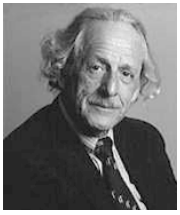

Current Comments

Reflections on Learning Foreign Languages Part II: Electronic Translators

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In Part I of this essay I discussed some of the many language-teaching courses, methods, and devices available to persons interested in language learning. I also expressed the hope that modern electronic technology may someday make language learning easier. The recent appearance of several new electronic translating devices on the market is a significant step in that direction.

In a future essay I intend to review the field of mechanical translation. My interest in that field goes back to 1954 when I first contemplated working under Leon Dostert at Georgetown University.[1] My first contact in the field of information retrieval was James W. Perry, the author of the first self-teaching book on scientific Russian.[2] Subsequently, I studied linguistics and the problem of machine-translation of chemical nomenclature.[3]

It is only natural, therefore, that I was excited by the appearance of several new translating devices. Less than a year ago, Lexicon Corporation of Florida introduced the first model, the Lexicon LK3000. Craig Corporation of Japan followed soon after with the Craig M100. Most recently, Texas Instruments (TI) announced the development of a pronouncing translator. This will combine the technology they developed for calculators with the new technology of digitized speech. This was first demonstrated last year with "Speak and Spell," a "toy" that sells for $50.00. This toy contains a complete alphabetical keyboard, a visual display, and a digitized speech synthesizer.

Out of curiosity, and hope that they might prove useful, I eagerly bought the Lexicon and Craig models when they first appeared. These devices are presumably designed to make the job of translation easier. Unfortunately, that is debatable. Portable, hand-held devices somewhat larger than the average minicalculator, they "translate" words and phrases from one language to another. They are designed to accept various modules (or capsules) which provide the "memory" needed for translation. It would be inaccurate to say they are "programmed," as they only store information.

It is tempting to compare these devices to a portable dictionary. It is also relevant to mention that nobody bothers to publish dictionaries that are limited to 1500 words or phrases. If they did then maybe you could make a proper comparison. But the fact is that most people cannot look up words in a dictionary as quickly as they can with a keyboard. Furthermore, if they have to look up many words in succession frustration sets in. This is similar to the point I made in discussing the problem of Russian-English dictionaries.[4]

So in critiquing these devices one must remember that for many people they will be much better than an inexpensive pocket dictionary because many people simply find the use of dictionaries difficult. To use either the Lexicon or Craig you simply key in, letter by letter, the word you want to translate. As you do so each letter is displayed on the screen. When you hit the "translate" key the translation is displayed—quickly, but not necessarily instantly. Except for certain specialized functions, the Craig and Lexicon operate similarly. Both have a keyboard in which the letters are arranged in alphabetical order. Other keys perform spacing, backspacing, clearing, translation, and other functions. Unfortunately, many translation requests result in the display: "NOT FOUND," (Lexicon) or ????? (Craig). Since the dictionaries only store between one and two thousand words you are bound to ask for words that they do not contain. Before these devices can effectively compete with ordinary printed dictionaries they will need to store at least 5,000 to 10,000 words. There is every reason to believe that as chip technology advances this will be achieved. In the meantime, unless it is a language you have never studied, you are apt to be disappointed. In a recent review, *Consumer Reports* shared my opinion. They tested the Lexicon, and although they felt that the translator was a promising beginning, in its present stage of development they felt it "would not be of much practical use for innocents abroad." They advised the traveler to "take a good pocket dictionary or foreign-language phrase book instead."[5]

Using one of these electronic translators will give you first-hand experience of the limitations of word-for-word translation. This reminds me of a personal experience. In 1960 I was a guest lecturer at the National University of Mexico Computing Center. The director, Sergio Beltran,was interested in the then very active field of mechanical translation. He wanted to develop a computerized system for translating English scientific texts into Spanish. So he asked me to lecture his students on mechanical translation and information retrieval. He also insisted that I lecture in Spanish even though I protested that I had not spoken Spanish for many years.

So I went to the library. The only dictionaries available were rather old. But I managed and created technical words whenever necessary. I wrote out my lecture and read it to the class. In it I suggested that the use of mechanical translation as a substitute for learning English was somewhat impractical. When my lecture was over, the students applauded politely. Then Sergio arose, thanked me for my lecture and said to the audience, "You see my friends, mechanical translation does work."

Electronic translators in their present stage of development would not have aided me in my lecture. Nor will they enable you to engage in meaningful conversations unless you have a lot of time and energy. Undoubtedly, under certain circumstances they will facilitate communication. If you are trying to say something to a person who doesn't know your language, the visual display of a phrase or sentence will have more impact than pointing to the individual words in a dictionary. The device will usually impress a person more than a few scribbled words on a piece of paper or some mispronounced words.

I pulled out my Craig translator in a posh Paris hotel recently. The service was disrupted for the next fifteen minutes. I had to lend it to the head

waiter so that we could continue our meal. But he was much more impressed, as were my friends, by TI's "Speak and Spell." The impact of the spoken word is enormous. That's why I suggest you wait until TI comes out with its translator.

If you can live with such translations as "the meat is able but the alcohol is feeble" (the flesh is willing but the spirit is weak), then you can manage to create some useful sentences. When I showed the device to a French neurologist she said it would be extremely useful for certain types of patients who could not speak. But apart from this, playing with the translator can be an enjoyable learning experience. For example, by keying in one, or several letters, such as "EV," you can easily display all the words that begin with those letters. Certain phrases can also be accessed. If you first key in "how," a set of phrases such as "how are you," "how many," and "how much," are successively displayed. To translate any of these phrases, you press the translation key.

The Craig has also stored 52 special phrases that can be retrieved by touching a specified key and the "Phrase" key. For example, "Do you change traveler's checks?" can be obtained simply by pressing the "Phrase" key followed by the letter V. The list of common phrases is printed on the back of the translator. The Craig also contains categories of words, such as "clothing," and "transportation."

Beyond their basic operational similarities, however, the Craig and Lexicon differ in many features. And, despite the fact that both are promoted as a combination "dictionary, phrase book, teaching aid, and interpreter," neither quite equals that billing. The Lexicon is especially problem-ridden. It lacks some of the most obvious and necessary words, while it contains other words whose usefulness is questionable. Neither the French nor German modules, which I have, contains, for example, "have," "are," "am," or "hungry," although they do have "bourbon," "scotch," and "rum." The manufacturer apparently never heard of the Thorndike word list,[6] a compilation of 30,000 English words ranked by frequency of appearance in newspaper and other commonly read texts.

Many other words, such as "watch," which have more than one meaning, are programmed in the Lexicon with only one of their meanings. So when I tried to translate into French the phrase "Watch the movie" I got the equivalent of "Wristwatch the movie " (Montre le cinéma). Or, when I tried to say, "Her coat is there," I got "Elle manteau est là"—"She coat is there." These particular difficulties, however, can be reduced if multiple meanings for homonyms are stored.

The Craig translator does just that. It seems to have a wider, more complete vocabulary than the Lexicon. It includes such common words as "have," "has," "be," "are," and "am." Words with two meanings, like watch, are stored with both meanings. When you key in such words, they are "questioned" immediately. You select the proper meaning before continuing.

Neither translator, unfortunately, has much grammatical sophistication. One example of this problem in both devices is the treatment of verbs. The translators cannot conjugate. Most verbs are stored in their infinitive forms. So "I want" becomes "Je désirer" (Lexicon) or "Je vouloir" (Craig)—in French, literally, "I to want." Try to say, for example, "I want to eat," and you get the translation "Je vouloir à manger," "I to want to to eat." I suppose the average waiter

will get the message. In addition, neither translator has many past tense verb forms, any verb-subject agreement, or any noun-subject agreement.

If you spell poorly you will probably have trouble with the Lexicon. When you spell a word wrong, you simply get "NOT FOUND" displayed. Unless you have a dictionary handy, or are good at devising alternative spellings, this can be extremely frustrating. There is no easy way to find out just why the word is "NOT FOUND," either. It may be misspelled, as mentioned, or may be "Found" in only another form. ("See" is found, but not "Saw"), or, of course, the word may simply not be in the Lexicon's memory. Unlike the Lexicon, however, when you misspell a word, or type in a word not contained in the Craig's memory, it flashes ????? on the screen. Pressing the "Search" key calls up the dictionary for all words spelled similarly. So while you won't find "worked" in the Craig's memory, you will find, with ease, that "work" is available.

Should you, for example, enter "sugest" for translation, the Craig will respond with ???????. Press the search key, and the Craig begins to search its memory for all words listed under first "sugest," then "suges," "suge," and finally "sug," where it finds the entries "sugar" and "suggest," which it displays. You then press the translation key for the translation.

Since the Lexicon and Craig keyboards are arranged alphabetically, anyone used to a typewriter keyboard, will have trouble. I suppose I would have preferred a standard typewriter arrangement. To build up any speed keying in words takes some practice. It might make some sense to locate all vowels at the center top of the keyboard.

Despite their various problems, these translators are proving interesting, if not especially useful. Since their introduction, less than a year ago, over 300,000 units have been sold. As a result, other companies are entering this fast-growing field. TI recently announced its new translator. There are unconfirmed reports that several other major companies will soon enter the translator market.[7] So far, prices are beyond the reach of the student or average individual. The TI translator is expected to be priced at about $300, plus $50 for each module. The Lexicon currently costs $225, plus $65 per module. The Craig sells for $200, plus $25 per module. Both the Craig and the Lexicon come with one module included. Although I don't have all of them, modules for French, German, Spanish, and Italian are currently produced for both models.

In addition, Lexicon produces Portuguese and Greek modules, and a multi-lingual module, which contains everyday phrases in English and five major European languages. The manufacturer promises that modules in Swedish, Polish, Russian, Arabic, Hebrew, Japanese, and Chinese will soon be available. For languages that do not use the Roman alphabet, a special keyboard overlay allows the user to enter the correct characters. Portuguese, Dutch, Russian, and Japanese modules are planned for the Craig translator. Unlike the Lexicon, the Craig has the capacity to translate to and from three languages at one time. This requires inserting three modules at once.

To a certain extent, of course, these devices rely on a process of transliteration. I find this an exciting development, as I have experienced the power of transliteration several times. When I first lectured in Japan, many years ago,

I asked my friend Takashi Yamakawa, ISI®'s first representative in Japan, to translate into Japanese a short speech which I had prepared in English. Then I *transliterated* his translation into Roman script. I read the speech to a group of pharmaceutical industry scientists in Osaka. They listened politely, occasionally smiling at my pronunciation, but in the end I received thunderous applause. That experience convinced me of the power of transliteration. I had a similar experience when ISI was visited by a delegation of Chinese scientists. With the help of an ISI staff member I was able to say a few words of greeting in Chinese.

Even though they are marvellous technological feats, the electronic translators are not substitutes for actually learning languages. It is difficult to judge their value unless you use them in a situation where you have no familiarity with the language being translated. Even though they provide no grammatical subtleties, or pronunciation guidance, they can be helpful. The Chinese say that a trip of 1,000 miles begins with a few steps. If true, these devices may be the first steps toward the exciting "Universal Translator" used on the old Star Trek TV series.[8] That translator, which was no larger than a transistor radio, was able to instantaneously convert alien languages to English and vice versa. Such a device would, of course, be extremely useful. Until its creation, however, we will have to use traditional language learning methods. When TI comes out with its speaking translators, sociologists may want to study their impact in certain situations.

The famous information scientist and philosopher Joshua Bar-Hillel said that mechanical translation would never be successful. I wonder what his reaction to these gadgets would be.

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"Current Comments"

Citation Analysis, Mechanical Translation of Chemical Nomenclature, and the Macrostructure of Science†

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The microstructure of science is very different from its macrostructure. For example, I can confidently assert that "milestone" papers—those which are subjectively rated as important by a large number of scientists—are, on average, frequently cited. However, I cannot truthfully assert that *every single* "milestone" paper is highly cited. A few may have been almost totally ignored, for a variety of reasons. In fact, some portions of my own work that I regard most highly have been least cited. Thus it is painfully apparent to me that models which are valid and reliable in the macrostructure of science can crumble when the focus is narrowed to the microstructure of science.

How extensive this phenomenon is we have not yet been able to determine. I wonder whether Watson and Crick would agree that their 1953 paper in *Nature*[3] represents the pinnacle of their work? I know that Oliver Lowry[4] correctly asserts that his most important papers are not his most cited. But that does not say his most important are not heavily cited. Keep in mind that I am not saying citation analysis cannot detect the significant though infrequently cited paper. Back in 1964 we produced a "computerized" history of DNA[5] which showed some papers that were infrequently cited but were significant in breaking the genetic code.

Examples of this kind have given me reason to question the assertion by Cole[6] that there is no validity in the Ortega hypothesis.[7] This theory asserts that advances in science depend in part on the contributions of mediocre scientists. While we may all stand on the shoulders of giants, they in turn depend upon many average or less eminent scientists. Whether they depend upon dwarfs is another question.

All this is leading up to a discussion of some work I did which is rarely cited but which gave me fantastic satisfaction. I refer to a paper on mechanical translation of chemical nomenclature.[8] This was the subject of my doctoral dissertation. Since I'm so often asked why, I'd like to tell you how I happened to take a degree in linguistics rather than library science.

I entered the field of documentation, now information science, from chemistry by joining the Johns Hopkins University Indexing Project in 1951. I stayed until its demise in 1953. By the middle of 1954 I had already accumulated a master's degree in library science and sufficient graduate credits to satisfy the minimum requirements for a Ph.D. But it proved impossible for me to find a faculty member at Columbia University who would approve for my dissertation topic the use of machine methods in scientific information. The only sympathetic ear was that of Professor Merrell Flood, but in order to take a degree with him, I would have had to take undergraduate training in industrial engineering. In retrospect, I see more clearly how relevant systems work has been in my career.

I tried to form an interdisciplinary faculty group, but I was not interested in spending ten years trying to satisfy an interfaculty group that would supervise my work. By that time my family had already been convinced I was going to be a student forever. I left Columbia disappointed. But in 1954, through my friend and colleague, Casimir Borkowski, I met Professor Zeliig Harris at the University of Pennsylvania, Department of Linguistics. His work in structural linguistics was already well known to scholars, but in the field of scientific information he was unknown. In 1956, I wrote a paper on the application of

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structural linguistics to mechanized indexing[9] and showed it to Harris. Though it was never published, Harris became sufficiently interested in the field of information retrieval to accept some huge grants from NSF over a ten-year period. Most of this work is now continued primarily by Naomi Sager at New York University.[10] Some of you may recall transformational and discourse analysis.

I suppose it was prestige that made me seek a Ph.D. I ultimately worked out a doctoral program with Professor Harris which commenced officially in 1958. We had agreed on the amount of course work and my ultimate dissertation topic. By then I was quite preoccupied with problems of chemical indexing. We were encoding all new steroids for the U.S. patent Office under a contract with the Pharmaceutical Manufacturers Association.

By 1960, the Institute for Scientific Information (ISI) was publishing *Index Chemicus*. The original purpose of this service was to index compounds by molecular formula. So it was natural for me to want to find a way of calculating molecular formulas in the simplest way possible. Until that time *everyone* assumed that it was necessary to draw a structural diagram in order to calculate a molecular formula. Even Ascher Opler,[11] who wrote the pioneering paper in 1956 on "New Speed to Structural Searches", assumed this was the case. That is why he first wanted to represent the compound in a topological matrix which later was called a connectivity table.

My linguistic studies convinced me that the "meaning" of chemical nomenclature had to include enough information for calculating molecular formulas straight away. Otherwise, how could we do this so quickly in our heads for simple compounds? I told Professor Harris my theory and he accepted it as my doctoral thesis, the first in the new field of chemico-linguistics. Thanks to the recognition by Professor Allen Day of Penn's Chemistry Department that it was a nontrivial problem, the topic was agreed upon in the graduate school. However, before I could work on my dissertation, I had to prove my theory worked. If it did not, I would have to choose another topic, no matter how long I spent on the research.

Recognizing that the dictionary work alone might take me several years unless I got help, I proposed that the theory be proven with respect to acyclic compounds. During the next few years I got into the detailed problems of discourse analysis for my target language—chemical nomenclature. The details are not essential to this story. When I was ready for actual computer trials, I got the help of John O'Connor in programming Univac I, which was then in use at Penn. But I found that I could never get time on the computer, so I had to buy time at the Franklin Institute computer center.

The outcome of all this was "an algorithm for translating chemical nomenclature into molecular formulas."[12] When I submitted it to the department it was only ten pages. My substitute adviser was dumbfounded by this. Dissertations in linguistics are written by the pound—not the page. I spent a whole semester filling it out with interesting theoretical statements and formal analyses of chemical morphology, etc. By late 1960 I had made the first successful computer run in calculating a molecular formula directly from a systematic name.[8] I had done this manually hundreds of times earlier in the year.

As it turned out ISI was never able to finance the research necessary to complete this work. NSF was not very kindly disposed to us in those days. We also were up to our ears in the *Genetics Citation Index* project so I had to put chemical nomenclature work on the back burner. We never did input compound names for *Current Abstracts of Chemistry* (CAC); on the contrary, we now input Wiswesser Line Notation (WLN) for each compound and that is what we use to compute the molecular formula. However, the double bond checking routines that we used for so long were included in my algorithm.

About eight years ago I saw the proposal *Chemical Abstracts* made to NSF regarding chemical nomenclature translation research. Naturally I felt envious that they should get this support when it was clearly an operational development they needed more than ISI. That's what made it applied for them and academic for us.

However, I was very glad someone was

doing this and read with mixed feelings the first reports of this research in 1967.[13] A recent paper in the *Journal of Chemical Documentation*[14] shows that this work is finally coming to fruition, and I congratulate the CA group on their accomplishment.

Returning to the main point of my essay. Here is a topic of research which has multi-million dollar economic significance. There are only a few people in the world interested in it, so the number of times this kind of work will be cited is bound to be small. Clearly it is the kind of thing that is less cited than, e.g., papers on WLN, but there is an important connecting thread. Perhaps historians will decide that Opler's notion of a connectivity table for chemical compounds has been the most important concept in this field.[11] Most people seem to think that Sussenguth was the first one to use his concept.[15] But clearly none of these chemical information milestones has had any major discernible impact outside the field, and that is what the historian seeks and seems to find in large-scale citation analyses. This again demonstrates that the microstructure of science is very different from its macrostructure.

So much for the history of mechanical translation of nomenclature. Let me digress now to make some observations on the future of chemical and scientific publication. This has been much in the news these days, that is, *C&E News!* Joel Hildebrand, my freshman chemistry professor, has caused a lot of soul-searching with his rediscovery of the ancient idea of publication by abstract. I've had some contact with him in recent years and I know why he is making these proposals. Unlike James Stemmie who in *C&EN*[16] seems worried that some important ideas will be lost to posterity if we adopt any changed systems, Hildebrand is trying to tell us that the system is overloaded with useless information; he is talking about information pollution on a large scale. I have recently[17] asserted that the abuse of the page-charge system may be aggravating this pollution problem. And I regret to say *Chemical Abstracts* may be equally guilty. CA does this unwittingly in its hopeless aim to be complete. Consider that 25% of the abstracts in CA are of Russian material.[18] From our extensive citation analyses we know that this is absurd in relation to the significance of Russian research. They are polluting the waters of science with a lot of mediocre and unrefereed material. Probably another 10% of CA falls into this category. No doubt others do it too, but the data show clearly that the Russians are the worst offenders. Does anyone anywhere doubt the superiority of the *Journal of the American Chemical Society* over the *Zhurnal Obshchei Khimii*? How would you compare the abstracts of the ACS meetings to the abstracts of unpublished papers that the Russians are now loading into the *Russian Journal of Physical Chemistry*. Undoubtedly it gives the Russians significant political leverage to assert they account for 25% of CA's coverage. Maybe they will even claim CA should pay them a royalty for abstracting without their permission. After all, CA abstracts do constitute a substitute for the original Russian material.

There is an important distinction to be made between unrefereed material appearing in high-priced journals and unrefereed material listed in a depository. Each abstract requires the same space and work. But at least someone was willing to pay for that so-called high-priced journal. If librarians are as indiscriminate as they are accused of being, then why aren't they buying the original Russian journals and abstracts? I'm sure that Earl Coleman would be delighted if libraries bought his translation journals without the slightest evaluation. He knows how hard it is to sell the best that the Russians publish. He would court disaster to publish everything without regard to quality.

It is a rather interesting observation that 10% of CA's budget is about $2 million. If they cut back on Russian material they would find the same $2 million they want the Russians to pay for pirating CA.

At ISI we have very mixed feelings about CA. On the one hand, we resent their high price because a chemistry department is generally apt to say that it can't afford the *Science Citation Index* (SCI) but it must buy CA. If for no other reason, it couldn't get ACS accreditation without it. On the

other hand, the higher CA's price becomes, the more easily we can convince buyers that SCI or CAC is a good value. However, given my choice, I would much rather see CA priced lower. So I have a real concern for their cost-effectiveness. In fact, given my druthers, I would provide for CA a citation index to the chemical literature that would complement CA searches. The combined use of CA and SCI is happening increasingly, but it would be nice if we could accelerate the use of SCI by chemists as was suggested by the Hannay Committee many years ago.[19]

The recent paper by Parry, Linford, and Rich[1] shows a clear trend toward such complementary use of large data bases. This will increase as the cost of on-line services declines.

I recently did a search of the CA data base using our *Permuterm Subject Index* (PSI) to identify pertinent search terms and then followed up the output from CA by checking the items retrieved in the SCI! This is frequently done when people use MEDLINE and SCISEARCH,[2] but obviously the inclination to do so is tempered by the vast differences in per-hour rates.

In closing, I will mention miniprint, which has now come into the limelight. As the cost of paper goes up, CA and ISI may well have to adopt such methods. Whether users will accept miniprint more readily than microform is hard to determine, but there is a whole new technology opening up now that the "Oxford English Dictionary" has become so successful in this medium. Ralph Shaw and Albert Boni experimented with miniprint long ago. I just rediscovered it when I was thinking about ways to cut down on indexing costs. Maybe it's still not too late for CA to try it. After all, the most successful publishing venture of the past decade has been in the miniprint edition of the "Oxford English Dictionary".

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