How can we make electronic dictionaries more effective?

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1   Introduction

The rate at which electronic dictionaries have been replacing their printed counterparts is impressive, though not altogether unexpected, at least by some experts (Atkins 1996). As a result of the revolutionary character of the transition, designers of electronic dictionaries find themselves in a void when it comes to user studies specifically addressing this dictionary format. Naturally, it takes time to plan, conduct, analyse and disseminate the results of empirical user studies. In a rapidly growing area such as e-dictionaries, user research may find itself overtaken by events. While it is certainly reassuring for designers of electronic reference works to be able to base design decisions on solid empirical evidence, holding back development until such evidence is available is often thought to be a waste of time. With such direct evidence lacking, lexicographers can instead look for design principles in user studies done on paper dictionaries: many of the material issues in dictionary design are relatively form-independent, and so findings from paper-based studies may still supply useful pointers for the design of e-dictionaries. Further relevant evidence may come from non-lexicographic studies involving human-computer interaction. Expert intuition continues to be an important source of insight, as are new feedback channels from users, including what has been termed simultaneous feedback (De Schryver and Prinsloo 2001; De Schryver and Joffe 2004) as well as the use of log files (De Schryver and Joffe 2004; Bergenholtz and Johnson 2005; De Schryver et al. 2006; Bergenholtz and Johnson 2007; Tarp 2009; Verlinde and Binon 2010).

There is a body of studies comparing the effectiveness (and other usability aspects) of paper and electronic dictionaries—in their various mutations—and the results are summarized in Dziemianko (this volume) as well in some other recent papers (Chen 2010; Dziemianko 2010). Without unnecessarily duplicating the discussion here, let us just observe that the picture that emerges is a somewhat confusing one, with findings from seemingly similar studies often pointing in opposite directions. Likely, this is due as much to the broader spectrum of lexicographic solutions in e-dictionaries than in paper dictionaries, as to the range of variation in the user- and task-related variables. The challenge then is to try to assess which particular e-lexicographic solutions work best (and for whom, and under what circumstances), so that future electronic dictionaries can be made more effective than their paper predecessors, and more effective than the dictionaries available today.

Caution is advised in evaluating the empirical evidence as well as users' subjective assessment of dictionaries of different types. A case in point is a study by Tan (2009), who looked at the effectiveness of sense discrimination and found electronic dictionaries to be as good as, but no better than, paper dictionaries. However, Tan probed more deeply than most previous studies and concluded that successful use of the electronic form was conditional on the users receiving sufficient focused training in using the interface, based on concrete problems they were confronted with. This is an important finding which may hold a partial clue to the disparity in the findings reported in various studies: human users find new solutions confusing before they have learnt to use them efficiently, so their performance may vary widely depending on where exactly on the learning curve they happen to be at a particular time. Tan also assessed the reliability of user declarations with regard to the

efficacy of dictionaries, and found them to be out of sync with the empirical findings. Thus, the conclusion is that self-assessment is not a reliable predictor of the actual effectiveness of electronic dictionaries. This, again, is an important methodological finding, and very few studies have directly addressed such questions. Pending further results, it is probably safe to assume that the lack of reliability of self-assessment methods is not restricted to just electronic dictionaries.

2   What makes e-dictionaries effective?

In functional terms, the conditions for e-dictionaries being effective tools are broadly the same as those for paper dictionaries: dictionaries need to be able to answer the specific reference needs of the user, needs which typically arise in a non-lexicographic situation (cf. e.g. Tarp 2008). Dictionaries should be able to satisfy those needs within an acceptably short time and with the required degree of detail. In addition, the data have to be presented in a form that is maximally comprehensible. From this it follows that the demands on lexicographic data need not vary dramatically depending on the delivery platform of the dictionary. However, the best lexicographic description will not help the user if it fails to be located, and where e-dictionaries can make a clear difference is in the efficiency of access to lexicographic data (Verlinde, this volume), and possibly in the use of multimedia. Therefore, I will here focus on the above two aspects, with the understanding that the notion of dictionary effectiveness extends far beyond the confines of this chapter, encompassing an enormous range of user categories (school children, language learners, content learners, teachers, translators, tourists, scholars, word game aficionados, language purists ...) and uses (reading, writing, text revision, translation, word learning, playing Scrabble ...). In the following section I will address issues of access to lexicographic data in the context of electronic lexicography, tracing the access process along the typical steps involved in a dictionary consultation act. Then, in section 4, I will comment on the role of multimedia in e-dictionaries.

3   Effective access to lexicographic data

Metalexicographers recognize that the process of locating data in a dictionary involves a number of steps, with different skills being involved at each step. Models of the dictionary lookup process have been proposed in several publications (Scholfield 1982; Hartmann 1989; Müllich 1990; Bogaards 1993; Scholfield 1999; Hartmann 2001; Bogaards 2003). All of these models distinguish between the lemmatic or macrostructural stage (getting to the right headword) and sublemmatic or microstructural stage (locating relevant data within the entry). In this section, I shall be taking a closer look at the following issues: getting to the relevant headword when the exact spelling of the (citation) form is not known (section 3.1); locating multi-word expressions (3.2); active assistance in entering search terms (3.3); the possibility of presenting the contents of the entry in an incremental fashion (3.4); navigating polysemous entries (3.5).

3.1 Headword identification

One problematic area of dictionary consultation involves headword identification. A facet of this problem which has received some attention from metalexicographers and linguists (Scholfield 1982; Bogaards 1993; Scholfield 1999) is the need to reduce a word-form encountered in the text to its base (citation) form. This operation may be problem-ridden in the user's non-native language.[1] In a paper dictionary, finding an inflected word form normally entails mentally stripping the inflection to arrive at the citation form, as a printed dictionary will not usually list regularly inflected forms as lemma signs. This may not pose much of a problem when the inflected form is alphabetically adjacent (or very close) to the

citation form, so that even a user unaware of the need to extract the citation form may readily hit upon the right entry. For example, when looking up the English progressive form *involving*, one would typically arrive at the headword **involve** anyway, and in some dictionaries (notably, those targeted at children and language learners) the *–ing* form may even be listed explicitly towards the top of the entry.

A well-designed electronic dictionary should be able to handle the work of reducing an inflected form to the lemma (or a menu of lemmas, if ambiguous). However, the step from the inflected form to the base form is just one step — and a relatively unproblematic one for a poorly inflected language such as English.

A more challenging aspect of lemmatic access is the dominance of the graphemic access route. The tradition-sanctioned orthographic supremacy dictates that spelling representation be the starting point of a consultation act. But this need not be the case. Dictionary users may well wish to look up items whose standard spelling they cannot be certain of. This may happen when they recall words from earlier encounters or when their exposure to lexical items comes from audio (including video) materials. Then again, even if the orthographic form *is* immediately available, users may not carry it over perfectly into the dictionary interface. Being able to access the right base form is thus revealed to be a central area in dictionary use, and one where the effectiveness of electronic dictionaries can probably be improved with solutions that are not necessarily very advanced technologically. For more than a decade now, Sobkowiak (e.g. 1999) has argued for the implementation of phonetic access in dictionaries. In a nutshell, this proposal foresees an access path that is spelling-independent, and instead uses lookup by phonetic symbols. While such access can now be found in isolated dictionaries, it has not been generally adopted. The reasons may lie in pessimism as to its real usefulness to the average user, who would need to be conversant with the particular symbol inventory and correctly distinguish between similar phonemes. This may simply be too much to ask of a casual dictionary user, especially if a second or foreign language is involved. And those few users who do have the requisite level of sophistication can probably get by well with traditional access routes. In this way, the use of phonetic access would be largely restricted to users with above-average reference needs, such as teachers wishing to produce word lists with certain phonetic features. Of course, this does not in itself mean that such an access route should not be offered as an alternative, especially if it can be provided without much additional expense. Of the electronic versions of learners' dictionaries for English, the CD-ROM editions of the *Macmillan English Dictionary* stand out as offering a similar facility under the brand name of SoundSearch (for details see Sobkowiak 2003: 432-435).

Another mode of phonetic access is the direct use of the audio channel, perhaps a more promising option for the average dictionary user with moderate reference skills. Its relative success is largely due to — and contingent upon — advances in speech recognition, and here a particular problem spot lies in dealing with accented speech, as well as tuning in to the idiosyncratic accent of a particular user without being sidetracked by individual variation.

Leaving aside literal phonetic access and recognizing the orthographic supremacy in the literate world, a more modest — and more immediate — goal of electronic dictionaries should be to improve the accuracy of the standard orthographic access route by honing their ability to "guess" the intended spelling by recognizing associations between non-identical but sufficiently close variants (fuzzy matching). In essence, this boils down to dealing effectively with misspelled words, much like the spellchecking function in word processors. However, the latter tend to be optimized for users writing in their native language, while a substantial proportion of dictionary consultation is done by non-native speakers, especially for an international language such as English, and almost invariably in learners' dictionaries. A further challenge comes from the fact that a dictionary interface does not usually have access

to the textual context which a word processor usually does have, and can use as a guide in disambiguation.

A study in progress (Lew and Mitton 2011) examined how well the leading English learners' dictionaries in their online versions deal with actual misspellings by foreign learners of English. Three corpora of misspellings were tested: Polish, Finnish, and Japanese, representing three unrelated mother tongues. For each attested misspelling, the position of the intended target on the list of items suggested by the specific dictionary was noted, if it was present on the list at all. Ideally, the right word should be offered at the top of the list, but it is not realistic to expect perfect performance, given the varied nature of misspellings. Spellchecking dictionary search terms is more challenging than spellchecking a text in a word processor, as there is no textual context (co-text) here to serve as a source of additional clues. As a consequence, detecting real-word errors is impossible: for example, when a user keys in **pale** in the dictionary's search window, there is no way for the system to guess that they might have meant **pail** instead. Further, if the non-word **peil** is entered, there will be no context to help decide whether **pale** or **pail** is more likely and should be given priority on the list of suggestions.

These difficulties aside, a spellchecking system as part of an electronic dictionary should still be able to offer reasonable suggestions whenever possible. In January 2011 I tested the performance of seven popular online dictionary interfaces (see Fig. 6) on a total of 202 misspellings by looking them up in each of the dictionaries. The seven interfaces included five monolingual learners dictionaries. Of the latter, *Longman Dictionary of Contemporary English*[2] (two versions, *LDOCE Free* and *LDOCE Premium*) and *Merriam Webster's Advanced Learners English Dictionary*[3] (*MWALED*) performed best and were able to identify the majority of misspelled target words, about half of them as the top suggestion in the list of alternatives returned ("first suggestion" in Fig. 1). Somewhat unexpectedly, the free version of *LDOCE* outperformed the Premium version. The other three learners' dictionaries, *Cambridge Advanced Learner's Dictionary*[4] (*CALD*), *Macmillan English Dictionary Online*[5] (*MEDO*), and *Oxford Advanced Learners' Dictionary*[6] (*ALD*) did much worse, especially when it came to selecting the most likely suggestion. The *Google English Dictionary*[7] (*GoogleED*), which at the time when data were being collected appeared to be based on the content of the *Oxford New American Dictionary* (McKean 2005), was also included, primarily to see if an interface from the world's celebrated leader in information retrieval would overtake the more traditional dictionary publishers. Quite the opposite turned out to be the case. In terms of the total proportion of target items identified, the *Google Dictionary* performed the worst of the lot. However, at this time the interface only offers one "best" suggestion, which is why there are no "further suggestions" in Fig. 1 for this dictionary. When only the first suggestion is considered, the *Google Dictionary* is still beaten by *LDOCE* (both versions) and *MWALED*.
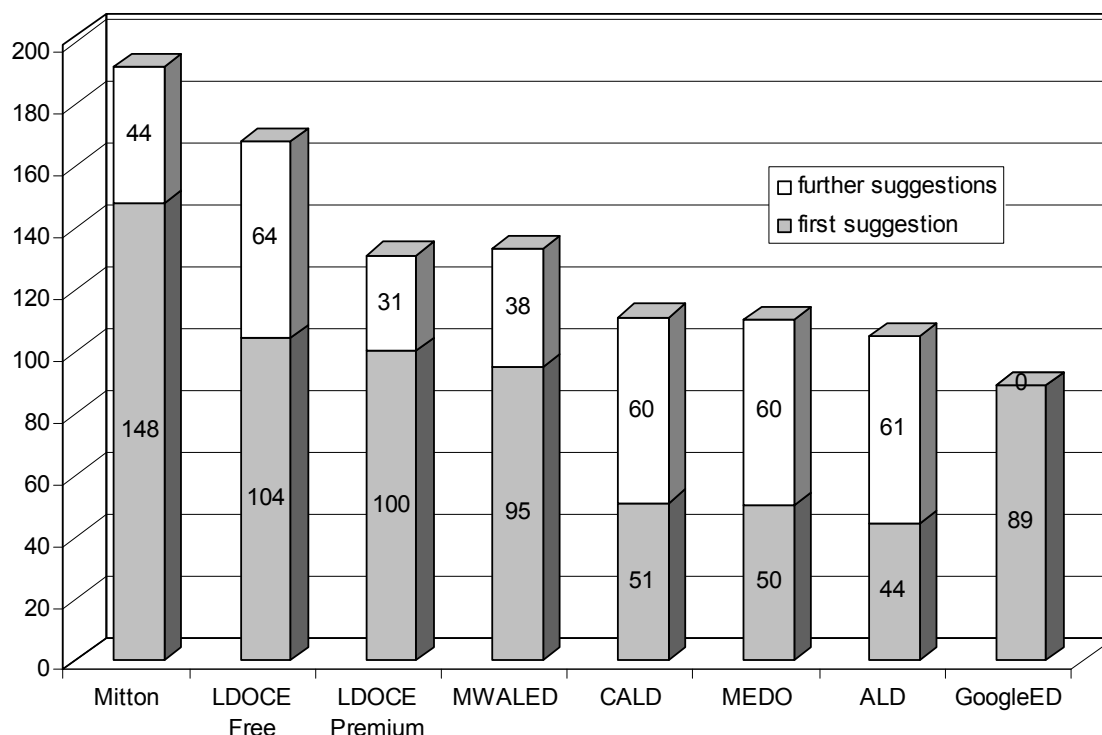
Fig. 1: Success in identifying words misspelled by learners of English in online monolingual dictionaries of English compared with Mitton's context-free spellchecker (Lew and Mitton 2011).

There are a number of misspellings in our corpus which are understandably challenging to spellchecking systems. However, some of the dictionaries appear to be able to do a far better job of identifying headwords spelled in an unorthodox fashion than others, and the dictionaries in need of an upgrade include major and authoritative titles as well as the *Google Dictionary*. Some of the misspellings which intuitively appear to be relatively easy to correct are nevertheless missed, with very unlikely alternatives offered instead, such as *spigot* as the top suggestion for the misspelling *spagetti* rather than the obvious *spaghetti* (MWALED), or *imprecisions* for *imiteision* (an attempt at the word *imitation*; *ALD*). Sometimes the "best" suggestion is not much of an improvement on the misspelling itself, such as when *GoogleED* responds to *aidentiti* (*identity* being the target word) with *identiti*. Even the best-performing dictionaries admit defeat with items that should not be all that difficult to handle: *LDOCE Free* offers *probable* as the first suggestions for *probabli* rather than the target *probably*.

But perhaps this is as good as a context-free spellchecker can get? Are the best dictionaries doing the best job possible? To answer this question, an experimental spellchecking system designed by Roger Mitton (in its context-free version, Mitton 2009) was run on the same set of misspellings. As it turns out, Mitton's spellchecker (first from left in Fig. 1) performed significantly better than any of the online dictionaries. In particular, it managed to offer the target item as the best suggestion in as many as 148 out of 202 cases: that is 50% better than the best-performing dictionaries tested, and up to three times the rate of the less successful ones. This comparison shows rather convincingly that the spellchecking components of even the best of the dictionaries tested leave plenty of room for improvement. In fact, the success rate of Mitton's spellchecker could be improved even further by customizing the rules to reflect the misspelling errors typical of the native language of the dictionary user (Mitton and Okada 2007). This added layer of L1-sensitivity could optionally be used in those cases where

the L1 of the user is known, or can reasonably be inferred from the browser settings and/or IP geolocation.

3.2 Accessing multi-word units

Multi-word expressions have remained a neglected aspect of language when it comes to treatment in dictionaries (Oppentocht and Schutz 2003: 219). This is a natural consequence of the privileged status that the (orthographic) word has traditionally enjoyed in lexicography. Part of the blame for this situation lies with an attachment to the atomic view of language. But even lexicographers sympathetic to the Sinclairian view have to contend with the fact that the orthographic word has a deeply entrenched function as the major indexical component in the organization of dictionary entries. There are many reasons why breaking with this tradition has been difficult. First, the scope and stability (fixedness) of multi-word lexical items often tend to be variable, and this creates problems if they are to be entered as pivotal units (cf. Moon 1998; Philip 2008). Second, in those cases when this is not a problem objectively speaking, dictionary users may not be sure of the exact scope or form of a multi-word unit; they may not even come to realize that their comprehension problem involves a multi-word unit (Scholfield 1999: 15). Third, even if a user does realize that a multi-word unit is involved, they are still likely to follow the orthographic-word-based lookup strategy, either due to the folk linguistic view of words as the building blocks of language, or because this is how their experience with dictionary consultation has conditioned them to operate.

Thus, raising the status of language chunks larger than the word requires, not just innovation in dictionary interfaces, but also an evolution as far as the habits and strategies of dictionary users are concerned.

Advanced dictionary users tend to have a higher level of awareness of the fact that language does not portion out meaning into individual orthographic words, that larger chunks are often important, and that these chunks have a place of their own in the better dictionaries and can be looked up. Dwornik and Margol (2011) focus on the process of online dictionary consultation by advanced Polish learners of English, and report on users getting stuck on the following text fragment "It came on the heels of a U.S. plan ...". Using the free online versions of *Longman Dictionary of Contemporary English* (*LDOCE*) and *Macmillan English Dictionary Online* (*MEDO*), study participants tried a number of seemingly reasonable search terms, which did not, however, result in the successful identification of the phrase. The search strings attempted were the following: "come on the heels", "on the heels of", "on the heels", and finally "come on heels". Unfortunately, all of the above happen to be different from the "canonical" form of this subentry, which in *LDOCE* is *(hard/hot/close) on the heels of something* and in *MEDO follow (hard) on the heels of something* (at the entry FOLLOW) or *(hard/hot/close) on the heels of* under HEEL[8], and so none of those attempts succeeded in locating the expression. This finding suggests that fuzzy matching mechanisms should be employed, so that approximate matches might be recognized as well, in line with the creative variability of natural language. Apparently, this is exactly what is happening. The experimental searches described above were done in early 2010, but at the time of this writing (20 May 2011), *MEDO* already appears to support partial matching, so that the target phrase *follow (hard) on the heels of something* (lemmatized under FOLLOW) can now be accessed directly by typing into the search box a substring "on the heels" or "on the heels of". This is a major improvement on the past versions and on the competition, and in the future this approach could be extended to handle the less mechanical types of phrase variability. However, the new functionality still needs some tweaking, as the alternative phrase form listed under HEEL remains inaccessible in this way. At this time (20 May 2011) *LDOCE* still fails to find the expression in either its free or premium interface. Interestingly, the latest DVD-Rom version sold with the paper copy of

LDOCE5 (Mayor 2009) does succeed in locating the complete phrase on searching for "on the heels". It is quite surprising to see the online interfaces lag behind an optical disk version in this way, as the ability to update quickly and incrementally is seen as a particular strength of online dictionaries (De Schryver 2003).

The above discussion refers to a situation in which the dictionary user encounters a text-reception problem, but realizes that they are dealing with a multi-word expression, and this is what they are actively seeking. However, in real life there must be many cases when users merely realize they are missing something, yet are oblivious of the fact that a sequence of words in the text forms a conventionalized multi-word unit. Or, if they are aware of this, they may still choose to follow the traditional word-based search strategy and only type a single word into the search box. These two scenarios might benefit from a capability of a dictionary to automatically recognize multi-word units by scanning the co-text for potential lexical units spanning several words, and suggesting these to the user (cf. also De Schryver et al. 2006 and Verlinde, this volume). In order to be able to examine such a co-text, the dictionary needs to have access to the text which the user is reading. This is most readily achievable when the text itself is in the electronic format and is accessed on the same device as the dictionary. A typical example would be reading an internet page on a laptop while consulting an online or locally-installed dictionary, or an electronic book being accessed on a dedicated e-book reading device with the help of a resident dictionary pre-loaded on the device. Such contextual sensitivity could also work, however, with printed or handwritten text, provided the device is coupled (or equipped) with a still camera and OCR technology. In this manner, a user would be able to take a snapshot of, say, a door sign in a foreign language and, via OCR, call up a co-text-sensitive dictionary entry on their mobile device.

3.3 Type-ahead search

Relevant to both headword spelling and access to multi-word units is a search interface enhancement variously known as *type-ahead search*, *search-as-you-type*, *incremental search*, *inline search*, or *instant search*. In its typical e-lexicographic application, the search box of a dictionary suggests a list of hits after typing a certain number of characters. For instance, the online version of *Merriam-Webster's Advanced Learner's English Dictionary*, which has had the feature ever since it was launched, offers search suggestions already at the initial letter. A single-letter trigger is generally thought to be too intrusive and distracting, thus normally the mechanism becomes active after anything from two to five initial letters are typed.

Type-ahead search not only speeds up access to (particularly) longer words: it may partially relieve the user of having to reproduce exactly the standard spelling beyond the few initial characters. A more advanced use of the functionality is available in *Macmillan English Dictionary Online* (see Fig. 2). Here, a pull-down list with suggested items opens after typing the second character of the search term, and the important advantage of this particular interface is the inclusion of multi-word units already at this stage. On top of the immediate benefits of allowing the user to access complex lexical units more easily, the feature acts as a background reminder to the regular user that multi-words are valid building blocks of language (as well as search terms), and in doing so provides useful hands-on training in reference skills.
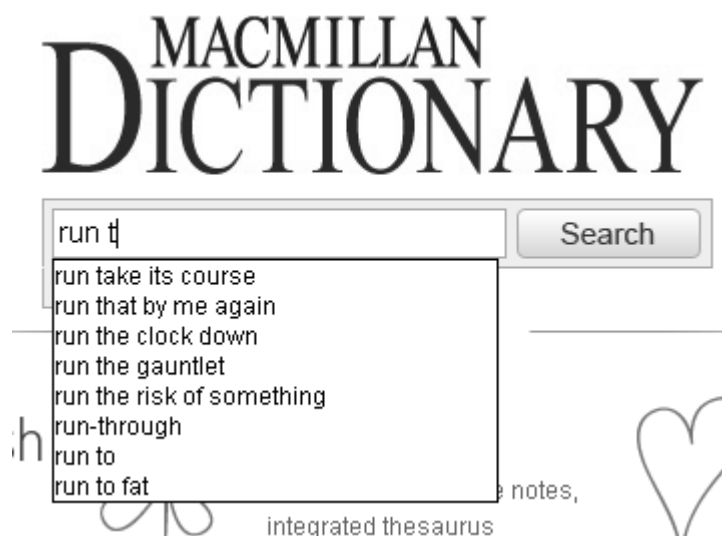
Fig. 2: Type-ahead search in *Macmillan English Dictionary Online*, with a pull-down list of suggested multi-word expressions presented after typing "run t" into the search box

3.4 Step-wise outer access

Since, in electronic dictionaries, what the user sees at any given moment need not reflect the full stored content of the underlying lexical database, the question becomes relevant as to how much of the data should be displayed, and in what progression. Hulstijn and Atkins (1998: 16) propose these three scenarios:

> 1. The whole entry is simultaneously available (as it is in a normal paper dictionary).
>
> 2. The information in the entry is presented in various phases. At each step, users are given two or more options to choose from, and are thus led towards the information they will finally select (whether correct or incorrect), without seeing all the rest of the information which the entry contains.
>
> 3. The computer offers preliminary customization by users of the type of information offered, and users work using their own menus.

These are thought-provoking suggestions and — over a decade later, and with electronic dictionaries having claimed much of the ground of their paper ancestors — it is interesting to reflect on how they stand up in the light of current lexicographic practice. In my recent overview of online dictionaries of English (Lew 2011), I was struck to find the paper-like option 1 to be particularly common, even for dictionaries from well-known publishers.

As far as option 3 goes, we do see some attempts at implementing a degree of customization (cf. also De Schryver 2003; Trap-Jensen 2010), but typically in a half-hearted fashion. For example, users may be allowed to switch phonetic transcription on and off, but are given little control over the more central entry elements. A notable counterexample would be the (subscription-based) online *Oxford English Dictionary*, where the user can select for display any combination of the following lexicographic data categories: Pronunciation, Spellings, Etymology, Quotations, Date Chart, Additions. A problem with this particular implementation of user control is that it only works on the assumption that the users actually know which particular data fields would be helpful to them in a specific situation. While this assumption may perhaps work for the majority of users of a scholarly dictionary such as the *Oxford English Dictionary*, expecting this level of sophistication from non-academic users is unrealistic. An alternative would be to follow the lexicographic-functional approach (Tarp 2008) as implemented by Verlinde et al. (2010), where the user only needs to recognize the

basic type of activity or extra-lexicographic context which prompts consultation, and the best combination of lexicographic data to serve this context has already been pre-selected by the lexicographers. Another interesting implementation inspired by the functional approach is being developed by Granger and Paquot (2010a, b).

In my survey of the solutions used in major English online dictionaries (Lew 2011), I was surprised to find so few implementations of Hulstijn and Atkins' second option: step-wise access. In this connection it is important to observe that in the dynamic environment of an electronic reference work, the notion of an *entry* becomes less sharply-defined than in static paper dictionaries, as the separation of the storage and presentation layers allows for combining, in a coherent textual block, elements which need not be literally contiguous in the underlying data. Similar fuzziness encroaches on classical-structural lexicographic notions such as *microstructure*. A good illustration of this are the step-wise options open to the e-lexicographer in those cases when a search term matches more than a single lemma (e.g. homonymous items, or those characterized by syntactic class conversion, such as **trial** N → **trial** V), or else is part of a multi-word unit such as fixed phrases, idioms, or phrasal verbs. As noted in Lew (2011), the range of solutions adopted in current online dictionaries with regard to the ways in which search results are initially presented, can roughly be clustered into the following three approaches:

1. a menu of target items is displayed in the form of a list of lemmas as well as additional multi-word items including the search item;

2. a menu of target items is displayed as in 1., but the one entry ranked as the most likely candidate is given in full right away;

3. snippets of the target entries are listed, more elaborate than in option 1., but not showing any complete entries yet.

The most common approach appears to be that under 1. above: the user is initially offered a menu of potential target items, usually arranged in a vertical list. The individual items are hyperlinked, and once the user clicks on the item of their choice, the relevant entry (or its pertinent part) is presented. This approach is illustrated in Fig. 3 for the search string "wine" in the free online version of the *Cambridge Advanced Learner's Dictionary* (*CALD*), as displayed on 30 October 2010.

Cambridge Advanced Learner's Dictionary

| wine | Look it up |
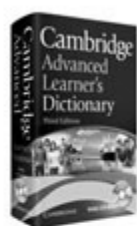
Advanced Learner's ▼

Does your English Dictionary give you the help you need? We publish dictionaries for people learning English all over the world.
Find out more…

Results for wine

wine was found in the Cambridge Advanced Learner's Dictionary at the entries listed below.

- wine *noun*
- wine *verb*
- dessert wine *noun*
- fortified wine *noun*
- ginger wine *noun*
- table wine *noun*
- wine bar *noun*
- wine rack *noun*
- a case of wine, etc.
- milk/oil/wine, etc. lake
- wine and dine sb

Fig. 3: Search results screen for the search string "wine" in *Cambridge Advanced Learner's Dictionary* (30 October 2010)

The second approach can be illustrated using the current (20 May 2011) version of the *Macmillan English Dictionary Online* (refer to Fig. 4 below). Here, too, a list of items rather similar to that in *CALD* is presented in a panel on the right, with the "Related dictionary definitions" heading on top. However, unlike in *CALD* (or, indeed, an earlier version of *MEDO*), a complete entry is presented already at this step, for the item which, according to the ranking algorithm in the dictionary, is the most likely choice (here, **wine** NOUN).

Fig. 4: Search results screen for the search string "wine" in *Macmillan English Dictionary Online* (20 May 2011)

When revising this chapter in May 2011, I revisited all the online entries discussed and found CALD to have changed the default behaviour to option 2, now offering an output quite similar in concept to that of MEDO (Fig. 4).

The third approach, in turn, is implemented in the online version of *COBUILD*, myCOBUILD.com[9], which is made available to buyers of printed copies of the *Collins COBUILD Advanced Dictionary*. This option represents something of a compromise between a bare list of lexical items and complete entries. Fig. 5 gives the myCOBUILD.com search results screen for the same search string "wine". Here, the dictionary interface warns the user that multiple entries have been identified ("We have found more than one result for the word wine."), and then displays a roughly paragraph-length top section from each target entry, each followed by a "**More**" link, which then points to the complete entry.

Fig. 5: Search results screen for the search string "wine" in myCOBUILD.com (available by subscription; 20 May 2011)

It is hard to judge which of the three approaches illustrated is the most effective. In particular, it is risky to offer any such judgment in abstraction from the details of the extra-lexicographic situation and the needs and skill level of the user. Rather than point to one such approach, let us consider some of their benefits and potential pitfalls. An obvious advantage of the full-entry-at-once approach is that it may speed up the lookup process by relieving the user of the need to click through to the full entry, provided that the entry selected by the ranking algorithm is the one relevant to the user's search (as, in our example, **wine** NOUN). On the other hand, in cases when the presented entry happens *not* to be the right one, some users may miss this fact and still seek an answer to their query in the wrong entry. The key element here seems to be then how accurate the ranking algorithm can get in guessing the appropriate target item. The accuracy will no doubt be both item- and language-dependent, but in general we can expect this success rate to improve as artificial intelligence features in dictionaries get more sophisticated. For the moment, withholding the complete entry at stage one, and only presenting a bare list of items will probably reduce somewhat the risk of the user getting stuck in the wrong entry. On the other hand, users may dislike (and ultimately write off as unfriendly) a tool which expects them to do too much clicking, if their patience gets exhausted before they navigate through the initial menu of items to the complete lexicographic treatment.

Given these reservations, it is a little surprising that the third option, which presents a list of snippets in the initial screen, has such a modest proportion of followers (Lew 2011). It would appear that this approach gives a better indication of the choices available than a plain list (as in approach 1.), and, as a consequence, provides the user with a better basis on which to make an informed selection from the initial screen. On the down side, there is more text to process

initially, and the user will still often need to take further action by clicking on one of the choices, as entry snippets may not provide sufficiently complete information. This again begs the question of whether the user will be in a position to appreciate the need to go to the full entry, which sends us back full circle to the reference skills of the user. Still, another factor that speaks in favour of the snippet-type presentation is that it is reassuringly similar to the typical output produced by internet search engines, including Google. And, since searching the internet is now one of the most fundamental skills of an educated human, the analogy should work for a large proportion of dictionary users, giving them the confidence of a familiar interface (see also De Schryver et al. 2006).

3.5 Effective sublemmatic access: entry navigation

We have known since at least Tono's (1984) study that dictionary users experience great difficulty in locating relevant senses in polysemous entries (see also Nesi 1987; Bogaards 1998; Nesi and Haill 2002; Lew 2004). All too frequently, users do not have the perseverance to examine the complete entry and will instead stop at the first sense listed, unless there is a very obvious clue that this sense is not the one they need. To help alleviate the problem, some dictionary publishers have experimented with devices designed to assist users in entry-internal navigation, mostly by placing brief cues pointing to specific senses, either at the top of the entry (as *entry menus*), or distributed across the individual senses (*signposts*, *guide words*, *shortcuts* or *mini-definitions*). The effectiveness of entry navigation devices has been the topic of a number of studies (Tono 1992, 1997; Bogaards 1998; Tono 2001; Lew and Pajkowska 2007; Lew 2010; Lew and Tokarek 2010; Nesi and Tan 2011; Tono 2011). The majority of these studies focused on paper dictionary entries, and their cumulative findings suggest that both menus and signposts help dictionary users get to the relevant senses faster, improve the accuracy with which these senses are identified, and provide assistance in completing the original task (which prompted dictionary consultation) with better success. In addition, two of the studies (Lew 2010; Nesi and Tan 2011) compared different types of navigation devices, and both concurred that signpost-type cues (distributed between the respective senses) were more effective than menu-type devices (with all cues collected in a block above the entry proper). In Lew (Lew 2010) I speculate that the reasons for this may be of a dual nature. The first possible factor has to do with semantic processing, and more specifically with the ability to assess the relevance of the different senses: there may be synergistic effects between the telegraphic signposting of the guiding cues and the fuller lexicographic treatment given at the sense, and these effects have a chance to exhibit themselves when the two types of data are physically contiguous and can thus be taken in at the same time. The second factor proposed is more mechanical and has to do with how accurately the user can navigate from the guiding cue to the target sense. If the cue is part of a menu at the top of the entry, then the search path from the cue to the sense is more complex (the sense may even be on a different page) and, as a consequence, more prone to error. Perhaps a combination of menus and signposts might be advantageous but this has never been investigated: printed dictionaries have never adopted this format, likely because its redundancy seems to make excessive demands on space.

While the above findings based on paper dictionaries should in broad outline also hold for electronic dictionaries, some differences are to be expected. First, users of dictionaries in the context of computers (including handheld devices) work in a familiar environment which is already heavily menu-driven. The salience of the menu as a concept in the IT context could make menu-based navigation a more natural option, unlike in paper dictionaries. Second, the dynamic nature of electronic display allows one, with imaginative design, to anticipate and correct some of the problems that entry navigation exhibits in printed dictionaries.

Working along these lines, Lew and Tokarek (2010) proposed a new experimental entry menu system for online dictionaries. The starting point was a standard concept of a hyperlinked menu navigation system, wherein clicking on an item (here representing a specific dictionary sense) in the entry menu (i.e. a list of senses) would take the user to the target entry and scroll it automatically to the target sense. In addition, however, the system would highlight the target sense against a different background than the remaining senses. Such an experimental system was tested against two more conventional solutions: the menu alone and a bare entry with no access-facilitating devices. It was found that the addition of target sense highlighting resulted in a significant reduction of access time to the target sense, compared to the other two experimental conditions. In addition, error rates in the accompanying task (translation) were nearly halved in the version with target sense highlighting compared with either of the other versions, an effect which was marginally significant.

Fig. 6: Partial *MEDO* entry for SHOW with sense 7 highlighted.

The study by Lew and Tokarek (2010) thus illustrates how a relatively simple device which takes advantage of the affordances of the electronic medium can enhance the efficiency of entry navigation. Interestingly, in this study the menu alone was not significantly faster or more accurate than the bare entry. However, this has been the only study of sense-guiding devices using *bilingual* entries, as all the remaining studies have used monolingual entries. We might expect that the presence of the user's native language in the dictionary facilitates navigation, as scanning and skimming are naturally quicker and more successful in one's L1. This would translate into a lower functional load on extra guiding devices, which might explain the lack of benefits of a standard entry menu without target sense highlighting. That

the positive effect of highlighting was noted in bilingual entries suggests that it might offer even greater benefits in monolingual entries. At this time (20 May 2011), two popular English monolingual learners' dictionaries use target sense highlighting in their online versions: *MEDO* (see Fig. 6) and *LDOCE*.

4   Multimedia in dictionaries

The possibility of including multimedia in lexicographic data may seem to offer an attractive path towards enhancing the efficiency of modern dictionaries. And indeed, a pioneering study by Chun and Plass (1996) did find significant positive effects of picture annotation on vocabulary acquisition. However, video annotation did not result in a similar improvement. Chun and Plass attribute this to the transience of video material, which — unlike static pictures — may not have the stability to allow the viewer to develop a robust mental model (see also Kozma 1991).

A similar problem may affect animated graphics, as suggested by Lew and Doroszewska's (2009) findings. In their study involving an experimental online dictionary, those dictionary users who viewed animations for the target entries had significantly lower vocabulary retention rates than those who ignored the animations. The negative effect of animation was quite independent of what other lexical information participants chose to view in addition.

The use of audio recordings of headwords, on the other hand, has produced a positive effect on vocabulary retention, at least for learners of English from Hong Kong (Laufer and Hill 2000). However, this could be due to the specific reference habits of Chinese dictionary users. As the typical macrostructural organization in Chinese dictionaries is phonological (by phonetic radical; Laufer and Hill 2000: 70), phonological representation plays a practical role in dictionary consultation. As this is not the case for most other languages, it would be premature to claim that similar benefits of audio recordings would obtain for speakers with other language backgrounds.

Thus, the evidence with regard to the effectiveness of multimedia in dictionaries is rather sketchy: it involves speakers of a small subset of languages in a restricted range of situations and tasks, and is mostly restricted to general dictionaries for language learners. But multimedia may have a special role to play in specialized dictionaries, for example in a dictionary of architecture (Fernández and Faber 2011), and in some cases they are of central importance, e.g. in dictionaries of sign language (Zwitserlood 2010; Kristoffersen and Troelsgård, this volume).

Also, the primary focus of recent research seems to be on vocabulary retention seen as a long-term benefit of dictionary consultation. However, a more central role for dictionaries is to help solve immediate lexical problems as they arise, for instance during text comprehension, production, or translation. While it can be argued that comprehension is a prerequisite for acquisition, we need to be cautious not to overextend the outcomes of acquisition studies to all dictionary uses.

What we can say at present is that the available evidence invites optimism with respect to static pictures and audio recordings, but look less optimistic when it comes to video and animation enhancements. Here, the difficulty of matching playback speed of the material with individual users' cognitive pace might be a large part of the problem.

5   Conclusion

Effective lexicographic solutions are those that are suited to the needs of a particular user in a particular situation, and it is not possible to specify all possible constellations of these factors

— and the optimal lexicographic treatment they invite — within a single chapter. In fact, with respect to the nature of lexicographic data, these optimal solutions are not at all unique to the electronic format. What is more characteristic of the electronic medium is that access to data can be made more effective (i.e. successful) and efficient (quicker) in electronic dictionaries than in their paper predecessors, and this is the aspect that I have focused. We have seen that a number of fairly straightforward improvements can be made to enhance data access in electronic dictionaries once designers liberate themselves from the constricting paper tradition, and many of these improvements require neither serious technological breakthroughs nor substantial investment.

But electronic dictionaries also form a perfect platform for non-textual media, such as sound, video or animation. Whether and to what extent dictionaries should make use of these modalities ought to be decided on the basis of sound lexicographic principle and evidence of their effectiveness in the specific situations of use, and not by questions of fashion. There is some evidence, sketchy as it is, that not all types of media benefit dictionary users in ways that might be expected.

Dictionaries will be most effective if they are instantly and unobtrusively available during the activities in which humans engage — and ultimately aware of those activities. As more of our work, study and play is done in an ICT-enhanced environment, electronic dictionaries have a chance to blend into that environment by discreetly staying in the background and coming to the rescue when needed.

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Notes and URL's of online dictionaries cited in the text

[1] Occasionally also in one's L1, depending on the combination of the morphological complexity of the language, lemmatization policy adopted, and the user's level of reference skills; cf. Prinsloo, this volume.

[2] Two interfaces were tested: the free-access version at http://www.ldoceonline.com/ (LDOCE Free) and premium version for buyers of paper copies at http://www.longmandictionariesonline.com/ (LDOCE Premium).

[3] http://www.learnersdictionary.com/

[4] http://dictionary.cambridge.org/

[5] http://www.macmillandictionary.com/

[6] http://www.oxfordadvancedlearnersdictionary.com/?cc=global

[7] http://www.google.com/dictionary?langpair=en%7Cen&hl=en

[8] Listing the same expression differently in two diffent entries is another minor lexicographic sin which electronic lexicography should help eradicate.

[9] http://www.mycobuild.com/Default.aspx (login required)