ithaca, London, Cornell University Press.

Chisholm R 1986 Selecting metaphoric terminology for the computer industry. *Technical Writing and Communication* 16(3) 195 -220.

Cohen L 1993 The Semantics of metaphor. In Ortony A (ed.) *Metaphor and thought*, 2nd edition, Cambridge, Cambridge University Press. pp 58 -70.

Constantine L 2001 *The peopleware papers*. NJ, Yourdon Press.

Coyne R 1995 *Designing information technology in the postmodern age, from method to metaphor*. Cambridge, Mass. and London, MIT.

Goatly A 1993 Species of metaphor in written and spoken varieties. In Ghadessy M (ed.), *Register analysis: theory and practice*. London and NY, Printer. pp 110 -148.

Goatly A 1997 *The language of metaphors*, London, Routledge.

Grevy C 1999 Informationsmotorvejen og andre metaforer i computerfagsprog. *Hermes* 23: 173 -201.

Gross A 1990 *The rhetoric of science*. Cambridge, Harvard University Press.

Hesse M 1980 *Revolutions and reconstructions in the philosophy of science*. Bloomington, Indiana University Press.

Izwaini S 2000 *Translating collocation: Arabic/English/Swedish*. Unpublished MSc dissertation. University of Manchester Institute of Science and Technology (UMIST).

Izwaini S 2003 Building specialised corpora for translation studies. In *Proceedings of the Workshop on Multilingual Corpora: Linguistic Requirements and Technical Perspectives, 27 March 2003, Corpus Linguistics 2003,* Lancaster. pp 17 -25.

Johnson G 1991 Agents, engines, traffic, objects and illusions; paradigms of computer science. *Technical Writing and Communication* 21(3) 271 -283.

Kittay E, Lehrer A 1981, Semantic fields and the structure of metaphor. *Studies in Language* 5 (1)31 - 63.

Lakoff G 1992 Metaphor and semantics. In Crystal D (ed.), *International encyclopedia of linguistics*. Oxford, OUP.

Lakoff G 1993 The contemporary theory of metaphor. In Ortony A (ed.), *Metaphor and thought*, 2nd edition, Cambridge, Cambridge University Press. pp 202-251.

Lakoff G, Johnson M 1980 *Metaphors we live by*. Chicago, University of Chicago Press.

Levin S 1977 *The semantics of metaphor*. Baltimore and London, John Hopkins University Press.

Martin J 1996, Computational approaches to figurative language. *Metaphor and Symbolic Activity* 11(1): 85-100.

Meyer I, Zaluski V, Mackintosh K 1997 Metaphorical internet terms: a conceptual and structural analysis. *Terminology* 4(1): 1 -33.

Microsoft, 1993 *The GUI guide: international terminology for the windows interface*. Redmond, Washington.

Mulder M 1996 Perception of anthropomorphistic expressions in software manuals. *Technical Writing and Communication* 26(4) 489 -506.
Ricoeur P 1978 *The rule of metaphor: multi-disciplinary studies of the creation of meaning*. London, Routledge and Kegan Paul.
Rothbart D 1984 The semantic of metaphor and the structure of science. *Philosophy of Science* 51: 595 -615.
Scott, M., 1997, *WordSmith tools, version 2*.0, Oxford, Oxford University Press.
Searle J 1993 Metaphor. In Ortony A (ed.), *Metaphor and thought*, 2nd edition, Cambridge, Cambridge University Press. pp 83-111.
Öberg P 1989 Metaphors we compute by. In Odenstedt B, Persson G (eds), *Instead of flowers: papers in honour of Mats Rydén on the occasion of his sixtieth birthday*. Stockholm, Almqvist and Wiksell.