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COMPUTERS, GRAPHICS, AND PAPYROLOGY

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The spread of affordable, "user friendly," sophisticated personal computers has already affected how scholars in many disciplines work. Because of the extreme difficulty scholars have in reading demotic script, demotic studies have lagged and many basic research tools are lacking. When I reactivated the demotic dictionary project which had come to Chicago from the great German Egyptologist Wilhelm Spiegelberg via Spiegelberg's student William Edgerton and on which my own teachers, George Hughes and Charles Nims, had worked as young scholars, we began by collecting all the vocabulary from texts published between 1955 (the year after Erichsen's *Glossar* was published) and 1979, a 25-year period which saw the publication of major collections of religious, "scientific," and literary texts as well as economic and legal documents. The first Apple Macintosh computer appeared just as we were preparing to write entries and this machine immediately appealed to us because of its graphic orientation. The Macintosh's "what you see is what you get" coordination between screen and printer allowed us to see and control our formatting directly on screen and made it easy to use various diacritics and non-Latin fonts.

Because of the cursive, ligatured nature of the demotic script, our research depends on accurate copies of texts. One of the most important elements of our dictionary would be the facsimiles of the thousands of words which would appear in it. We wanted our copies to depend as much as possible on mechanical reproduction of the form of a word and as little as possible on the human eye and hand. We began to experiment with "scanning" the photographs and electronically "cutting and pasting" the facsimiles into the document holding all the text.

A "scanner" is a piece of computer hardware which works rather like a Xerox machine. A laser beam "takes a picture" of whatever has been put on the screen and stores it in the computer. The picture is recorded as a series of small squares or "pixels" and the "greyness" of each "pixel" is noted. Our machine can read and store 300 pixels to the inch, i.e., 300dpi resolution, and 16 shades of "grey" from pure white to pure black. The stored image can then be studied "on screen" and signs, words, phrases, or sentences can be copied from the scanned image into a word processing or database program. The image or any part thereof can be printed, separately or within a word processing or database program.

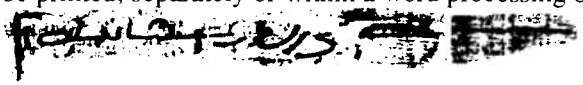

Figure 1: P. 'Onchsheshonqy, 7/14
m-ỉr ḥrr r šms pȝy⸗k nṯr
Don't neglect to serve your god!

Various software programs allow modification of this image, dramatically increasing our ability to work with the text. The resolution of computer screens is approximately 75dpi, i.e., only 1/4 the resolution of the scanner we are using. Thus, if a scan is displayed on screen at the same size as the original photograph, the screen displays only 1/16 the resolution available. But it is possible to magnify the image, displaying it at anywhere from twice original size (and 1/4 the possible resolution) to 4 or 8 times original size. I have found that the display at 4 times original size, i.e., display at the same resolution as the scanned image, usually provides the best view of the text. Such a display combines the advantages of maximum resolution with magnification, making it possible to read on screen signs, words, or sections of text which are difficult to read on the original photograph. In addition, both the

brightness and the contrast of the image can be changed. This makes it possible to read both darkened, smudged areas and areas where most of the ink has flaked away leaving only very light traces. Scanned images can be combined in order to test suggested placement of fragments; it is possible even to trace fibre lines in the papyrus while doing such restoration. Broken ostraca can be restored and a complete (or more nearly complete) text seen as a whole.

It is also possible to take the "greyscale" image and produce from it both a halftone and a line drawing. When making a halftone, both contrast and brightness can be adjusted. To produce a line drawing from a greyscale image, one selects a "threshold" (one of the 16 levels of grey) at which the machine differentiates between black and white. Everything darker than this appears as black, everything lighter appears white. By adjusting the threshold, maximum resolution of the ink can be obtained. From the same greyscale, then, one can prepare and publish a halftone and a line drawing. The two types highlight different aspects of the original and nicely complement one another.

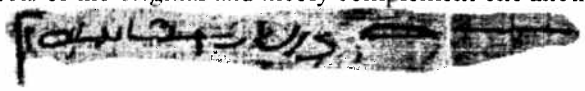

Figure 2: halftone

The scanning programs, and other programs designed for creating and manipulating graphic images, allow one to "clean up" or "restore" an image. For instance, line drawing produced from a greyscale will usually retain some "background noise": fibre lines, holes in the papyrus, palimpsest, stains, or the like. All this background noise can be erased from the line drawing, producing a clean facsimile of as much or as little of the text as is desired. The programs provide not only an "eraser" but also a "pencil," so it would also be possible to fill in damaged or destroyed areas if such were desired.

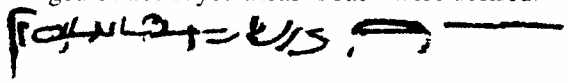

Figure 3: "clean" line drawing

We are preparing the dictionary facsimiles by taking greyscale scans of every text in our corpus which was published in photograph. When a published photograph shows the demotic especially large or especially small, reductions or enlargements are prepared from the greyscale scan. When we lack a photograph, the published hand copy is scanned and so noted. This process maximizes mechanical reproduction while minimizing the need for a good "eye" and skilled drawing "hand." The resulting copies of the words are as close to facsimiles as a photograph of the same resolution. Further, this method means that we will be able to provide copies of the complete dictionary both in standard book format and in electronic format. Scholars will be able to load a copy of the dictionary into their own machines. Users of such "disk copies" will be able to make additions and corrections directly into the text of the dictionary; we hope that this will encourage people to send us their additions and corrections for inclusion in the "master."

A valuable spin-off of the work on the dictionary will be the immense collection of scanned images which can serve as database for numerous future projects. Access to the scanned images, whether over an electronic network or via distribution of CD's containing copies of the scans, can also supplement library research. A scholar without direct access to a given publication could view the scan. In many cases viewing the scanned image would suffice to answer the question the scholar was raising. In other cases, the scholar would at least be able to ascertain whether or not a request for a photograph, or a visit to the appropriate text collection, was likely to produce the desired results. If a data-base of transliterations (and translations) of demotic texts were also compiled (along the lines, perhaps, of the Duke database), publication of and research using demotic texts could move

out of the 19th century and into the 21st. There would, of course, be various conventions which would have to be agreed upon, especially involving transliteration and the placement of diacritics.

It is not only published texts which can form a useful database. Catalogues of museum collections are more and more frequently being prepared on computer. If a scan of every item (whether it is a papyrus, ostracon, stela, statue, or whatever) is included in the catalogue, then museum staff and other authorized scholars could study the materials as appropriate for content, parallels, joins, etc. To the extent that the catalogue and scans are available to outside scholars for "browsing," it will be possible for people to track down unpublished texts appropriate to the problem or project on which they are working and to plan their research accordingly. It is quite easy to put various levels of security on such a system so that unauthorized users do not have access, so that use of the files is tracked and unauthorized copying identified, and so that users authorized only to "browse" don't make changes to text or image.

Another aspect of the use of computers, and specifically of scans, with which I have just begun acquiring experience is the use of scans in "desk-top publishing," i.e., publishing directly from pages printed on a laser printer controlled by a computer. Not only does such publishing eliminate the cost of typesetting; more importantly, it eliminates the typos which inevitably appear during typesetting and thereby eliminates the need for yet one more round of slow, painstaking proofreading. The use of scans whenever possible for hand copies of short texts produces further advantages: Page layout is much simplified and the cost of printing the books greatly reduced.

Anyone involved in making actual scans must have a good scanner (better ones than ours are now available at "reasonable" prices) and must have a lot of disk space to store the scans. However, people simply using scans prepared by someone else need only an appropriate graphics program. Although we are using Macintosh equipment, all of what I have been talking about today is accessible to IBM and UNIX users, although in a somewhat more cumbersome fashion. One might note that the preparation of the actual scans is time consuming (as is the preparation of any massive database, on computer or otherwise) but that working with prepared scans is relatively quick. It should also be noted that although flat objects could, in theory, be scanned directly from the originals, scanning can not now take the place of a good photograph. The resolution of a high quality photograph is higher than that of most scanners. In addition, a good photographer will illuminate his object using light coming from different angles to highlight ink on a papyrus or on the curving surface of a potsherd or to highlight the carving on a stela or statue; the light from a flat-bed scanner comes from only one direction and can not be controlled by the person doing the scans.