The Scholar and the Machine: Computer Technology and the Humanities

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Once upon a time, a very long time ago in the very recent history of computers, in 1967, an Arts graduate of this University was wandering the corridors of the Physics building. The Arts graduate was looking for someone of whom to ask a simple question about computing and texts. The Physics building then housed the University's computer resources, two, and soon afterwards three, large computers (what are now referred to as 'mainframe computers'), ideally suited for scientific applications requiring complex and lengthy mathematical calculations with numerical data. The Arts graduate had worked as a programmer for a commercial firm, using a mainframe to do commercial applications. Typically, at that time, these still involved numerical calculations, such as those associated with a large pay-roll, or with stock control of many branches of a large company, but they differed from scientific applications in two ways. First, the calculations were simple but the amount of data was extensive. This meant that, rather than the power of the central processing unit, the arithmetic unit of the computer, being most important, the efficiency and cost of input and output was also very important, that is, how you got the data into and out of the computer. It also meant that storage and memory were very important, how you kept data. The second way in which the commercial applications differed from the scientific was that the commercial applications typically included alphanumeric information, that is, data which mixes both numbers and letters of the alphabet, as, for example, in names with addresses and phone numbers.

The Arts graduate, now working at the University in a humanities department, had realized that work in the humanities

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would probably have more in common with commercial applications than scientific. But in the humanities—I am using the term empirically to describe all those departments usually located in a Faculty of Arts—the processing of alphanumeric information would be even more significant; typically input would be text, characters representing language, not numbers, and the mani-pulations of data required would be those appropriate to language. Still, the only people to ask about computers in the University were those specializing in scientific computing. So the Arts graduate was wandering the corridors of the Physics department.

The simple question which I, who was of course that Arts graduate, wanted to ask someone was: 'what is the most efficient way to tell where one word begins and another ends in a text?' At that stage, using the scientific programming language Fortran, the answer turned out to be the tedious one I'd already considered—read each character in the text in turn, and test if it was a space, or a full stop or a comma or any other defined punctuation mark. If it was any of these, you'd finished reading a word.

I have begun with this personal vignette because it still encapsulates, for me, many of the directions, and the problems, over the last twenty years, of the use of computing technology in the humanities. We are at present at the beginning of another surge of technological development, so it's a particularly good time to see what we can learn from past conditions, and how we can minimize likely difficulties in the future.

Consider how we can now see that many early difficulties for scholars in the humanities wishing to use the new technology were social, rather than technical. From the computer's point of view, alphanumeric characters are just numbers, though with a numerical indicator of some sort to indicate their different status. Technically, all data is manipulated as numbers—so the computer is just as suited to processing text as arithmetic quantities because, from the computer's point of view, both text and arithmetic quantities are represented as numbers, binary numbers, to be precise. Nevertheless, because of the close identification of the development of computers with their scientific use, initially it was usual to regard the primary function of computers as 'number-crunching', doing arithmetic calculations of daunting complexity, such as those associated with astronomy. The primary social function of the computer was seen then to be properly located in the context of scientific departments. From this perspective, people in the humanities were moving 'out of their field' when they wished to use computers. Yet one can imagine, in an unlikely but possible alternative social scenario, that the text-processing capacity of computers could have been perceived as primary, with introductory text books using examples of language analysis, and experts in natural language seen as the primary exponents of computing—until it was gradually realized that computers could also be used for numerical calculations, so that students of the new computer science must laboriously structure their tasks from studying the earlier subject of, shall we call it, computer arts. Needless to say, the reverse has been the case.

Until, say, the1980s, those in the humanities who wanted to use computers have had to become pseudo-science students in order to follow the introductory textbooks, with their mathematical and scientific examples to illustrate general computing techniques. Recognizing this difficulty, many universities and colleges in the United States began to introduce courses in computers specifically for students and staff in the humanities. The 1987 volume of the periodical *Computers and the humanities* is dedicated to such work; particularly useful is a survey of courses and a lengthy bibliography.[1]

What happened in the 1980s to modify the situation? Simply, the introduction of personal computers, also called micro-computers, together with the software packages associated with them. I first encounted a micro-computer, as opposed to mainframes, on a visit in 1982 to the Department of English Language at the University of Glasgow. It had just been delivered to be utilized there in a vast thesaurus project of the English language, which had begun in 1965 and is still not in print.[2] We looked at it, sitting on a small desk rather than occupying a whole room, like a mainframe, in some perplexity—and what was this *Wordstar* reference manual

[1]Joseph Rudman, 'Teaching Computers and the Humanities Courses: A Survey', XXI (1987), 235-43, and 'Selected Bibliography for Computer Courses in the Humanities', 245-54.

[2]Publication by Oxford University Press should eventuate in the 1990s.

which came with it? Another programming language? By this stage there were programming languages a bit more suited to processing natural text than Fortran, such as SNOBOL, but you still did a lot of testing of the 'is this a such and such string of characters? yes, go and do such and such, no, get another string and test it'. We discovered that *Wordstar* was a 'word-processing application', a programme for dealing with information of the alphanumeric kind, already written by expert programmers. Such a pre-written package is a software package. With *Wordstar* we could use this little computer much like a typewriter, except that, as well as producing 'hard copy' (that is paper copy) if attached to a printer, the output could also be kept on tape or disk, and edited, copied, collated with other texts, and so on, at a later session at the computer. *Wordstar* was the first commercial word-processing application widely available. It is still used, in a much updated version. Other word-processing packages, such as Microsoft *Word, WordPerfect, FullWrite Professional, MacWrite, Nota Bene,* now proliferate, with varying levels of complexity.

My question of 1967, 'what is the most efficient way to tell where one word begins and another ends in a text?', was a programmer's question. Now that the basic entry and editing of a text could easily be done with purchased software, a scholar in the humanities need turn to programming only if no prewritten applications package existed to do the required task. There are now many such useful packages besides those for word-processing and, as Robert Tannenbaum observes in a 1987 article, 'How should we teach Computing to Humanists?', 'describing even a fraction of these rapidly increasing applications would be an encyclopaedic task and not particularly instructive'. Tannenbaum teaches two courses in Computing and the Humanities and Social Sciences at Hunter College, City University of New York (a one semester undergraduate course and a two semester post-doctoral course for faculty members), and in these courses provides his students with very useful tables.[3] I'll consider first the following table, 'Taxonomy of Computer Applications in the humanities and Social Sciences':

[3] *Computers and the Humanities,* XXI (1987), 217-25.

A. Word and text editing, formatting, and analysis

B. Numerical processing

1. Statistical analyses
2. Relational databases
3. Spreadsheet analyses

C. Graphic Techniques

1. Graphic output Art
2. Graphic output Data representation
3. Graphic analyses

D. Modeling and simulation

E. Recording and controlling the environment

1. Data acquisition systems
2. Process control Computer control of experiments
3. Process control Computer generation of sound

F. Computer assisted instruction

In this table Tannenbaum identifies six general classes of software which he labels A to F. Specific software packages will typically belong to one of these general classes. For example, in class A, text analysis, we can list the package the Oxford Concordance Programme. In B.1, numerical, statistical analyses, we can place the application called SPSS, the Statistical Package for the Social Sciences; under B.2, relational databases, we can list the packages DBase II (III and now IV) or OMNIS, general packages from which the user develops a specific application, a specific data-base; in class B.3, a spreadsheet application, we can put Microsoft EXCEL. And so on. Some packages were designed for academic work, like the Oxford Concordance Programme, some primarily for commercial use, like EXCEL. It's up to the imagination of the researcher what can be made use of.

A second table from Tannenbaum, 'The Matrix of Applications and Disciplines', gives examples of use for several different disciplines in the humanities. The horizontal line, for the various disciplines, gives a possible use for each general class of software (the taxonomy category, on the left vertical line). These taxonomy categories are those listed in the first table as A to F. For example, the conjunction of the software class B.2, relational data bases, and the discipline 'literature/ languages' is given as the organization of bibliographic data. This is just one use, and a common one, of this conjunction.

Taxonomy Category	Discipline					
	History	Art	Literature Languages	Music	Sociology	Student's Discipline
text editing, formatting, analysis	analyze a historical document	write a critical review	perform a concord-ance	write and print lyrics	design and print a question-naire	?
ststistical analyses	analyze 19th cent. crime statistics	analyze geometric designs	determine authorship of documents	analyze prosody errors	analyze question-naire responses	?
relational data bases	study Caesar's officers	record museum holdings	organize biblio-graphic data	store and compare musical themes	organize research data	?
spread-sheet analyses	study medieval exchange rates	maintain a gallery's budget	study publishing expenses	record orchestra expenses	maintain a research expense budget	?
graphic output—art	illustrate reports	create works of art	illustrate reports	illustrate reports	illustrate reports	?
graphic output—data representing	present research data	present research data	present research data	present research data	present research data	?
graphic analyses	analyze battlefield artifacts distribution	calculate volumes for castings	study poetry shapes	analyze musical instruments	analyze geographic distribution	?

modeling and simulation	study population distribution theories	test theories for large mobiles		produce synthesized music	study group dynamics	?
data acquisition systems	scan a text to make it machine readable	monitor a gallery's climate	scan a text to make it machine readable	directly measure sound parameters	directly acquire experi- mental data	?
computer control of experi- ments		control a gallery's climate		study various sound com- binations	control ex- perimental environ- ment	?
computer control of sound			synthesize speech	synthesize music	give spoken experi- mental in- structions	?
computer assisted instruction	test knowledge of historical facts	teach art history	teach grammar	teach music theory	teach statistics techniques	?

Each of Tannenbaum's examples needs to be fleshed out by individual scholars from their detailed knowledge of the needs of their particular problem and discipline and from their reading about the work of other scholars in the field of computing and the humanities. The most useful introduction to this field is still, I suggest, the book *A Guide to Computer Applications in the humanities*, by Susan Hockey.[4] This book was published in 1980, so its discussion precedes the general use of personal computers and software applications, yet its general categories of research projects are still those commonly undertaken in the humanities, that is the use of the computer in:

word indexes, concordances and dictionaries
vocabulary studies, collocations and dialectology

[4]London, 1980. Other essential references are the following periodicals: *Bulletin of the Association for Literary and Linguistic Computing* (U.K.), *Computers and the Humanities* (U.S.) and *Revue* (Revue of the International Organization for Ancient Languages by Computer) (Belgium).

morphological and syntactic analysis, machine translation
stylistic analysis and authorship studies
textual criticism, including editing of texts
sound patterns
indexing, cataloguing and information retrieval

Hockey's book includes extensive references to scholarly activity in each area. The final chapter, 'How to Start a Project', though it assumes going to a computer centre to use a mainframe, is still worth reading.

Applications software may be utilized in any of the three principal areas of academic responsibility, that is in research, teaching or administration. Tannenbaum's last category, F, 'computer assisted instruction,' refers, I presume, to specialized software packages usually referred to as 'Authoring Packages'. These Authoring Packages provide an environment of computer choices in which the non-programmer can easily create 'creative courseware', as the advertising blurb for one such package puts it (for example, the package *Course of Action*—also called *Author-ware*—for the Macintosh). On the other hand, writers of computer courseware can use any other software application which suits their specific purpose. The adminstrative use of computer software is also well established. Recently, for example, the University Computing Service of the University of Sydney, together with the central administrative staff of the University, have developed SUDss, the Sydney University Departmental Student System, for keeping and maintaining student records. This application has been developed using the package OMNIS, a relational data base, category B.2 in Tannenbaum's taxonomy, and is being distributed to individual departments throughout the University for their use. I predict that staff in the humanities who might in the past have asserted no interest in the use of the computer in their research will nevertheless find themselves, within the next two or three years, taking for granted the use of a computer in administration.

Despite the wealth of applications becoming available, there may still be none that does just what you want. Then it is necessary to write your own programme, as in the bad old days. Of traditional programming languages, BASIC and PASCAL appear to have been the most frequently used, or at least taught, to students of computing in the humanities.[5] It is not however inevitable that the researchers themselves must do the programming, if there is sufficient liason between the humanities departments and those specializing in computer technology. For example, at the University of Otago, New Zealand, an 'integrated approach' has been established for developing applications for teaching using computers. Experts in three areas, in computing, in education, and in a specific academic discipline, are brought together in order to develop teaching packages for that discipline. Marjan Vlugter, CAL ('computer aided learning') Consultant and Programmer at the Computing Services Centre at Otago, has found the Hypercard application with the Macintosh personal computer particularly useful for this work. (As well as being a a method of linking textual and/or graphic information, Hypercard includes a complete programming language, Hypertalk.)[6]

I began by discussing factors I saw as particularly important to non-scientific work back in 1967, problems of text manipulation, of storage, and of input and output. Just as microcomputers and their associated applications have allowed 'non-scientific' scholars to work readily with texts, so the development in input and output facilities and computer storage associated with micro-computers has facilitated work in the humanities. Interactive sessions at a keyboard, typing in the text and seeing it on the screen, with the immediate opportunity to edit it, is a far cry from the old days of inputting information on paper tape or cards. Optical scanners, for automatic character recognition, are still improving but can, with various limitations, now read information directly from printed or typed copy to computer disk, so saving the lengthy process of manual keying. In storage, hard disks provide storage capacities once associated only with main-frames, while the even newer

[5]That is, taught in computer courses where programming was taught to students of the Humanities. Many such courses teach only about applications. See Rudman, op. cit., p. 243.

[6]Marjan Vlugter 'CAL: An Integrated Approach', *ASCILITE–88, Computers in Learning in Tertiary Education*, ed. Kay Fielden, Frank Hicks and Nick Scott, Canberra (College of Advanced Education), 1988, 76-86.

compact disk method of storage has a mind-boggling capacity.[7] And finally, the development of high-quality printers, such as the laser printer, with the software provision of exotic fonts, the special characters for different languages particularly needed by output in the humanities, has allowed the development of that new publishing phenomenon, desk-top publishing, where 'camera-ready copy' is delivered to the printer. The problems and questions of one wanting to work with computers and text in 1967 have been abundantly dealt with. But, as Joseph Raben wrote in an editorial, 'Retrospect', on the first twenty years of the periodical *Computers and the humanities* (from1966 to 1986), 'much more important than ... dramatic advances in technology is the arrival of scholars who have grown up with it ... Unlike their intellectual forebears, who brought only standard problems to the machine in the hope of faster or more accurate solutions, the new electronic scholars are recognizing new questions because they can conceive the new means of answering them.[8] In other words, for these young scholars, the social context of computing has changed. Scholars in the humanities will not be 'going out of their field' in utilizing the computer. But equally the social dimensions of the humanities have changed, if the new technology lies within their 'natural' compass. Moving within these new dimensions, students can talk about new tasks as 'the concern of the humanities' because they can talk about new ways of acting as a scholar in the humanities. For most young post-graduates in the Sydney University English Department, for example, using the computer as a word-processor to create, edit, and print text for their thesis is already as routine as my generation's use of the typewriter. Later, if they continue in scholarly research, moving on to other Applications Packages will be comparatively easy for them.

In the remainder of this paper, I am not going to speculate about these new questions and new tasks which students and scholars of the future may ask or set about. Rather, I want to

[7]'This storage technology is so large that ten years of ten journals in one subject could be kept and indexed on the same disk, ready for rapid searching and printout to a screen or printer.' Robert L. Oakman, 'Perspectives on Teaching Computing in the Humanities', *Computers and the Humanities* XXI (1987), p. 231.

[8]*Computers and the Humanities*, XX (1986), p. 325.

indicate broadly the developments in the technology which will, I consider, open up the most expansive possibilites for the humanities.

First, hardware, that is, machinery or physical technology. Two developments here are especially significant. First, the multimedia technology, by which different types of information can be integrated through a computer. Consider this account of such an integration from a project on the use of an interactive videodisc for computer aided learning in the Health Sciences:

> The IVD (Interactive Video Disk) workstation has been placed in the S.A.I.T. (South Australian Institute of Technology) Library so that it is readily accessible for students after-hours and on weekends. It runs continuously throughout the day and the student accesses the lessons through a menu on the screen. The workstation consists of a microcomputer, special adaptor boards, mouse, videodisc player and monitor and costs approximately A$8500. The instructional design of the videodisc material required a single screen presentation so that the broadcast quality video pictures could be overlaid with computer generated text and colour graphics.[9]

Those of us who read the Monday computer section in the *Sydney Morning Herald* confront an acronymic proliferation of these marvels. For example, CD-ROM (compact disk, read only memory), CD-I (compact disk interactive), or DV-I (Digital Video Inter-active).[10] By these means verbal text, written or oral, music, graphics in diagrams and drawings, pictures, as in photographs or slides, and films—all these can be brought together into some vast

[9]Allan Christie, 'Evaluation of an Educational Innovation—Interactive Videodisc in the Health Sciences', *ASCILITE–88*, p. 53.

[10]CD-I (compact disk interactive), 'generated out of the compact disk audio and the playback of the video tape recorder, CD-I is a multi functional product played as a peripheral into the television/monitor set'; DV-I (Digital Video Inter-active), having 'a two-chip RCA video display processors (sic), compressing digital video that plays back seventy two minutes of action packed moving pictures'. From T. Robert Haynes and Vince Blacburn, abstract for 'A Comparison of Compact Disc-Interactive CD-I and Digital Video Interactive: the New Media Technologies', *ASCILITE–88*, p. 64.

data base, from which the scholar can select interactively. The study of semiotics generally, that is meaning conveyed in any medium, rather than only in language, becomes a viable study. One could study, for example, a theatrical performance, or the social interaction of the medical interview, and so on. Bond University, I believe, has interactive video for the teaching of French, so that students can learn the body language of the culture as well as the verbal language.

In my own discipline, English, the oral and visual texts (using the word text in a more general sense than 'verbal text') of late twentieth century culture, with its television, film and video clips, may at last readily become objects of study, even as literary texts, such as those of the novel and drama, have been. (Of course courses on film have existed, though typically not at conservative universities and not with the opportunities of study presented by the new technology.)

The second development of hardware which is particularly significant for those in the humanities is that of networking, the physical linking together of computers. First, a department, if it is physically compact, can link its computers with each other in a local area network. For example, you can use the central catalogue in Fisher library at any terminal in the Fisher building. Secondly, local area networks can be linked to a larger network. The University of Sydney only last year opened SYDNET, a major cable or backbone, to which individual computers, or local area networks in individual buildings, can be connected, so that through the SYDNET network computers in one part of the University can communicate with those in other parts. I'm sure we all look forward to quizzing the Fisher on-line catalogue from our own department—is the book I want owned by Fisher? is it out on loan? before we set off on the physical trek in the rain. Finally, a computer in a department can be linked to a computer which is external to the University of Sydney, either directly through a modem and the telephone system or through SYDNET and thence via a University Computing Service link to that external computer (routed of course through the network of which it is a part). These external computers could be outside Australia. Perhaps you have already made use of on-line bibliographic searching from a Fisher terminal to a bibliographical data base in the United States.[11]

These physical networks are the channels through which an Information Network comes into being—in fact the term 'Information Technology' is now often used, rather than 'Computer Technology', for the whole complex of inter-related hardware and software developments. The two hardware developments I've mentioned, multi-media, interactive, with vast storage capacities, combined with the networking of computers, are the necessary technologies for the development of the remote on-line multi-media data base: remote, because the physical location of the data base is irrelevant, on-line, because a user can interrogate the information directly while sitting at a terminal work-station, multi-media, because information in the form of words, diagrams, slides, film and so on can be part of the data base. Such facilities will certainly help overcome that 'tyranny of distance' which scholars in Australia have traditionally experienced. On a global scale, you may like to reflect on the social implications of the growth in information technology co-inciding with the decline in oil supplies. Ultimately, with a personal computer in the scholar's home connected to outside networks via the telephone modem, the scholar will not go to the library—the library will come to the scholar.

The limitations on the use of information technology will be economic and legal, rather than technical. How many international phone calls can your department afford in order to use these fabulous data bases? How can privacy and security of information be maintained, for example if SUDss, the student records system, were put on-line via SYDNET? And what are the social consequences of this shift in the way humans can interact? Sara Kiesler, a Professor of Social Sciences in the United States, is studying the

[11] Sylvia C. Krausse and John B. Etchingham give a helpful overview of what is available in their article, 'The Humanist and Computer-Assisted Library Research', *Computers and the Humanities*, XX (1986), 87-96. To their list add Arts and Humanities Search (reviewed *Computers and the Humanities*, XX (1986), 121-4), CALICO for linguistics (Brigham Young University) and the London Stage Information Bank (Lawrence University); these last two are mentioned by Robert L. Oakman, 'Perspectives on Teaching Computers in the Humanities', *Computers and the Humanities*, XXI (1987), p. 230. No doubt there are many more.

social effects of computer technology. Three of her conclusions I mention briefly.[12] First, in 'computer conferencing', that is where a meeting is held with individuals communicating through a computer network, not face to face, individuals with lower status play a larger part, make more verbal contributions, than in face to face discussion. 'When the visible signs of social status are hidden, less dominant, less secure individuals, with lower status, tend to talk more.' Women, both students and academics, may find this observation particularly interesting. Secondly, sending messages in the network of an organization correlates with commitment to that organization. Just receiving messages does not have such a correlation. This suggests, perhaps, that students had better be given as active a role as possible in any computer aided learning. And thirdly, comparable to the activity of 'phonies' in the introduction of the telephone, that is people who spoke anonymously or deceitfully because they could be heard but not seen with the new technology, an activity described by Kiesler as 'flaming' occurs in the use of information networks: a tendency to very informal, even obscene, language, and lengthy written outbursts, of indignation, complaint, general rudeness and so on. The 'cure' for excessive flaming, Kiesler suggests, is the clear identification of participants (no code names) and the explicit development of a protocol for communication. As the University of Sydney intends to move to electronic mail sent via SYDNET, this third social effect is worth noting. I mention Kiesler's work because it illustrates, if you like, not the applications of the computer to the humanities, but the applications of the humanities to the computer. Each of us in our own discipline might like to construct relevant questions in our own field—for example, in English, I immediately think of the question: what are the effects on writing style of the use of word-processors? Certainly, academics in English literature will miss the author's several written drafts of the past.

You recall I am discussing the developments in computer technology which will open up the most expansive possibilities for

[12]Sara Kiesler gave a 'keynote address' at the sixth Annual Conference on Computers in Learning in Tertiary Education, *ASCILITE–88*, Canberra, in December 1988. The conclusions mentioned are taken from this address. See further: *Computing and Change on Campus*, ed. Sarah Kiesler and Lee Sproull, Cambridge, 1987.

the humanities. I suggest there are two such developments in software: that of Artificial Intelligence together with its sub-field, Expert Systems, and that of Hypertext.

Hypertext is a term used for the organization of data so that it is accessible in very 'flexible and intuitive ways.' I quote from a recent article:

> what differentiates this technology from other retrieval systems is that a user can 'browse' through information, moving from one place or idea to another through a web of associations. It is this unlimited branching capability which has led some to suggest that such a facility more closely supports the way the human mind works than conventional, linear data base managers.[13]

(The latter were class B.2 in Tannenbaum's taxonomies.) I have already mentioned an example of Hypertext, called Hypercard, for use with the Macintosh personal computer. Another example, called GUIDE, can also be used for the IBM or compatible personal computer. As I remarked earlier of Hypercard, Hypertext allows information from different media applications to be brought together, such as verbal text, graphics, video disk. In summary, the user can control the multi-media hardware through the Hypertext software. The user can 'browse' through this complex information environment; at the same time, the system keeps a record of the path the user is taking through this information. The latter feature can be used, for example, in modeling student learning habits. I confess here to definite bias: I think that for those with a non-technical education, such as has been traditionally experienced in the humanities, Hypertext offers a much more compatible computer environment than other methods of organizing information.

Finally, a word on Artificial Intelligence and Expert Systems.

Artificial Intelligence, usually referred to as AI (though my

[13]Malcolm J. Morrison & Pascal Grant, 'The Elaboration Theory Model of Instructional Design: Hypercard—New Perspectives on Learner controlled CAL', *ASCILITE–88*, p. 72.

North Coast farming background makes me a little uneasy with this abbreviation), has been described as 'the study of how to make computers do things that people [do] better.'[14] In 1967 I had to ask about computers in the Physics Department. By now, computers are part of everyday life. You don't go to the Physics department to learn how to get money out of your bank's Flexiteller or Green Machine. For this change to happen, a great deal of work has had to be done on the 'interface', as they call it, between the computer and the human user. The more 'natural' this interface appears, the more artificial intelligence theory has been applied to allow the computer to simulate human inter-action. AI is also used to attempt tasks usually done by humans by themselves, for example, machine translation. Artificial Intelligence must study language or verbal communication, it must study logical inferencing, or human cognitive skills, it must study inter-personal or social behaviour, and it must study the nature of the knowledge about the world which humans bring to bear on a particular problem. AI thus shares many of the same objects of study as (at least) linguistics, psychology, sociology and philosophy. Certainly, in these days, a computer science student with a question about natural language is quite likely to be wandering the corridors of linguistics.

In addition to these established disciplines of linguistics, psychology and so on, a new academic field of study has developed as an object of study in artificial intelligence. This new field is called 'expert systems' and it has developed from the concern of AI to make explicit the nature of expert knowledge, that is, to make explicit the knowledge made use of by an expert in a discipline in solving problems in that discipline. I quote from a recent textbook, by William Clancey:

> In this decade we have witnessed a phenomental growth of interest in expert systems—computer programs that codify the knowledge of experts in diverse areas of science, engineering, medicine, and business. These programs use qualitative modeling techniques, developed in the subfield of computer science called artificial intelligence. Routine expert practice is thus codified,

[14]Elaine Rich, 'Artifical Intelligence and the Humanities', *Computers and the Humanities,* XIX (1985), 117.

> allowing knowledge to be distributed, accumulated, and conserved in what is called a knowledge base.[15]

(No mention of the humanities one notes!) The concern of Clancey's book is to consider how such a knowledge base could best be utilized in teaching. The sort of CAL, computer aided learning, associated with expert systems or artificial intelligence is of a quite different order of complexity and flexibility from the CAL associated with conventional Authoring packages, the CAI applications in Tannenbaum's taxonomy. This sort of generalization could be extended to all the conventional software packages we earlier considered.

The development of Artificial Intelligence will have two implications for scholars working in the humanities.

First, the interface between human and machine will move further in the direction of the human—computers will be more 'user friendly', in the jargon of computerese. We saw such a development in the movement from mainframe computer and individual programming to personal computer and pre-written software packages. This movement will continue with, for example, increased use of 'natural language' in 'talking to' the machine, rather than the use of fixed commands which have to be looked up in a software manual. Of course the intelligent computer may be accumulating its own knowledge base about users and may 'talk back'—e.g. 'You do use the laser printer a lot. It's very expensive. Please use the Imagewriter for drafts'. The more 'natural' the interaction between human and machine, the more accessible it is of course for those from a non-technical background such as scholars in the humanities.

The second implication of the development of Artificial Intelligence relates to the research of specific scholars—those who actively participate in the development of AI for the humanities. The 1985 volume of *Computers and the Humanities* contains several papers on this subject; for example: 'Intelligent Knowledge-based Systems in Archaeology: A Computerized Simulation of Reasoning

[15] *Knowledge Based Tutoring*, Cambridge, Mass., 1987, Preface.

by Means of an Expert System,' by Marie-Salome Lagrange and Monique Renaud, and again, 'Integrating Artificial Intelligence into Literary Research: An Invitation to Discuss Design Specifications,' by Nick Cercone and Carole Murchison.[16] This sort of work is very much 'work in progress' at the moment. In theory, if it is successful, it will enable the scholar to ask questions which require knowledge of humans as social beings, qualitative questions, rather than the traditional questions expressed in quantitative terms. For example, the expert system POLITICS can predict the interpretation of newspaper headlines by those of different political persuasions.[17] A scholar in literature, for example, might one day ask questions about point of view in the novel, rather than ask for, say, a vocabulary count of certain words in the text. Of course the expert system, the knowledge base of literary knowledge through which the scholar is asking this question, must contain a codified representation of a literary scholar's understanding of point of view (with a caveat that the designer of the expert system is thus in an ideologically dominant position). The quantification, then, of the problem is in that coded representation; ultimately the machine is still processing the human request as a pattern of binary numbers.

At this point, I should offer a conclusion. Yet how inappropriate any closing remarks would be at this stage of the development of the subject, Computers and the humanities. In that historical text of scholarly practice, we have, I believe, reached the end of the introduction, but we are no more than one paragraph into the central development of the theme.

[16] *Computers and the Humanities*, XIX (1985), 37-52, 235-43.

[17] An example discussed by Cercone and Murchison, p. 241, n. 20.