COMPUTER STUDIES IN THE HUMANITIES: INTELLECTUAL, EDUCATIONAL, AND SOCIAL IMPLICATIONS

John B. Smith

Introduction

Not too long ago if one mentioned the words, **computer** and **humanities,** in the same breath people would look at him rather quizically and wonder if he were not a little "off." Today, it is becoming increasingly apparent that **something is happening** involving the computer and humanists. One mark of development is the number of publications involving this combination. In addition to the two basic journals in the field, **Computers and the Humanities and Computer Studies in the Humanities and Verbal Behavior, there are numerous** newsletters devoted to special interest or discipline-oriented groups; these include the Newsletter for the Special Interest Group for Language And Studies in the Humanities within ACM—the main professional organization for academic computer scientists; CALCULI, a Newsletter for Classicists; Computer Archive Notes for individuals interested in forming a consortium for distributing texts that can be "read" by the computer; and the **Bulletin** for the British based Association for Literary and Linguistic Computing. At the most recent meeting of the Modern Language Association there were at least a half-dozen seminars involving one aspect or another of applications of computers to literary studies as well as a paper presented at the large, general Forum on New Methods of Literary Analysis. Similar seminars are being held at meetings of the professional societies for most other humanities disciplines Last and least, the presentation of this paper attests to the growing interest in computer studies in the humanities.

Having recognized that something is happening, we may ask the question, "What do we do about it?" Should we encourage even further use of the computer in the traditional humanistic disciplines? Should we ignore it and hope that it will go away? Or, perhaps, should we, as individuals interested in education, confront the computer, inform ourselves about the potential benefits as well as dangers that it may offer, and try to adapt it to legitimate humanistic ends where that seems desirable. Whatever the decision that an individual or an institution makes, it should not be a casual decision; for it is a decision that is likely to have significant remifications. To reject the computer completely may be to loose an increasingly important educational resource and to encourage intellectual isolation. On the other hand, to accept the computer into the humanities is likely to have equally extreme implications. It will require the allocation of funds that might have been spent in other ways. The necessary restraining of faculty in its use may generate emotional as well as intellectual repercussions. Students' academic careers will obviously be affected. In the remarks that follow I shall try to consider these and other problems by addressing these questions: **What,** exactly, does one do when one uses the computer for a humanities study? second, **why** would one use the computer for such a study? and, finally, what are the intellectual, educational, and social implications that we might expect from such applications?

What Does Computer Studies in the Humanities Mean?

I, obviously, can't give a complete answer to that question here. The journal, **Computers and the Humanities,** periodically publishes survey articles of applications by discipline area as well as a yearly bibliography. Instead, I will concentrate on three "representative" applications to show the kinds of things one does when one uses the computer within the humanities. The examples chosen involve art, history, and literature; unfortunately, space does not permit consideration of applications in music, anthropology, political science, and other humanistic areas. While some of their work involves analysis of written documents, **per se,** and is similar to the literary study I shall describe, they have developed other, specialized techniques. Again, I refer the reader to the survey articles and bibliography mentioned above.

The first project, involving computers and art, is that of Charles Csuri and his associates in the Computer Graphics Research Group at Ohio State University.[1] They have developed a number of techniques that allow the artist to explore the imaginative dimensions of graphic art through a t.v.-like graphic terminal supported by a relatively small, but dedicated computer. Using the system the artist may draw a sketch and see it displayed on the screen; he may then use the computer to manipulate and transform his image in a variety of ways, thus exploring its abstract, graphic dimensions.

For example, one of Csuri's earliest systems allowed the artist to sketch a face and have the computer store its image for future reference; then he could draw a second shape, say, an outline of the African Continent. The two forms could then be combined by placing the face in the center of "Africa" and then uniformly distorting the face until its outline coincided with Africa. A variety of other transformations were available to bend, fold, spindle, and mutilate the image. In this manner, the artist could see instantly how an image would look should he transform it in some way without having to actually resketch the basic form.

A second stage of the project added movement so that the system could be used to produce animation. One result was the prize winning experimental film, "Hummingbird." A basic image of a hummingbird was sketched and stored in the computer. This image was then transformed in very slight stages; by photographing each stage as several frames of a motion picture, Csuri was able to produce apparent movement. The film shows the bird image moving around in space, disintigrating into pieces that reassemble in some other place, and, in general, gambol about the screen in a rather surrealistic way.

A third development was made possible by fitting the graphic terminal with a sonic pen. Directional microphones were aimed along perpendicular axes: horizontal, vertical, and aiming straight out from the screen. The "pen" emits a high frequency signal that the three microphones can locate in space. By moving the pen about in front of the terminal, the artist can "sketch" a surface in three dimensional space. Supporting programs fill in the area between curves sketched in space and display on the screen an image of the surface. Thus, the artist can produce a free hand sketch of a sculpture and see immediately what it would look like. Further, he can see his experiments in form as quickly as a few moves of his hand, without the necessity of producing time consuming physical models.

The most recent development in Csuri's system allows three-dimensional, real time animation. Where "Hummingbird" was produced by photograph-

ing separately each frame of the motion picture, the current system is able to move an image about in space, following a path described by the sonic pen, while the artist actually sits in front of the screen: all in 3-D. The three dimensional effect is produced by displaying two separate images on the screen. The artist wears polarized glasses that join the two images into a single three dimensional image. By varying the separation between the two and enlarging or shrinking the image the 3-D figure appears to fly about in space. One interesting illustration of this system is a free-hand sketch of a helicopter with blades on the top and rear. The helicopter and each of the blades move at different rates following their appropriate paths as the craft flys about controlled by the viewer with a device called a joy stick, actually immulating flight.

The possible uses that can be forseen for Csuri's system are practically unlimited. Most apparent is a whole new art form in which the viewer become an active participant as he sits at the console and participates in the experience programmed for him by the artist. Psychologists already have begun using the system to examine the human perceptual process. A third anticipated use is in the analysis and evaluation of impairedness among the handicapped. Finally, the system will be used to produce highly animated instructional films designed to make maximum impact on the viewer.

The second project involves the use of computers in history. Alan Calmes has used the computer, both in research and in teaching, to analyze Virginia public records during the 1860's and 70's; demographic data used was Virginia county death, marriage, and tax books, local historical society records, and tomb stone rubbings.[2] From this disparate collection of information, Calmes has used the computer first for family reconstitution and, from there, moved on to consider community kinship networks and social patterns within individual counties and several county regions. Among the questions he is addressing are the following: How frequently and how far did people migrate in Virginia in the mid and late 19th century and how well off were they financially; did they successfully or unsuccessfully compete with the well established, persistent, families of their adopted counties? One possible outcome may be a challenge to the notion that "carpet-baggers" came into the south after the Civil War and dominated the local economy.

Calmes' earliest family reconstitution was for the families of Fincastle, Virginia. The computer was used to trace family histories from parents to children to establish kinship networks. There, he found some twenty-two families that formed the persistent core of the community, their children marrying among one another. Preliminary results suggest a comparable, but expanded pattern for larger areas.

As interesting as his results is the ingenuity exhibited by Calmes in implementing this project in a small college with no computer facilities. Much of the field work was done by students taking a two term course in demographic networks. Calmes reports that student reaction to an actual research experience was extremely favorable. To have the vast quantities of data keypunched for computer consumption, he enlisted the services of a local county educational center, a vocational training institution, thus giving their students actual experience while learning to keypunch. To obtain computing services, Calmes was able to make arrangements with a local bank to use their computer when it was not required for banking operations. Calmes' successes in research, instruction, and industriousness are promising for faculty and students who wish to use the computer, even

at institutions with limited computational resources.

The third project, an example of a literary study, is one that I have been involved in for the past several years. It is a close textual analysis of James Joyce's **A Portrait of the Artist as a Young Man.**[3] The study is based on a thesis derived from the discussion of esthetic theory that Stephen Dedalus, the novel's protagonist, has with a friend, Lynch, in Chapter V of **Portrait.** Stephen tells Lynch that all literature is concerned with the representation of Image and that for both fictional character as well as reader the perception of Image can be a profoundly moving experience (elsewhere, Stephen calls Image Epiphany); however, Stephen does not directly distinguish between everyday image (the flood of sensory components we constantly perceive) and the image of fundamental, Epiphanal impact—the dozen or so experiences that truly change a person's life. The context of the discussion suggests a possible answer: that is, we might expect that the greater the individual's awareness of the sensory components of an experience and the greater the relevance of those components for that individual, personally, the greater the impact the whole experience is likely to have. A second implication is that what, exactly, changes in such moments of major transition of the personality are the connotations or associations that the individual perceptual components have for the individual. For example, early in the novel, Stephen is pushed in the school's cesspool—a traumatic experience, to say the least; whenever he thinks of that experience, he remembers the way the cold, slimy water felt. Similarly, cold water reminds him of that experience. By contrast, when he thinks of home and the security it offers, he thinks of the literal warmth of the hearthfire. Late in the first chapter Stephen is unjustly punished by having his hand slapped with a pandybat. At the moment the bat strikes these two dialectically opposed themes—fire/heat and water/cold—are literally welded in the image of the "scalding tears" that burst from his eyes. After that scene these individual perceptual components assume quite different associations. Fire, rather than connoting warmth and security, goes on to become closely related to the picture of Hell painted in the priest's sermon in Chapter III. Similarly, water reverses its previous association and becomes closely related in Chapter IV with the mind and personality of the artist—a thing Stephen values above all others. The thesis, then, that I sought to show was that major moments in the development of Stephen's personality (epiphanies) will be marked in the text by large concentrations of important images and, second, at these moments the patterns of association among the sensory components of that experience will be radically rearranged. Thus, we can trace the development of the protagonist's mind by first establishing the pattern of association and then noting the changes that take place at epiphanal moments.

Before the thesis could be applied to see whether it was true or not and what it would reveal about the **Portrait,** the novel had to be prepared. The entire text was keypunched, one line per 80 character card, virtually as it appears on the page. Each word was extracted and numbered sequentially by the computer (the first word, one, the second, two, etc.) and then sorted into alphabetical order. From a dictionary of all word types that appeared in the text I selected some 1300 words or images that I consider to have sensory or thematic value. The analysis that followed was based on this set of images.

To show that epiphanal moments are marked by large concentrations of important images, I developed a model that produces a measure of rich-

ness that varies with the number of images present and a weight or measure of importance for each specific image. As richness goes up, the value increases; as it declines, so does the value. The model was applied to each 500 word section of text (a little more than a page) and a distribution of the results was produced by the computer. Specific experiences drawn into focus by this model include the pandybat episode at the end of Chapter I (the richest of all experiences), Stephen's first sexual experience, the hellfire/damnation sermons, the esthetic experience on the beach in Chapter IV when he decides to become a writer, and the experience of creating his first competent poem. Indeed, these would seem to be the most influential experiences in Stephen's developing personality and, hence, would confirm the first part of the thesis.

To trace the changing patterns of association was more difficult. First, I had to define "association" and then develop models and techniques for determining and characterizing the inherent structure. Since all events are developed from Stephen's perceptual awareness, I assumed that images that appear close to one another in the narrative sequence are "close" to one another or associated in Stephen's psyche. We may, thus, view the narrative as one long, consecutive sequence of images, each "associated" with the images to its left and right. With this underlying assumption, the important work became to uncover particular combinations or patterns that appear with some regularity in one part of the text but which change at epiphanal moments. To do this, I employed a variety of computer aids. The frequency of occurrence for each image was tabulated for each of the five chapters; an image concordance was produced in which each occurrence of each image was listed along with the five preceding and succeeding images; a statistical program, called principal component analysis, was used to determine combinations or clusters that are statistically significant in each chapter. More recently I have extended this set of techniques to include a whole series of programs which I call CGAMS. This system concentrates on thematic collections of images (such as fire = burn, burned, burning, hot, fire, flame, etc.) and draws a visual representation of the associative structure among a group of themes. Each theme resembles a mountain peak so that the height of the peak reflects the prevalence of the thematic group within the section of text being considered, and the relative separation between peaks reflects the relative tendency among the themes to be closely associated or less so for the section. In the succession of pictures produced for, say, the first 1000 words, the first 2000 words, the first 3000, etc. one can see the way in which themes grow and shift in their relations with one another.

Using all of these computer resources, I was able not only to confirm the second part of the thesis but, to an extent, actually portray the growing mental structure of Joyce's surrogate, Stephen Dedalus.

Why Use the Computer for Studies in the Humanities?

One inevitable answer is, simply, because the computer is there. As long as there are computers, someone is bound, sooner or later, to begin using it for a humanities-type study. A more serious answer is that for both instruction and analysis in the humanities the computer, perhaps ironically, may prove to be more cost-effective than conventional humanities programs. Don Bitzer, director of Project PLATO, estimates that his system will soon be able to provide computing services at the rate of 50c per student hour at the terminal. PLATO's offering is extremely rich, ranging from preschool instructional games to innovative open-ended college level

programs. By 1980, Bitzer predicts that he will have a two million volume reference library that is available to the student, anywhere, anytime, and virtually instantaneously.

A third reason for using the computer in the humanities is that it reduces significantly the time between intellectual conception and realization of that conception. In Csuri's system we saw that the artist could draw a basic figure and then quickly transform that image into numerous variations and permutations, virtually instantaneously. Similarly, a 3-dimensional "sketch" for a piece of sculpture can be projected by the computer and explored and modified by the artist before transferring mental image to physical medium. Using the programs discussed in the Joyce study, the user may move from intellectual "hunch" to a consideration of textual material that can substantiate, modify, or refute that intuition. In all of these cases, and many others, the user is able to do more **conceptually** because he can simulate or greatly accelerate the physical or clerical aspects of his endeavor.

Finally, while the computer can be used as a mental crowbar to make us more effective in our normal activities of learning and studying, it inevitably leads to what, for the humanities, is really a different mode of conceptualization. To illustrate this last point, I will concentrate on the literary study. Fundamental to this mode of humanistic study is the notion of a problem to be solved or a question to be answered. To approach a subtle and intricate work, such as Joyce's **Portrait,** one must first realize that there are virtually an infinite number of approaches one might take. From this bewildering assortment, the individual must finally close on some specific matter to be considered, some thesis to be tested. Having derived a specific hypothesis, the student or researcher must then take that hypothesis, defined in the context of traditional literary terms or critical apparatus, and translate it into operative terms. That is, if the study involves, say, imagery, that term must be translated from a conceptual definition, such as "a word or phrase that arouses one of the five senses or evokes a specific theme or concept," to a form that the computer can recognize, i.e. a list of words or phrases or, less likely in this case, a set of rules that the computer can follow to determine images. To realize the importance of such a simple, but neglected, matter as definition of terms one need only pick up several handbooks of literature and look up any major critical term.

Having developed a set of operative definitions, the user must then restate his hypothesis in terms of relations among operatives. That is, "association" must be translated into some specifiable relation involving context or "richness" of imagery as some defined function of the frequency and weights of the images present.

The computer user must next select or develop analytic models that can be applied to the operative design of his study. That is, if a concept such as "association" is cast in terms of repeated combinations of specific groups of words, he might apply one of several ready-made programs that discover and specify such clusters. If the study involves a concept that cannot be dealt with by existing analytic models, the user must derive his own model; such was the case with the notion of "richness" mentioned earlier.

Having performed the analysis at the operative level the humanist must then interpret and characterize his results **at that level.** That is, if a factor analysis program is used, he must select the significant factors or clusters, determine the comprehensiveness of the collection, and then determine what relations, if any, exist among factors.

After all computational procedures have been carefully considered in terms of the analytic models themselves, the user is finally ready to construct his argument back, once again, in the context from which he began—

in this case, the literary critical level. That is, he must blend the material supplied by the computer with his own observations about the work to produce a coherent, tactful discussion. The computer, like any other critical apparatus, should be downplayed, if not relegated to footnotes or appendices, so that proper emphasis may once again be placed on the interpretive rather than methodlogical aspects of the study. Presented in this manner, the study should be inoffensive and readily understood by the conventional reader of literary commentary but it should also be built on a foundation of factual information that is impractical to produce any other way.

What Are the Implications of Computers in the Humanities?

In trying to answer this question, I shall look first at the intellectual implications for the individual student; next at the implications for the educational institution; finally, at the resulting implications for society as a whole.

For the individual student, the use of computers within a humanistic context is likely to be a highly integrating experience. The avowed aim of most liberal arts programs is the production of a well rounded educational experience. Usually this means heavy emphasis on literature, history, philosophy, foreign languages, with some math and science included. Some curricula attempt to balance the proportion of science and humanistic courses. Only a few have begun to integrate the two by considering topics such as the relevance of individual and cultural value systems within the practice of science. The other side of the coin, the use of scientific techniques in pursuit of humanistic studies, has been even more neglected. The introduction of computers in a humanistic program offers an unusual opportunity to move in this direction. Approaching a humanistic problem with the assistance of a computer offers the opportunity to use his studies in literature, history, mathematics, statistics, physics, computer science, and many others, all in a single, integrated endeavor. To finally bring so many facets of an educational experience into focus is often an exhilerating experience for the student.

A secondary aspect of this process is an integration of content and skills. While the strength of an analysis, such as the study of Joyce described above, must lie in its substance, the application of the computer highlights the analytic process used to discover the content. The student of literature often begins with an extremely subtle hypothesis that has been derived from a bewildering range of possible perspectives. He must then apply it, using a variety of analytic models, over a large volume of data.

The final description of the form and structure found must be lucid and free of jargon if it is to be understood and accepted. The process, to my mind, is problem solving in the most affirmative sense of the term. If the student can function in this manner, the training to approach a subtle problem, break it in do-able steps, carry out the steps and describe results may be the best we, as educators, can offer our students in a period when the one certainty is likely to be constant uncertainty.

There are also important implications for the educational institution itself. During the past ten or fifteen years one iron clad principle has been established regarding computing costs. That is, each new line of equipment offers more computing power per dollar, but the dollar costs are always higher. Wide spread use of computers in the humanities will cost money. For a set of reasons too complex to go into here, the more cost effective path seems to be for large universities to obtain equipment that meets their own needs but with computing power left over to share with others. Small institutions, on the other hand, are moving steadily in the direction of pur-

chasing this left over computing power rather than attempting to supply computing services through their own machine. The result is a growing number of networks linking both small and large institutions. Today, such networks are primarily state or regional: Penn State University services some twenty-five smaller institutions; the Triangle University Computing Center links Duke, U.N.C., N.C. State, and their various branch campuses; the campuses of the University of California are joined in a computer net. Consequently, even the smallest school can offer its students, faculty, and administration the same computing services available at the largest.

It is just a matter of time (and probably just a few years, at that) until these state and regional nets begin to link to form a nationwide computing-power grid. In this way, while Californians are yawning over their morning coffee their computers can help relieve the midday surge in East Coast computer consumption; after Easterners have gone to bed their computers, in turn, can absorb some of the West Coast after dinner student computer jobs. A national network that helped to level computing consumption would justify itself on quantitative grounds: lower costs, faster response, etc. However, there would be important qualitative results also. A Stanford Research Institute group has developed a system in which the entire work of the group, from secretarial to developmental to managerial, is done through a computing system.[4] Members communicate with one another through the computer; they investigate a topic by exploring a common data bank of information; all new information is "published" in terms of and becomes part of this common data bank. Since the group is a group by virtue of the common computing system, it is an "accident" of history (with some regard for communication line costs) that they are still grouped geographically. When large scale networking is here, there would be no reason such a group could not be scattered all over the world, joined through the common computing system. The implications of such a development for educational institutions are important. In addition to sharing computer resources, educational institutions will be able to share faculty, staff, and library resources. A student or faculty member at a small school would be able to contact scholars at larger universities. Where that scholar worked in a system like the Stanford system described above, the inquiry might be addressed to his files rather than to the scholar himself. Such wide open access to an individual's thoughts and information resources would play havoc with our current tradition of intellectual possessiveness, but it would be a long step toward a kind of global consciousness with possibilities we can scarcely imagine. Institutions, while losing some of the doctrinaire influence they still exert, would find themselves inter-related and interdependent to an unprecedented extent. The physical resources to establish this worldwide intellectual community will be available quite soon, probably by 1980; it may take longer to work out the administrative, legal, and ethical aspects. But, if it **can** happen, it probably **will** happen. For an individual or institution to ignore it may mean severe intellectual isolation.

The implications for society as a whole are related to the implications for its members and institutions. In a period of accelerated change, individuals trained in a specific subject matter will increasingly find their training obsolete before they can use it. Already many industries are more interested in an individual's capacity and willingness to learn than they are in what he actually knows. The humanities student, trained to apply a particularly wide set of skills to a problem, may be better suited to cope in the future than the more narrowly trained technical specialist. Imaginative problem solvers could well be our educational institutions' most important product.

If our educational institutions do achieve the kind of communication and

inter-connectedness I have described, it is difficult to believe it won't accompany an even more profound political and societal change. Network communication by computer will be like a two way street. One way could lead to mindless group-think that makes the standardizing influence of contemporary media seem pale. In the other direction is a richness and diversity of thought that would epitomize the humanistic tradition. We are approaching the intersection; whether we turn left or right is yet to be seen.

NOTES

1. For a discussion of Csuri's latest project with references to earlier studies see Charles A. Csuri, "Real-Time Computer Animation," **Information Processing '74: Proceedings of IFIP Congress '74** (Amsterdam: North Holland Publishing Co., 1974), pp. 707-11.
2. Alan Calmes, "A PL/1 Free Field File Handling System," forthcoming in **Historical Methods Newsletter** (Dec., 1974).
3. John B. Smith, "A Computational Analysis of Imagery in James Joyce's **A Portrait of the Artist as a Young Man," Information Processing '71: Proceedings of IFIP Congress '71** (Amsterdam: North Holland Publishing Co., 1972), pp. 1443-7.
   See also, "Computer Generated Analogues of Mental Structures from Language Data," **Information Processing '74, pp. 842-5.**
4. Douglas C. Engelbart and William K. English, "A Research Center for Augmenting Human Intellect," **Proceedings of the Fall Joint Computer Conference, 1968,** pp. 395-410.