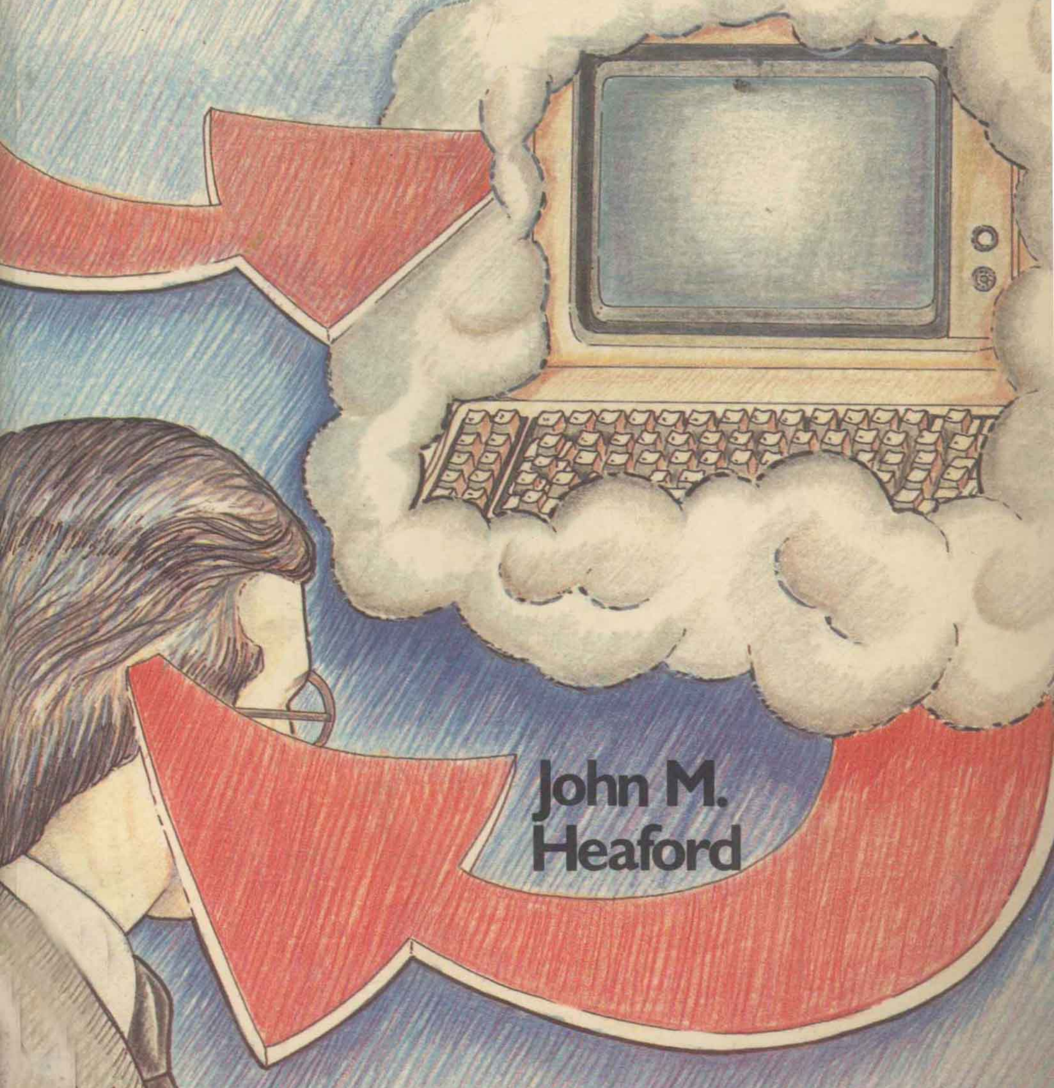
Myth of the Learning Machine

The Theory and Practice of Computer Based Learning



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PREFACE

Computer Literacy - at any level, at any age, at any price - is the fundamental basis upon which the future of industry, and maybe society, will depend.

It is estimated that around ten million people in the U.K. will need to undergo some form of computer-related training during the next 5 years. As computers become more powerful, this training will become less technical, and subjects of a more general nature will be delivered to wider and wider audiences. Traditional training methods will not keep pace. The answer to the computer literacy problem lies in the technology itself.

The emergence of cheap microprocessors programmed for a specific instructional procedure, interactive video/computer systems and computer software packages for do-it-yourself instruction design, make possible a truly individualised approach to training and education. Yet there is a concern, which is shared by many educationalists and which this author supports, that there is too heavy an emphasis on the provision of a recipe or tool kit for packaging standard instructional sequences using new equipment and empirically validated instructional materials. Recent investigations have uncovered over 200 of these 'tool-kits', often referred to as Authoring systems or Authoring languages. Computer Based Training or CBT, is a phrase being commonly used to incorporate all the aspects of the computer in the learning process, whether managing the administration controlling the student's progress through learning paths, or directly delivering new material through a computer terminal. We sometimes refer to this development as 'educational technology'.

This book challenges some current ideas in educational technology and places an emphasis on the need for the development of the requisite theory and practice of Computer Based Training design, which caters for the idiosyncratic capabilities of the learners.

In the United Kingdom and especially, but perhaps not surprisingly, amongst the computing fraternity, there exists a preoccupation with authoring systems and languages which suggests a predominant concern with finding a market for the technology, or finding a problem for the solution. Surely, the aim of educational technologists must be to develop facilities which allow the student access to a "freedom of learning" experience hitherto unavailable.

Now we can represent ideas in concrete form and change them instantly on a screen, thereby affecting the way people learn to think. A golden opportunity to change for the better, the way we teach. Yet there is a crying need for more research into understanding how the computer can be made to deliver truly individualised instruction, which takes us beyond today's de-synchronised systems of learning/teaching style mismatch.

Whilst the emphasis here is on industrial training and education, there is much we can learn from activities in schools and examples of work done with children. Where appropriate, I have included references and case studies from both observed activities and personal experience.

I am indebted to Seymour Papert for his work with children and his LOGO system, eloquently described in "Mindstorms; Children, Computers and Powerful Ideas", and to John Holt, who challenged popular training methods in his controversial "Instead of Education". Equally so, the warning bells, loudly tolled, in Joseph Weizenbaum's 'Computer Power and Human Reason' have greatly influenced my thinking.

Through this book, I want to carry their ideas to industry and schools with as loud a voice as I can muster. I want help to create the change: A Renaissance in Education; because I believe that the myth of the learning machine that begins, "Computers can never......", will be exposed in the next decade. Computer Based learning will replace todays teaching systems, and new roles for school teachers and industrial educators will emerge.

A warning however, should be heard. Whilst euphoric claims for computing power continue to rise with alarming pace, educators must understand the upper limits of this power. Human intelligence and thought cannot today be measured or understood. It will be several hundred years before neurophysiology reaches such heights. To suggest that computers will 'think' like people is dangerous - and perhaps more injurious to progress than the earlier 'myth' to which I referred - misunderstanding and underestimating of computing power. So the myth is double- edged. The computer is more powerful than most people believe or can comprehend, but less potentially capable, in the short term, than the artificial intelligencia would have us believe. The issue will not be *whether* intelligent machines are possible but if indeed they are desirable.

The argument here is about *people* and better ways to live in society. If machines can help us to do that, so much the better. If misunderstanding about their capabilities (machines *and* people) surrounds our attempts to integrate machines into society - so much the worse.

It is precisely *because* of the potential impact of computers - good and bad -upon education, that I have written this book.

I hope it raises much debate and controversy.

I believe that of all the aspects of life for which we predict change, with the successful integration of computers, *none* will change as dramatically as education.

JOHN M. HEAFORD.

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PART ONE - THINKING & OBSERVING

PART TWO - PLANNING & DOING

CHAPTER 1 — SOME DEFINITIONS

1.1 Computer Managed Learning (CML), Instruction (CMI), Education (CME)

Although used originally by many to signify the generic concept of teaching by computer, these terms have latterly come to signify the more administrative tasks of record keeping, scheduling, curriculum design, training room log, evaluation letter generation, confirmations, task analyses etc. These terms are not important, but the implied computer function is.

We will discuss these functions later.

1.2 Computer Enhanced Multi-Media Training (CEMT), Computer Based Training (CBT)

These two suggest a mix of other teaching media which are controlled by computer or, in most cases, to which the student is directed during the lesson. The latter expression has become the industry 'standard' for all aspects of using the computer in training and education. In some cases this misleads prospective users into believing that all aspects of the computer's function are contained in any system with the 'CBT' label. This could not be further from the truth, as we shall see.

1.3 Computer Assisted Learning, (CAL) or Instruction (CAI)

These have been used to indicate *delivery* of training material through the computer. On occasion, however, you will see these expressions used to describe some of the functions vaguely noted above.

1.4 What's it all about ?

Well, to begin with, the computer industry is notorious for inventing strange acronyms, abbreviation and word-association games in order to deepen the mystery of computers and to perpetuate the elitism which still exists in this once-exclusive club. Of course, anything as new as teaching by computer has to receive the full treatment before some standard emerges, and this usually occurs through process of fashion rather than need of clarity or appropriateness.

Since we mostly do not have time to wait for conventions to formulate, perhaps we should take a look at what the computer can do in the learning process. I have divided these functions into three general areas for simplicity, because I believe that each area is fundamentally different in its contribution to training and education. The functions I want to discuss are those of MANAGING, CONTROLLING and DELIVERING.

Managing (Fig.1.1)

This is the use of computing power in its simplest form. All the lengthy, laborious tasks of record-keeping, reporting, keeping skills matrices, staff lists, performance statistics etc. can be painlessly managed by the computer. I say *can* be managed, because it is rare to find the computer performing these functions even in organisations where its other, more sophisticated functions are being exploited.

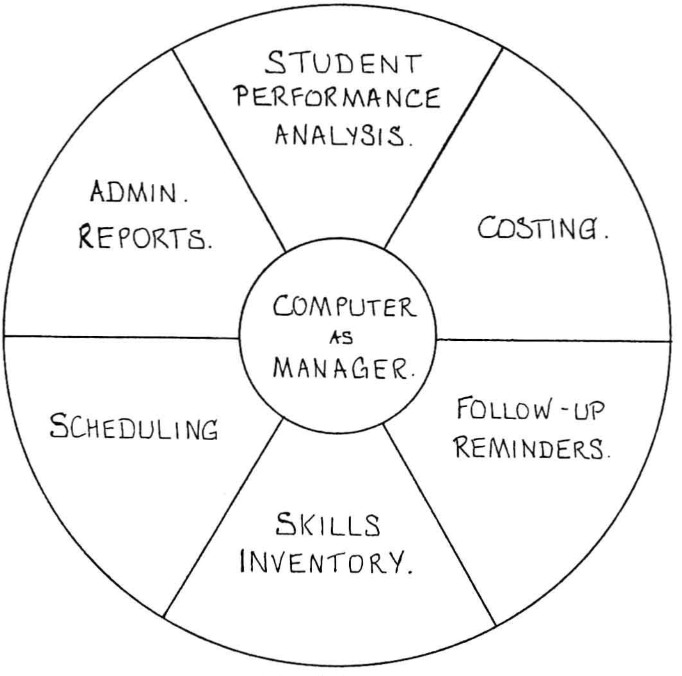

Fig. 1.1

The management of a professional training programme is done so poorly in the United Kingdom, especially in the Information Processing industry, that the introduction of a computerised control system is likely to *add* to the workload rather than prove to be a time-saving technological innovation. Nevertheless, it is worth relating the sorts of work we can perform with a little thought and application. A professionally designed training management system, should look something like this.

STEP 1

Establish a computer 'database' of tasks related to the jobs performed by the audience group. These tasks might be gleaned from simple job descriptions or may take the form of behavioural objectives as the result of a task analysis exercise. Purists in the training business recommend the latter, time-consuming step as *the* prerequisite to the establishment of any professional training programme. However, we cannot divorce the use of the computer for administration purposes from its role in delivery and control of individualised instruction.

This latter development, as we shall see in later chapters demands an entirely new approach to curriculum analysis. This approach suggests an enhancement to tasks analysis which puts more emphasis on the structure of the subject matter. Such analysis will show the importance of ideas and concepts as well as behavioural skills with a clarification of their inter-relationships. A critical aspect of personalised instruction is that of building on the learners' existing knowledge which stems from an understanding, not only of the selected topic, but from a complex network of inter-related topics. Pask[16] detailed conceptual entailment structures for conversational teaching systems which illustrate the organic nature of some of the more complex networks. Whilst I acknowledge the popularity (and simplistic nature) of behavioural objectives in the context of curriculum design and task analysis, it must be understood that a representation of *knowledge* is more important than a list of behaviours. Studies into human memory show this to be clearly so.

I strongly support the views of David Mitchell[39] in this area in that most of the instructional design advocates argue that a rigid instructional plan, based on task analysis and behavioural objectives is the *only* way to cater for all learners. The only reason that this approach seems to work is that students have adapted to it over the years, in the same way that generations have adapted to inadequate teaching and instruction delivery methods, shown by Holt[10], Papert[14] and Piaget[17] to be totally at odds with the nature of the learning process. To begin with, the job of creating a task analysis is extremely time-consuming and it is not surprising that very few organisations go to the trouble of effecting such long-winded affairs. I can think of only one training services company which has gone to the length of supplying such an analysis of all tasks common to the Information Processing Industry, and to have put them on a pre-packaged, editable, computer file. That company is DELTAK and its package is 'DELTA 1', which performs most or all of the steps indicated in this section on management of training by computer technology.

In later chapters I will discuss what changes are indicated in the initial step for managing the training programme. This will detail the way this feature is related to my suggestions for the development of new instruction design architectures. The conflicting natures of the traditional behaviourist approach and the educational technologists' desire to create true individual instruction, will also be reviewed.

STEP 2

Create a computer file of all students and their managers, (who may also be students). This file will contain details of training history and will build up a profile of course experience by department and individual, eventually acting as a source database for a company skills pool. This is only possible, of course, if the nature of the 'course completion' records is such that all completions are synonomous with mastery and understanding of the skills or knowledge in question. This is clearly not so in many of today's record systems since there is little evidence of post-course mastery testing or evaluation. We shall see later that Computer Based Training systems contain some very sophisticated automated mastery testing and record keeping procedures which should enable us to track more accurately, the availability of skills within companies.

STEP 3

Create a computer file of all available and approved training resources, including alternatives for the same skills where appropriate. This file should contain indicators which match the course to the appropriate task, skill or element or knowledge listed in the Task File in Step 1, above.

STEP 4

Create a simple diary file on computer which contains details of internal facilities availability.

STEP 5

Create computer programs to collect and manipulate input data from individual students' training requirement, time availability, course completions etc. Programs to update history files and all files indicated above should also be created. The output from these programs should include detailed training schedules for all students, internal facilities availability, reports showing actual training against planned, training costs, individual history, course popularity etc.

This, of course, is an over simplification, because I do not consider it of much value to the reader that I detail the nature of these hypothetical programs and files. What will be of value, however, is an example of such a system written by Chris Naylor of the East Midlands Electricity Board (See Chapter 2).

Controlling (Fig. 1.2)

Here, we are beginning to see the computer's power being exploited, although still somewhat primitively, to perform tasks which we have not previously undertaken in the training environment. We can control the student's progress through learning sessions via pre- and post- testing routines, pre- requisite verification performance evaluation, drill and practice, re-routing through difficult material with the help of sophisticated branching routines which take the student deeper into the subject matter upon request. All of these elements can be brought together in a learning session using some new course design architectures, which I will describe in detail in Chapter 4. In its simplest form the student is sometimes asked to take pre-course tests to determine which parts of the course material are relevant or pertinent to his or her current status. This method of status determination has been used for some years in the training of athletes developing physical motor skills and other attributes and yet has only recently emerged in the world of industrial training. Similar links with physiology may not at first seem apparent but will become clearer in Chapter 2. Those computer based systems which generate a 'learning prescription' based on student answers to these pre-tests clearly demonstrate considerable time-saving in eliminating superfluous course material. This is especially apparent of course, when the student is undergoing 'refresher' training. Using the computer to analyse performance during drill and practice routines, and to recommend further or remedial re-training is also proving to be beneficial in ensuring that subject mastery is demonstrably achieved. Research in training into several different fields has resulted in a clear indication that time-saving is a major benefit in the use of the computer to control student environment. Results from experiences in training medical students, airline pilots, military personnel, and computer programmers show that significant reduction in time taken to achieve mastery is observed when compared with the time required to reach the same level of competency using traditional training methods.

But a word of warning - Which methods are being compared ? Certainly gains of as much as 30% in time saving over lecture-based methods have been achieved. Gains of this magnitude, however, have been consistently apparent for a number of years using self-paced, multi-media training, where the student learns through a variety of presentation media like text, audio, video, slide, film etc.. In many cases where multi-media methods are used, the necessary follow-up tutorials are given scant attention and the resulting student performance is less than otherwise might have been. Adding pre- and post- instruction tests through a computer to this process will hardly result in time saving over such unprofessional methods.

What we *must demand* from suppliers and designers of computer based learning packages is much more sophistication.

Just what to ask for and how it might be achieved will, I hope become clearer in Chapter 3 (What we might achieve).

Delivering (Fig. 1.3)

This is where the computer screen or output device acts as a presenter of learning material through simulation of the working environment interactive dialogue, animation, graphics, speech synthesis, screen text etc. Undoubtedly, those who have studied the

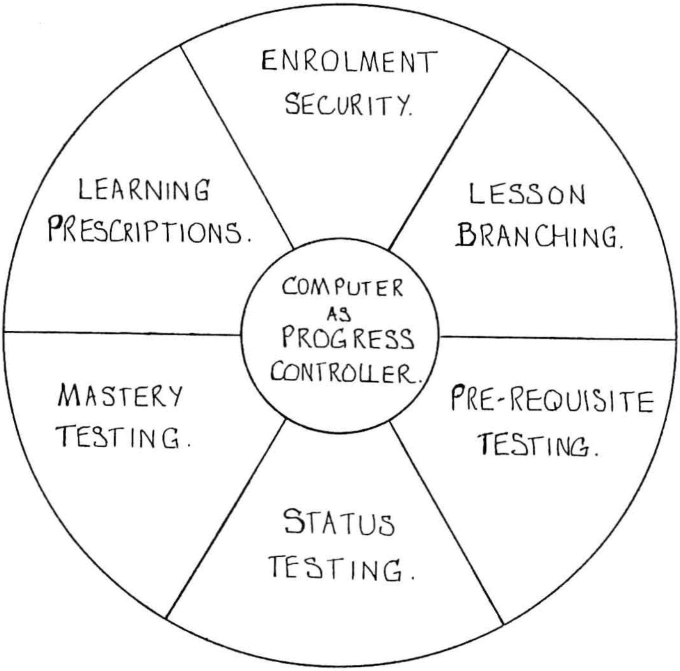

Fig. 1.2

computer based training case in any depth, will agree that the addition of the above elements into the learning session constitutes a major step in the effectiveness of the instruction process. Delivery of instruction through the computer, *where appropriate,* results in most cases in greater confidence in applying the skills when the student returns to the job. There is clear evidence that direct instruction through the computer is significantly more effective in producing high levels of achievement in performance related skills than traditional classroom methods. This is achieved through personalised instruction, active involvement of the learner and immediate, continual feedback. The exacting methods we use to evaluate the effectiveness of these new teaching methods are helping lesson designers to produce more sophisticated instructional routines. Regrettably, in five years of detailed study, I have yet to find more than a handful of organisations who professionally evaluate the effectiveness of their training programmes *whatever* media are used to deliver the instruction. How then can today's potential users of computer based training hope to compare its efficiency with other methods ?

Because of a clear lack of professionalism in the training of Information Processing staff in this country, little attempt has been made to understand the learning process of the adult learner in these environments. Consequently, these students are being exposed to their first taste of learning by computer through a stream of screen delivered text, electronic page-turning, original text transferred from 12-point type with lots of white space (a process we know to be successful in delivering detailed technical material) to small green letters on a grey background with 3-4 hours of unbroken delivery. A retrograde step in educational terms! Where are we going ? It is time to stop and take stock of the *whole* process of learning in industry and in schools. The computer has power to change the learning process beyond anything we have approached so far. But the environment must change to accommodate it. This entails a cultural and social change which goes beyond the overt direction of this book. Yet as you read on, you will see that this change must begin now if we are to harness the computer's power to enhance the learning process rather than further to entrench and perpetuate traditional, inefficient methods.

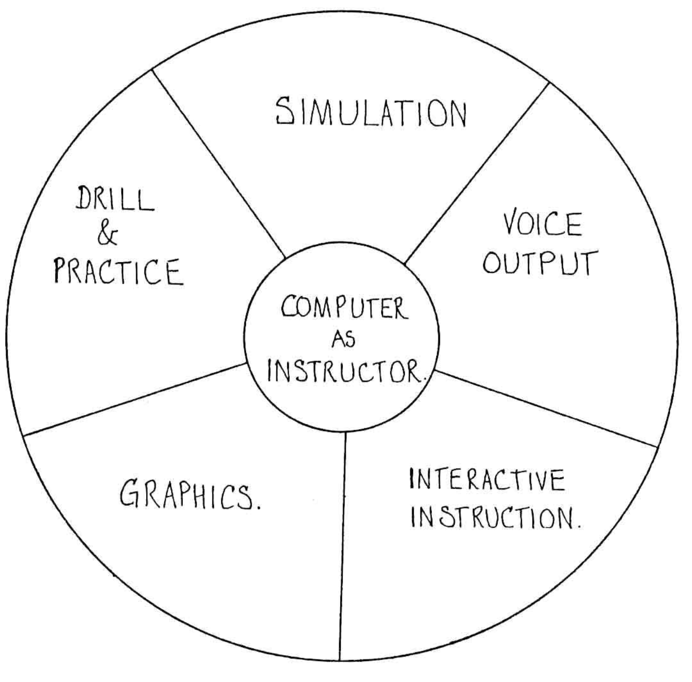

Fig. 1.3