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Educating Planners in Information Technology

by Michael Batty

UWIST Department of Town Planning
Athrofa Gwyddoniaeth a Thechnoleg Prifysgol Cymru
University of Wales Institute of Science and Technology

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EDUCATING PLANNERS IN INFORMATION TECHNOLOGY: EXPERIENCES FROM DEVELOPED AND DEVELOPING COUNTRIES.

by

Michael Batty

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Department of Town Planning, University of Wales Institute of Science and Technology, Colum Drive, Cardiff, CF1 3EU, United Kingdom.

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Town Planning Department,
UWIST,
Colum Drive,
CARDIFF CF1 3EU

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ABSTRACT

This paper presents a broad ranging review of the role of information technology in urban and regional planning, emphasising the critical issues involved in training and educating planners in the new skills required. The main theme developed concerns the ubiquity and diversity of information technology in society in general and planning in particular, and the need to develop appropriate responses in specific situations. After some preliminary definitions of the scope of this discussion, a model of the planning task environment and the way in which information technology is and can be applied is outlined. Possibilities and challenges for education and training emerge from this, but present responses appear somewhat muted, at least in British planning practice. It is argued that the speed of the transition to the information society and the 'shock' of being introduced to so many new opportunities involving information processing is as great in the developed as in developing countries. This is illustrated in the author's own working environment in terms of the way hardware and software have changed over the last decade. The difficulties of making use of these new opportunities are then discussed by noting case studies involving students from developing countries which the author is acquainted with. It is then argued that the basic task of training and education in this field is to provide planners with opportunities and skills in creatively handling and adapting standard software for specific planning tasks, not in becoming 'aware' **per se** or in learning analytical-programming skills. The challenge then is in providing methods which enable planners to blend a general knowledge of hardware and software opportunities with their specific knowledge of planning tasks and organisational structures.

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THE AUTHOR

Michael Batty is Professor of Town Planning in the University of Wales Institute of Science and Technology, Cardiff, CF1 3EU, Wales, U.K.

INTRODUCTION : THE EMERGENT INFORMATION SOCIETY

The radical transformation of modern societies through the development of information technology since the advent of the computer in mid-20th century is often compared with the development of the printing press in the mid-15th century. Daniel Bell (1979) who popularised the notion of the 'post-industrial society', uses this analogy to emphasise the all-pervasive nature of the new technology but it is only in terms of the dissemination, storage and retrieval of information that the analogy holds. A more dramatic comparison is with the development of writing for it is now clear that the really creative development of information technology involves processing information, in short in computing new information, transforming and manipulating data, thus involving qualitative as well as quantitative change.

The development of writing is so deeply embedded in our culture and consciousness that we do not have a clear picture of its impact. In fact, its development was so gradual that it is fruitless to speculate on the transition that took place and thus it is not possible to use the analogy to speculate on the impact which the present revolution in information technology is having and will continue to have. Although the notion of computing goes back into the history of mathematics, its formal embodiment in the technology of the computer less than 50 years ago has lead to a change so fast and so pervasive that we are only beginning to appreciate its consequences. Despite this rapid change, once the revolution has run its course, information technology and computing will be simply part of the background to everyday life, and there is no reason to think that it will be any less pervasive than writing and printing. There is even a chance that it may be more pervasive, embracing art and music as well. In time,

education and training will be widely based on such technology, it will suffer the same problems of literacy which plague writing and verbal expression today, and it will be organised into general and specialist areas. Nevertheless, because we are centrally involved in the transition to such an information age, it makes sense to study its impact and to prescribe how far information technology should be managed, particularly here in the context of urban and regional planning.

Although the technology of the computer is separate from the idea of computing, they represent an inseparable development in which one is not possible without the other. Computing and its technology have had a massive impact on industrial society through automation so far, but increasingly this impact is through the development of new ways of communication. The popular characterisation of industrial society giving way to postindustrial, where all basic material wants are produced by a small fraction of the workforce (Bell, 1973), is given an even more dramatic emphasis by Toffler in his argument that this represents only the third wave or period since prehistory, following settled agriculture, thence industrialisation. The shift from energy to information, or from a society based on locomotion to one of 'infomotion' as Nijkamp and de Jong (1987) describe it, implies an even more radical change which will have enormous implications for the structure of society as well as for any policy-making or organised action in changing that structure. In particular, it is not only computing and the computer, but its synthesis with new forms of electronic communications which comprise the new information technology or 'telematics' (Nora and Mine, 1980). A new social infrastructure based on such communication is being established, both freeing labour from mundane, routinised tasks and releasing people to

engage in education, which itself is highly dependent upon a sophisticated awareness of the technology. Indeed, it is already clear that to fully participate in the information society, the population will have to be trained to a much higher level in basic communications skills than exist at present. This is clear, for example, in the difficulties non computer-literate individuals have with electronic mail, public information systems and such-like general purpose technology.

The information society is also likely to be a much more heterogeneous structure than has been commonly supposed. Increasingly, portraits of the near future envisage undesirable information-based societies, and such diversity is already being reflected in the fact that a market place for information is being quickly established. Information, so long regarded by many as a 'free' or at least 'public' good, is becoming tradeable, value can be added to it through analysis and processing, and it can be communicated over global distances. Networks for its access are controlled by information brokers, and a situation of a society based on information-rich (those with access) and information-poor (those without access) is rapidly emerging (Openshaw and Goddard, 1987).

The speed at which this change is being accomplished constitutes a major problem of adaptation. The shock posed by such radical change in terms of the introduction of hardware and software represents a critical problem for many individuals and organisations, especially for the majority who have little prior experience of computation. Such issues will be central to this paper where we will concentrate on the problems of becoming computer literate and on the massive increase in opportunities for processing and communicating information which the new technology brings. These are not problems for developing countries alone. The shocks experienced by the

developed world are just as great, although different in scope and effect. We will also emphasise the sorts of organisation which information technology brings in its wake. Nijkamp and de Jong (1987) refer to this as 'orgware' and the success of introducing new hardware and developing new software is highly dependent on new forms of 'orgware'.

The way western societies are now moving to a postindustrial culture has never been very clearly predicted by the futurologists such as Bell (1973) and Toffler (1980). These predictions failed to anticipate ideological or value change which is strongly influencing present technological change. Since the end of the postwar boom in the late 1960s, there has been a reassertion of the primacy of the individual, a new emphasis on market economics, and pressures by society-at-large to 'roll back the frontiers of the state'. In short, self-interest has become fashionable once again and the public interest has become less significant. These forces are very complex but the issue is particularly relevant to urban and regional planning, which, in western societies, is an established function of the state and at present under severe scrutiny. In response, planning is becoming less strategic in focus, more entrepreneurial and more locally based. A good example is contained in Manheim and Schofers (1986) recent proposals for a new style of responsive transportation planning.

These changes, however, pose particular problems for assessing the impact of information technology on planning, and for the education and training of planners in its applications. For a rational assessment of such educational possibilities, a clear view of the planning task environment and the way in which information technology can be applied to it is required, so that appropriate education can be identified. If this task

environment itself is changing, applications of and education in information technology becomes uncertain. Already, there have been quite profound changes in the role of information technology in planning since the 1960s, when strategic, long term applications were to the fore, in contrast to today when short term, more routine applications are being emphasised. This is just one example of the more difficult general issue concerning the emergence of an information society which involves the intersection of both technological and ideological-social change in complex and convoluted ways, leading to surprising, novel and unanticipated effects (Gringich, 1984).

Out of this context emerge several themes which will be addressed in this paper. In previous discussions of education and training in information technology for planners, particularly in the two meetings sponsored by the United Nations Centre for Regional Development (UNCRD) held in 1984 (Sazanami, 1986) and 1986 (Manheim, 1987a), there was a sense in which the issues concerning training were clear and homogeneous. The emphasis was upon information systems around which such training could be focussed. In this paper, we will argue that the issues concerning training are nowhere straightforward, that the planning task environment itself is highly diverse, and that many different varieties of education are thus required. This, of course, has been widely recognised, for example by Masser and Wilson (1987), but we will not seek to provide a grand scheme for such training; we will emphasise particular questions and take the general context as given.

Accordingly, the focus here will be narrower than in many previous papers which have comprised the UNCRD project on training in information systems technology for planners. We will emphasise our experiences in teaching and

disseminating information technology to planners in formal academic environments, and we will detail certain examples rather than propose massive agendas for training. We will also set this in a very broad discussion of information technology in planning, emphasising that there is a continuum of information technology from the most rudimentary to the most sophisticated. Indeed, the prospect now exists of an 'alternative' information technology founded on very cheap computing. The impacts of different levels of information technology, however, all involve changes in habits, changes in organisation to support the technology and changes in what is possible. As Sundaram (1987) illustrates : '....what we are dealing with here is nothing less than a powerful "technological avalanche" which is unstoppable because of its innate dynamism....' We will examine in some detail the shock involved in such change. Finally, we will urge caution. The contraints already identified on the adoption of and training in such technology involving capital, finance, skill, availability of appropriate hardware and software, will all be taken as given but we will argue that the technological choices are difficult and complex everywhere, and that progress towards an information society is uneven, and never as remorseless as the pundits imply.

We will first begin with definitions, of information technology itself, but also of education and training. In focussing on education, we require a model of the typical planning task environment, and once introduced, we will then demonstrate how information technology can and is being applied in practice. Although our discussion will be in terms of experiences from developed societies, we will be very conscious of the transfer or otherwise of the conclusions reached to developing countries. We will then digress a little and sketch the kind of ideological change taking place in the

transition to postindustrial society, and how this is combining with technological change to induce severe shocks into established systems and practices. In particular, we will focus on changes in hardware and software in our own academic environment, emphasising the difficulties of assessing, let alone absorbing all the opportunities now available for applications. We will then recount some experiences in developing packaged software for teaching planning students from developed and developing countries, but in an academic environment. We will particularly emphasise the difficulties in adapting general purpose software to new tasks and new contexts, and conclude by once again, emphasising the long-standing dilemma over whether to teach planning students information technology in depth or in terms of only raising their awareness. Our general conclusions, however, concern the way in which new skills must be engendered. Building little by little, from the bottom up and gradually and slowly, appears to be the only successful training strategy which can meet the rapid changes which will continue in information technology over the next 2 or 3 decades. We will also speculate on how far these ideas can be transferred from academic to more practice-based planning contexts.

DEFINITIONS : INFORMATION, TECHNOLOGY, EDUCATION AND TRAINING

We have already indicated a threefold characterisation of information technology. In terms of activities, the use of computers creatively or for purposes of control involves **computing**, and is typically illustrated in **software**. Computing can involve qualitative change in information, but this is accomplished on **computers** or in terms of **hardware**. Computing and computers, software and hardware, although separable conceptually and in terms of use, operation and development, act symbiotically and cannot be separated in terms of the evolution of information technology. The third

component represents the organisation or **orgware** which represents how the hardware-software structure is implemented.

Hardware-software represents a basic building block, which when extended into a network of such blocks represents the very infrastructure of information technology itself. Communication of information in various forms represents the essence of information technology, and this convergence of telecommunications, electronics and computers is opening up dramatic possibilities for new types of creative computing, even in the most routine of tasks. How this infrastructure is being developed depends upon the tasks to which it is being applied, from the most routine to the most strategic. Moreover, the development of this information or 'wired society' as Martin (1978) originally referred to it, is altering the way we use information, not only in quantitative terms but also qualitatively. This will be a recurrent theme which runs throughout this discussion and we will return to it later. It represents a conundrum in that the very environment we are changing through planning is becoming a product of information technology (the wired society), just as the way we are able to explore how to change it is influenced by that same information technology.

Traditionally information systems and control paradigms in planning have not been exclusively related to information technology. Since the development of systems theory a couple of generations ago, planning has been based upon a model of information processing in which information has served to integrate the various tasks or stages comprising the planning process. The development of information technology represents a realisation of such integration which involves not just the substitution of previous forms of communication for the new electronic media, but a massive complementation of functions. Related to this is the dissemination of the

building blocks through miniaturisation, which is leading to strong decentralisation of functions, now computerised, but which have been traditionally centralised. This picture of decentralisation and integration, which will refer to here as 'decentegration', represents the third stage in the computer revolution, according to Manheim (1987), involving the use of computer tools and software in creative ways by end users intent on solving their own problems. Just as the information society is increasingly a self-service society, computing is becoming highly individualised with the appearance of much general purpose software which can be applied to a variety of tasks.

In a sense then, information technology is becoming increasingly diverse and heterogeneous, as it is adapted to specific and general tasks by users acting out many different roles. Miniaturisation and the dramatic fall in costs of computer memory are both leading to much more specialist computer equipment, as well as to the global diffusion of general purpose machines. As we will show in a later section, many different types of hardware exist in a teaching-research environment, while the proliferation of various types of network indicate the increasing number of distinct roles which are emerging as the new technology develops. We will identify various roles in which planners might interact with the technology later, but the diversity of hardware also extends to new means of inputting and outputting, or communicating information involving scanning, remote sensing, expert systems interfaces, graphics systems and so forth. We will see that applications in planning are beginning to reflect this diversity, and this will clearly need to be reflected in education and training. Different levels of software are beginning to appear generally, as well as specifically in planning, and training will clearly have to reflect these.

But so will the organisation of the planning task environment and we will consider this in the next section.

We also need to be clear about the distinction between education and training before we proceed. The terms are often used inter-changeably and we will continue to do so, but, specifically, education in this context will refer to more general and universal skills which are required to use information technology, in contrast to training which will refer to specific software applied to specific tasks. Although the emphasis here will be on programmes which seek to educate rather than train, largely because the academic environment from which these experiences are culled is non-task orientated, it is usually difficult to disentangle education from training due to the need to develop specific task-related skills in any more general context. The essential difference between the education and training of planners in academic and practice-based environments relates to the nature of the task, often 'hypothetical' in the former context in contrast to the 'reality' of the latter. Another important distinction, however, is that in academic environments, learning by trial and error is the medium of instruction, and this is clearly less appropriate in practice. Educating planners in information technology in the context adopted here will refer more to inculcating awareness, reflection and general purpose skills which can encompass the range from learning about general purpose software packages through to high level programming, but we will exclude any experiences drawn from education and training relevant to specific tasks in practice-based contexts. Others at this meeting will be dealing with many such examples.

One issue which will emerge time and again in this discussion involves the use of different types of software, implying the need for both educational

and training within the pursuance of a single task. For example, in teaching students how to write programs for modelling and forecasting urban activity patterns based on spatial interaction concepts, general purpose software for displaying and drawing map output, for inputting data and for debugging the programs themselves are all used. A variety of skills are thus developed in any single example ranging from the most elementary, for example, keyboard skills, learning how to deal with pop-up menus and such like, through to more sophisticated techniques (Batty, Bracken, Guy and Spooner, 1985). Awareness and general skills which are transferrable will be dealt with rather than specific skills on packages designed for specific practical problems. For example, we will not be referring to the sorts of skills required to operate geographical or planning information systems which are usually more appropriate to specific problems, and thus normally available only to practice rather than academia.

To summarise then, although education and training cannot be easily separated in any context, the emphasis here will be on education on non-specific tasks carried out in academic environments, in contrast to training in specific tasks carried out in practice which represents the other extreme in this threefold continuum. Nevertheless, these experiences are transferrable in some measure from one context to another. Many of the skills imparted in educating planners in information technology in an academic context are directly useful in practice, and this is evidenced by the large number of training programmes for practitioners which emanate from academia. For example, Masser and Wilson's (1987) discussion of four levels of information technology and systems training from policy makers through to analysts contains education, which is widely available in academic environments; what is more important here, however,

is discussion of the education and training for the technical-professional in contrast to the policy-maker and analyst. Policy makers require an awareness of new technology and some exposure to end-user skills, analysts require programming and even deeper computer skills, but the middle ground of the technical-professional requires exposure to both, and to new ways of containing and organising what has already been designed by computer experts. This is the area which we will emphasise in the subsequent discussion, but before we approach this, we need to discuss the sorts of tasks characterising planning and the way information technology is being and should be applied to such tasks.

A MODEL OF THE PLANNING TASK ENVIRONMENT

The logic of this argument is to first examine the tasks which comprise the activity of planning, and discuss how information technology can aid such planning, this being a preliminary stage in identifying the type of education and training required. This is an obvious approach, although it is much complicated by the fact that there is no consensus in the nature of the task environment itself, and, consequently, ideas about training are rather volatile. Indeed, this is a result of technological and social change itself which is the very activity which leads to this discussion. Nevertheless, a starting point is required and thus we will begin by outlining a set of minimally acceptable tasks which comprise a typical western planning system, the example chosen being Britain. This system is one of the most complete and organised in the industrialised world and, although it no longer exists in its original form in Britain, it is a stable model on which to assess information technology. It will then be brought up-to-date, and developing countries planning systems can thus be examined.

The legislative planning system in Britain involves the control of land development mainly through physical instruments designed to achieve social and economic objectives relevant to the public interest. Planning is achieved through both positive and negative instruments. Positive actions involve initiating direct changes to land development, while negative actions control what is being proposed, both reinforcing one another symbiotically or at least as the theory presumes. Positive actions involve the preparation of plans, typically at strategic levels dealing with urban structure at the macro-level, and community-facility location at a lower district level. A fairly well-developed hierarchy of plans exists which are updated every 5 years. Negative controls ensure that the 'natural' development of the system keeps within the bounds set by the plan. Development proposals are adjudicated upon at a much more frequent rate than plans are prepared, making such control more routine than the plan-making which guides the control. A well-developed system of laws and constraints exists in this development control process which enables, at least in theory, a match or compromise to be achieved between what is demanded and what is needed to account for the public interest. In theory, the two systems inform each other; in practice, there is much more emphasis on routine functions and much less on the strategic focus, and there is considerable role differentiation between the various parts of this planning system. Only in a few cases have attempts been made to organise processes which match the time frame of strategic thinking to that of development, usually involving some continuous process of plan preparation, implementation and monitoring using notions of strategic choice (Friend and Jessop, 1969).

Another feature of this planning system relates to its theoretical

rationale in systems theory and management science. The theory is loosely referred to as the rational decision model and involves a continuous cycle of observation, interpretation, analysis, design, implementation and further observation and monitoring of the impact of the proposed design (Chadwick, 1971). Four tasks comprise this cycle : first, there is monitoring or sensing problems in the urban scene and this comprises the observation-data collection phase. This is followed by analysis of problems, problem definition and the setting of goals. Designs, solutions or plans which alleviate the specified problems are then proposed, a best plan selected, and then implemented in time. At the end of this cycle, the process begins again and, in theory, continues indefinitely. In practice, several such processes can exist side-by-side, not necessarily in phase but usually each informing one another. The activities involved comprise sensing or surveying, analysing, designing, acting and deciding, and the cycle is illustrated in Figure 1.

As the model has been elaborated, the line from problem to plan is much disaggregated, drawing heavily on structured problem-solving analogies in the decision sciences, and involving further cycles, around which the planner may proceed, wander or explore until some progress towards the solution or plan is detected. Initially, the process is concerned with better problem definition or specification through analysis of the information, which ultimately leads to the specification or formulation of goals and objectives. Usually alternative solutions which reflect these goals are postulated, designed or invented, and a 'best' plan or solution selected by evaluating these alternatives against the prespecified goal set. During this process, views about the future system are made using forecasts and speculations and these serve to contain the problem and its

solution within feasible limits. Once the best plan is selected, it is implemented and it changes the system which itself is being influenced by other 'non-planned' forces. This change is then monitored and, if problems are detected, the cycle begins once again (Batty, 1979).

This process which is illustrated in Figure 2 is more complicated than any diagram can portray, although such complications always embody extensions to the form described. Each of the stages identified, particularly implementation and monitoring, may be the subject of a further, deeper cycle of rational problem-solving, thus indicating a hierarchy of decision-making in methodological terms. Mapped onto this is a hierarchy of plan-making with statutory plans in a British context at at least two levels - city and district - structure and local plans. In essence, the interlocking of these systems in hierarchical terms has never been well-worked out, although in practice the situation very much reflects this complexity. If there is a natural starting point to the cycle, it is sensing or monitoring, and in some characterisations of the process, information is seen as the hub around which the whole process is driven, affecting analysis, forecasting and design.

It is clear that information technology can affect all stages of this process. Information concerning what is happening is required, at whatever stage the process is initiated, and if a complete cycle is followed through from whenever such information is collected, the processing of this information affects all stages either directly or indirectly. Figure 3 organises the process described in Figure 2 in terms of the explicit development of an information system, and as such represents a fairly complete characterisation of how information systems and technology might influence the planning process. Of course, in practice, large-scale

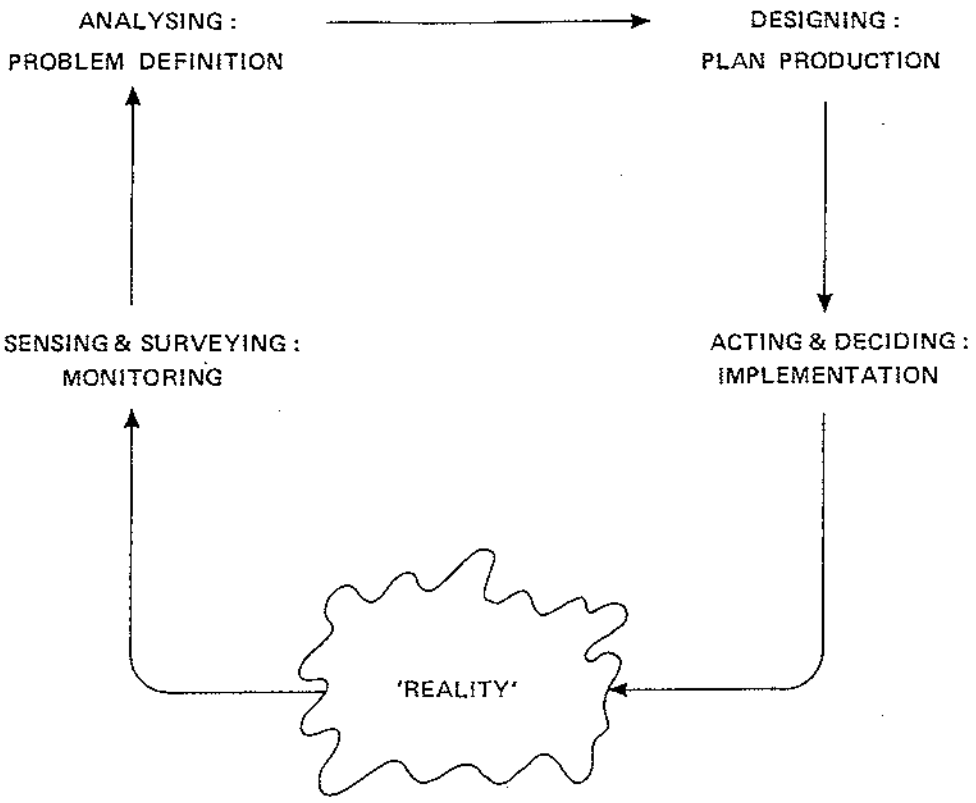


Figure 1 : The Cyclic Planning Process

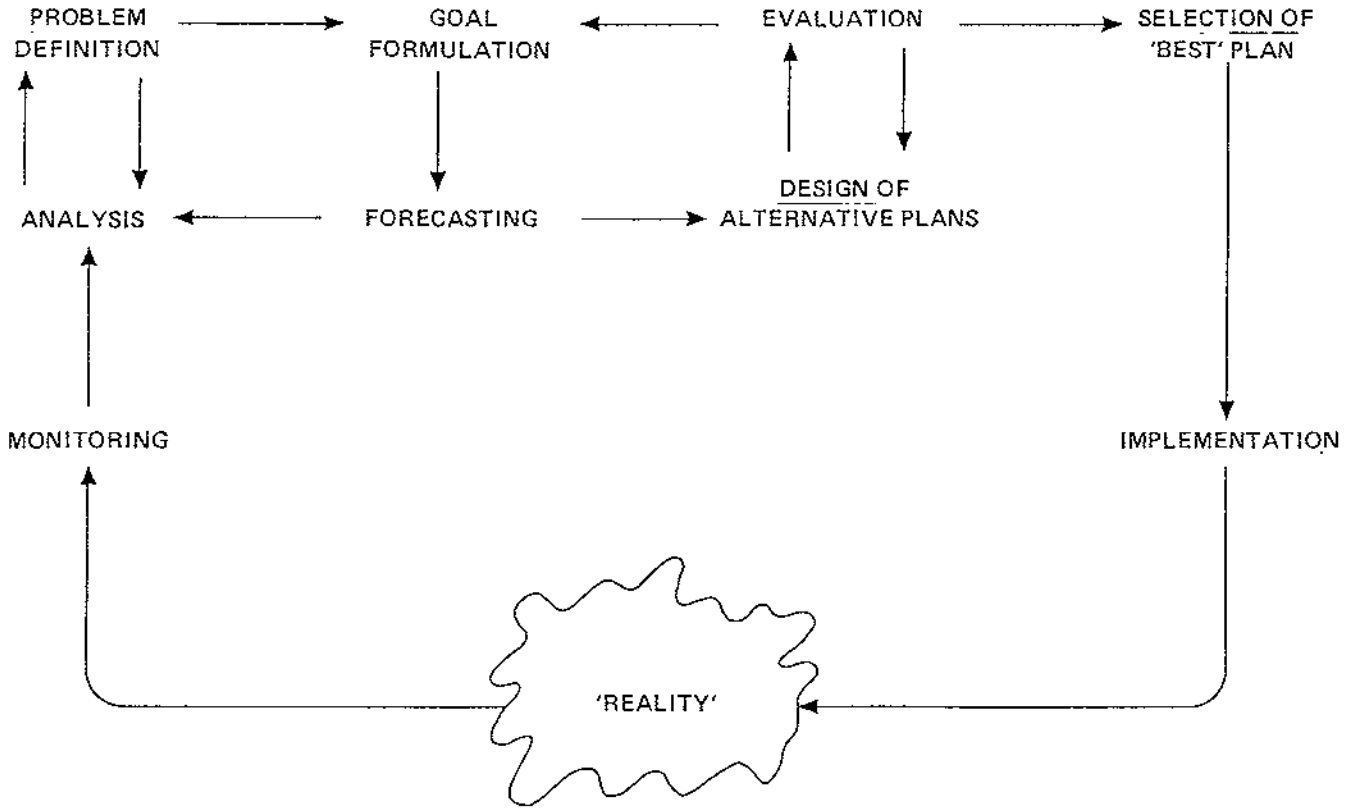


Figure 2 : The Sequence of Tasks in the Planning Process

information systems of the kind depicted here may not exist even though information is used in the process, and information technology used in analysis, forecasting, design. Many variants on this structure may exist with respect to partial developments of the model, as well as variants on the complexities of the process noted above.

It is worth examining the key elements of information technology in this illustration. First, there is the information system itself which is subject to all the principles relevant to efficient data storage and retrieval, and it is relevant to note that this system has a dual role - in monitoring change which is a routine matter, and in providing information for the key activities which comprise the planning process. These activities of analysis, forecasting and design are likely to involve quantitative computer modelling of various kinds, but increasingly qualitative information will be part of the information system, and hence subject to new forms of computer analysis. The arrows into and out of the information system relate to the input and output functions of computer-based systems. Input data is still largely collected manually and entered similarly, but increasingly data, particularly spatial or map data, is being entered using semi-automated scanning procedures, as well as fully-automated remote sensing methods. The output of information involves numerical computations traditionally, but increasingly in plain language terms and using graphics. But the most important feature of these systems at the present time is the development of interfaces regarding the way the user interacts with them. Intelligent interfaces - expert systems - are increasingly available for enabling unsophisticated end-users to grapple with the information system directly with respect to entering data and interpreting output. Moreover, users are also being regarded as experts in their own right, and systems are being devised to incorporate such

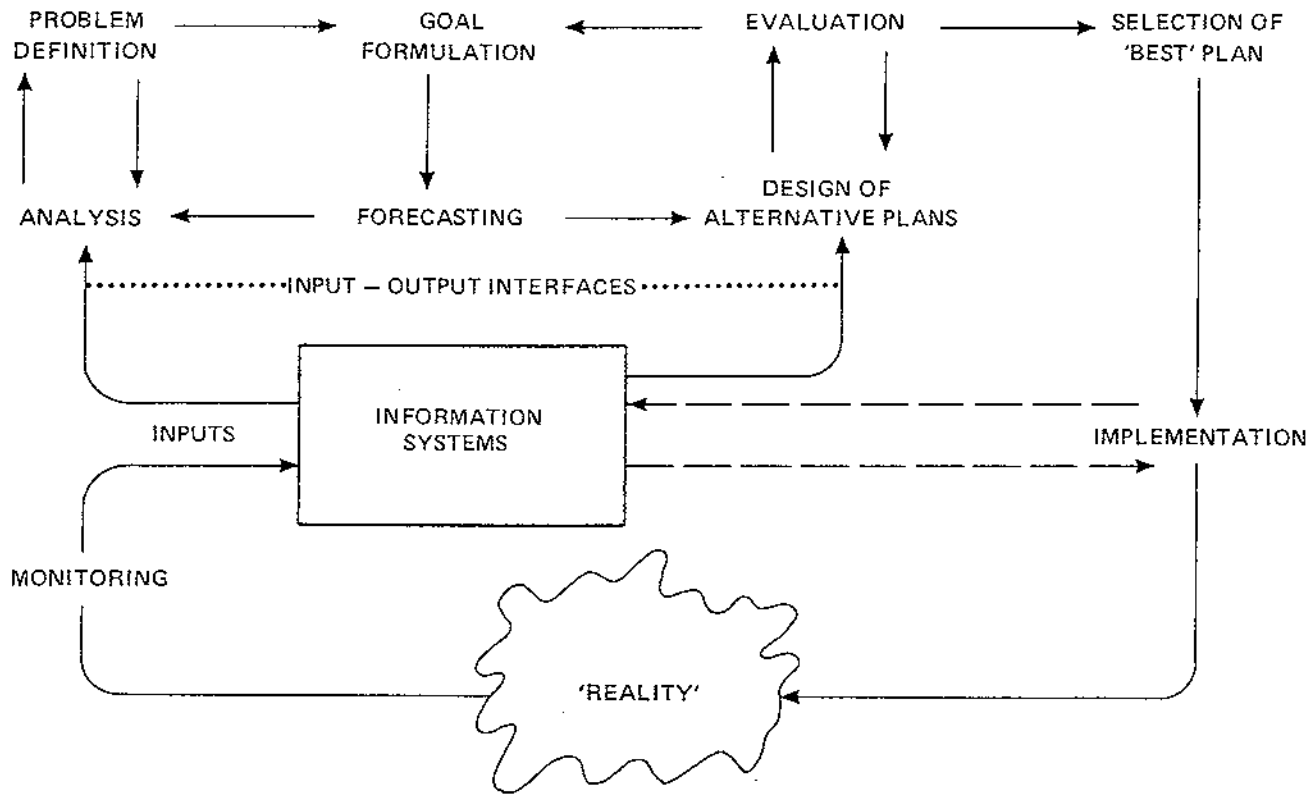


Figure 3 : Information Activities and Systems in the Planning Process

expertise into analysis, forecasting and design, following the true spirit of man-machine interaction.

We have sketched a maximal model of information technology within a minimal model of the planning process, but this does serve to impress upon the reader the potential integrating power of information technology in such processes. However, in reality, the development of such technology is invariably less integrated. Local adaptations of the process make such complete integration virtually impossible to achieve, but it is the temporal differences in the operation of different phases of the process which do most to alter this. The strategic planning function illustrated in the top phases of Figures 1 to 3 occurs infrequently, usually once every five years or so, in contrast to the monitoring function which is continuous. Consequently, it is rare for information systems to be developed which serve both functions. Development control systems are being developed quite separately for the more routine functions of day-to-day monitoring, and although various aspects of information technology relating to spatial input-output and expert system interfaces are accompanying such developments, such systems are not being developed with the longer phase strategic planning function in mind. Few, if any, information systems exist for plan-making **per se.** Usually, information becomes an adjunct to the computer-based activities of analysis, forecasting and design which are accomplished separately from any integrated information system which may exist at the monitoring level. Indeed, in practice, the day-to-day monitoring function rarely provides data for the strategic planning function, although the potential for such integration does exist. Large-scale information systems which intended such integration have been attempted a generation or so ago, but the

technology was not then present to support them (Barrett and Leather, 1983). Geographical Information Systems (GIS's) have not been applied in physical planning as yet, although the prospect does exist for their development as part of the strategic planning function (Chorley, 1987).

It has been assumed that the task environment is the domain of a single agency responsible for its integration. In fact, many agencies exist at different levels, each operating some variant of the planning function and this often involves a multitude of systems with elements in common. Other agencies involved with related public and even private sector planning problems are also involved in developing information technology which could benefit from coordination and common systems. In particular, a variety of agencies require census data for their functioning, and the prospect does exist for information technology to serve a much wider integrating function with respect to the public and private sectors generally. Another feature of the task environment is the emergence of initiatives and issues which do not fit the execution of this rational model. Agencies are often designed to cope with the implementation, justification, testing and/or elaboration of 'plans' and 'proposals' which do not emerge from the rational decision model. In fact, the continual construction of new information technology to serve new articulations of existing or previous problems as well as new problems, is a much more characteristic picture of how practice is reacting to new technology in contrast to the ordered, homogeneous picture painted here. This is reflected as much in the fact that information technology itself is rapidly changing, and combined with social change, new problems, new agencies and new organisations designed to cope with and apply information technology are contributing to this diversity.

There is one final point to note before we launch into a discussion of how information technology is being adopted in planning practice, and this concerns the complexity of various phases in the task environment. The collection and efficient storage, presentation and retrieval of data, is clearly a much less controversial activity than many of the analytical and design activities of the strategic planning process. Information collection is a routine activity in many agencies, and thus the application of information technology in this area is more likely to gain acceptance. It is easier to demonstrate 'savings' of various kinds in this context, although total savings in cost terms are largely illusory in the context of information technology developments, as will be argued a little later. Information **per se** is also more tangible than the products of its processing in terms of analysis and design, and thus it is not surprising that tasks associated with monitoring and information systems are in greater abundance in practice, than tasks associated with the strategic planning function. This is clearly reflected in the development of information technology in planning practice to which we will now turn.

INFORMATION TECHNOLOGY IN PLANNING PRACTICE

We will take three approaches to discussing the development of information technology in practice, which in terms of the previous discussion are each more pragmatic. First, we can explore the development of information systems and consider how far these systems extend into the day-to-day monitoring function on the one hand, and strategic planning functions on the other. Second, we can approach the question of information from the point of view of developments in analysis, forecasting and design which in some contexts clearly predominate. And, third, we can simply deal with ad hoc developments, mainly concerning the efficient input and output of

information, mapping, expert systems in development control and site selection, and such like. We will treat these in turn.

It is possible to define a continuum of information systems from the most specific to the most general. The most specific are those such as development control systems which are purpose built at one extreme, and range to general purpose software at the other. Systems exist which involve proprietary software with dedicated hardware - so-called turnkey systems, designed primarily to mirror some standard interpretation of a 'typical' local authority's development control function. In contrast, word processing packages and spreadsheets have been used for similar purposes, and often with the same effect (Haslam, 1982). These planning information systems have proliferated in Britain in the last five years. In the only authoritative survey of British planning practice and the development of information technology, Bardon, Stothers and Elliott (1984) show that 49 per cent of all local planning authorities (there are 503 in all) have adopted some form of information technology in dealing with and monitoring planning applications, and of these authorities, most had developed some form of development control information system. This was by far the largest single use of information technology in British planning practice, but the concern with such systems is predominantly in day-to-day routines involving counting, sorting and prompting the system into efficient response. There is almost a total absence of using such systems for strategic planning functions, and rarely is there any spatial mapping function attached to such systems, although here, progress is likely to be somewhat faster in the next decade.

Information systems for strategic planning hardly exist, despite the work, some 15 years ago, by the Department of the Environment on a **General**

Information System for Planning (GISP), and by Leeds City Council and ICL on a **Local Authority Management Information System** (LAMIS). These systems were ahead of their time in that the appropriate technology did not exist, but by the time such systems were feasible, the strategic planning function had become less important in planning practice. **Geographical Informations Systems** (GIS) are largely concerned with physical problems **per se** and are less generally suited to urban and regional planning. There is widespread use of such systems in the US, but mainly by government and other agencies dealing with land based resource problems and detailed physical design (Burroughs, 1986). Systems such as ARC/INFO have some potential for strategic urban planning, but generally contain a range of functions more suited to detailed physical articulations of problems and the spatial analysis of data. Such systems are, however, developing in more specific contexts and it is likely that some of the components of GIS will find their way into planning information systems in the next decade. However, such systems are more suited for utilities, environmental resource and such like agencies than for physical planning. In fact, only 7 per cent of local planning authorities have developed land and property registers in terms of computer information systems, and it is in this area rather than in GIS, that developments are likely to occur in the immediate future.

There is little evidence of any strong integrating function being developed in British planning practice through the use of planning information systems, and in the occasional case where systems are being considered which are authority and function-wide, the impetus for their development is through hardware and network developments. As already mentioned, such centralising initiatives are largely absent and where attempted, as in the case of LAMIS, were unsuccessful. More successful developments are based

on a bottom-up approach in which elements of information systems are being constructed in a trial and error fashion. This does, however, mean that robust software is being developed and that small-scale, not large-scale information technology is slowly but surely permeating planning practice. This is a clear conclusion of the Bardon, Stothers and Elliott (1984) survey.

Examining the development of information technology in analysis, forecasting and design, the picture is quite different. There is nothing like the impact which is evident in the development control function. Where such activities are being automated, the examples are techniques-led, based on more sophisticated programming of the traditional kind. This area represents the longest established area of computer use in planning, but its importance has declined for ideological reasons as much as anything. In transportation planning, work is continuing using micro-based modelling, but these areas are mainly dominated by consultants developing and marketing modelling software. There is quite a vibrant growth of model-based analysis packages which are being developed in the commercial sector for purposes of marketing, and some of these packages are being used in planning, usually for the analysis of individual initiatives and specific problems which fall outside of the main plan preparation cycle and development control functions.

Perhaps the other largest area of information technology in planning relates to interfacing techniques and data analysis of the information itself. Spatial data input for computer mapping is still laborious, although digitising technology has improved. Scanning and sensing methods are in their infancy at present. They are likely to make some impact once they become cheaper and more generally available, but the evidence is that

where extremely good software exists for input and output, such developments are quickly embraced. For example, the analysis of population census data using SASPAC and its mapping using GIMMS has been dramatically successful in practice where the power of such well-resourced and high quality software has become readily apparent. More elaborate methods of interfacing information systems and mapping packages using ideas from expert systems are on the horizon, but, as yet, such ideas are only in the form of demonstration projects. Nevertheless, the development of rule-based software designed to utilise expert knowledge as well as advise end-users could have major effects in areas such as graphics mapping and development control. For example, Cullen's (1986) site development system, Leary and Rodriguez-Bachiller's (1987) system for development control and the whole range of design applications reported in Sharpe (1987) herald important possibilities which are very practically based.

It would be possible to develop a more detailed and idealised set of applications of information technology reflecting the need to integrate across a range of tasks within a suitable organisation, but the prevailing picture of information technology usage in planning is far from this. As yet, there is little emphasis on using information technology to integrate functions and the dichotomy we have already noted between the fairly widespread but low level usage of such technology in day-to-day functions such as development control and its almost complete absence from strategic planning, is very marked. Much of what is happening depends upon local conditions, the availability of hardware, and skills, set against a background of increasing cost-effectiveness. Local government usage of information technology is still dominated by the 'management information systems' image where computer functions are centralised and there is more

emphasis on mainframe applications than on micros. For example, of the 66 per cent of planning authorities who use computers in Britain, some 36 per cent use mainframe machines exclusively, while 22 per cent just use micros. This picture in 1984 is changing rapidly, but much depends upon financial constraints and authority-wide procurement policies.

With respect to the types of software being used, Table 1 reproduced from Bardon, Stothers and Elliott's (1984) survey, provides a rank-ordered list of the most frequently used software, with some indication of the division between in-house development and bought software. This table reflects the comments already made. There is a mix of functions contained in the software listed, covering administrative as well as technical areas, and the obvious emphasis on routine control procedures, survey and, to a lesser extent, graphic output, reinforces the fact that information technology is nowhere being used to integrate several related functions. The absence of any mention of fully-fledged information systems development indicates that this new technology is not being used to organise the strategic functions of the typical British planning authority. It is rather difficult to generalise much further, apart from noting the very low levels of use of information technology in forecasting; and this table is complicated by the non-exclusivity of the categories, in that some standard software such as spreadsheets could have been used in, say population forecasting, and such like.

With respect to the need for skills in developing software, Table 1 shows that standard software such as spreadsheets and wordprocessing are invariably bought, as indeed is more specific but widely available software such as Census analysis based on the well-established SASPAC (Small Area Statistics Package). In contrast, software which takes a role in more

Table 1 : **Typical Software Usage by British Local Planning Authorities** (from Bardon, Stothers and Elliott, 1984)

Type of Software	Usage by Local Planning Authorities*			
	Percent	Number	Bought	In-House
Decision Analysis	49	244	106	159
WordProcessing	37	187	187	-
DC Systems	36	179	117	67
Census Analysis	32	161	156	15
Data Base Management	31	155	152	10
Statistical Analysis	17	84	84	5
Monitoring	16	81	3	78
Computer Mapping	14	71	66	18
Population Forecasting	12	63	14	54
Spreadsheets	11	54	54	-
Employment Survey	8	42	2	40
Property Information	7	37	22	17
Population Survey	7	35	4	31
Building Regulations	6	29	12	17
Housing Forecasting	5	27	1	26
Industrial Survey	5	25	-	25

Notes : the total number of British Local Planning Authorities is 503. *Bought software and software developed in-house are not mutually exclusive with respect to any local planning authority, and thus the sum of the last two columns can exceed the middle column of the table.

strategic planning such as population forecasting, and survey analysis are largely developed in-house, at least until well-developed packages become available. With respect to decision analysis, development control and other such routine functions, much has been developed in-house but as the systems get more elaborate, there is a drift towards bought software. It is clear, however, that skills in information technology more than just the ability to manipulate standard spreadsheet and data base management packages will continue to be required in some measure in the foreseeable future and training must clearly reflect this.

It is also clear that little software exists which might integrate common

functions between different areas of the public authority. For example, there do not appear to be systems used by education, health, utility as well as planning agencies, all requiring a common resource. There are major advantages to such integration, but it requires a strategic management focus before it is possible. In fact, it is more likely to emerge in the procurement of common hardware rather than software, due to central purchasing and the increasing development of multi-user systems both in the micro as well as the mainframe environment. Yet, it is even more difficult to generalise in relation to hardware because of the rapid fall in cost and rapid expansion of memory. If anything, the rather low-key picture of information technology use painted above is as much conditioned by the unevenness of hardware development, as it is by any positive or negative strategies concerning the suitability of various software for the range of planning tasks.

Nevertheless, in moving toward education and training issues, it is necessary to attempt to impose some order on the development and use of information technology in planning. It is possible to construe a continuum of software types which can be conveniently divided into general purpose to more specific, task orientated software uses. We can identify at one extreme, general purpose software such as spreadsheets, data base management systems, and possibly statistical analysis packages, although within this category there are clear differences implied in skill levels needed to operate the software. A second, intermediate category involves small system, task-specific software such as cartographic and mapping, forecasting and possibly small-scale development control systems. The last category would be large system, task-specific software such as geographical information systems, fully-fledged modelling and analysis packages and such like. These three categories would imply quite marked variation in usage

with very large numbers of individual users involved in general purpose software and very small numbers in the most specific software category.

A second continuum involves the particular role of the software user. Again, we can define three distinct levels with respect to these roles within planning. There is the end-user, as defined by Manheim (1987) as a manager or policy-maker involved in strategic issues but requiring access to software in various contexts. The second category involves the traditional technical-professional, the middle level planner involved in operating the planning process or tasks within it, in either a strategic or more routine environment. Lastly, there is the analyst involved in highly technical and scientific tasks which involve deeper computing skills, such as systems analysis and programming. There is some correlation with the three categories of software, end-users using general purpose software, analysts using large-scale task-specific software, but increasingly roles and software types are being mixed in any particular task. At this point, we can begin to anticipate the problem of training which will emerge in this paper. The training of end-users in general purpose software use, although necessary, is non-problematic for increasingly such software is designed to be self-training. Training analysts at the other end of the spectrum again is obvious in that formal computer courses are required. The problem really lies in the middle ground, in training technical-professionals to interact with a variety of software and to creatively begin to use and integrate it relative to their professional expertise. We will return to this in a later section, for it marks the most important training and education problem faced not only by planners but in many other professional contexts.

We cannot be as specific about the diversity and appropriateness of

hardware to the planning task environment, for increasingly major tasks can be developed on small machines. Software developed on one type of machine can be ported to others, and the appropriateness of different forms of general purpose hardware is a particularly uncertain decision area. Specific hardware is easier to identify, in mapping and graphics for example, and it is clear that decisions about more general purpose functions and whether or not mainframes, minis or micros are more or less appropriate depend more on financial and other resource and political constraints, rather than technical-professional issues. When it comes to orgware, even less is known about appropriate systems and it is also clear that as much training related to the type of task environment and how it can be reorganised to cope with information technology is required, as is training in the uses and design of that information technology **per se.**

THE TRANSITION TO POST-INDUSTRIAL PLANNING

We must digress slightly, at this point, to describe how technological change is converging with ideological change in the late 20th Century, and how this convergence is changing the nature of planning itself, notwithstanding the introduction of information technology into the task environment. We have already alluded, in the introduction, to the origins and impact of technological change which, in essence, is leading to massive automation of existing functions in everyday life, as well as new creative opportunities using information and ideas in the context of computing. Accompanying these changes, and perhaps because of them, values towards the role of individual action and decision in modern society are changing. In short, the primacy of the individual and self-interest in contrast to the public interest are being emphasised, and combined with some widespread dissatisfaction with the role of government in western societies, such

collective issues as planning are under considerable scrutiny. Thus, technological change is creating opportunities for indulging greater individual interest and this in turn is creating a new attitude towards the role of the state.

There are many views of this symbiosis of technological and ideological change. Barrett and Leather (1983) say : "....the thrust for IT development can be seen as a response to re-structuring problems facing a 'post-industrial' capitalist economy, for survival within the world economy". Equally, it could be argued that new technology is not a response but a fundamental force causing such restructuring. In essence, the implication is that such changes cannot be separated, and that such changes constitute a much more heterogeneous and volatile context for training and education in information technology, than was assumed in earlier discussions of this phenomena, at Kawasaki, for example, in the first international seminar held in 1984 (Sazanami, 1986).

The idealised model of the planning process which has so far in this discussion provided the implicit benchmark for training and education, and is illustrated in Figures 1 to 3, is dramatically changing as it is being adapted to an ever heterogeneous, confused and turbulent practice. The belief in a single collective rationality pursuable in a comprehensive, all-embracing manner, is no longer of central importance, if only because such rationality is not achievable in this form. Indeed, as the role shifts more to individual action, this model is being increasingly used competitively by several conflicting interests, thus emphasising the need to conceive of planning as a process of reconciling interests rather than as one of defining and reaching a uniform, homogeneous end-state embodied in the form of a blueprint plan. The strategic focus of planning is thus

becoming less significant.

Urban problems are no longer articulated in simple, comprehensive terms. Many agencies each have an interest, their responsibilities cutting across one another, and new areas of commonality are becoming important. New agencies are being defined for new problems which emerge in a 'political' rather than 'rational' fashion. The notions that the planning process must represent complete cycles of observing, analysing, designing, deciding and acting, and that there may be 'correct' starting points in the planning process have largely been abandoned. Thus the fact that many different planning processes compete within the planning environment has introduced a level of volatility and diversity into planning that makes it difficult to generalise about the use of information technology, even in theory, and makes any quest towards using such technology to integrate functions, as indicated in Figure 3, highly problematic. This, of course, is the picture borne out by the discussion of practice in the last section.

We must not digress too much, but it is worth making this volatility more apparent because much of the uncertainty being generated is directly due to new concepts of information and decision, as well as new technology. Information is clearly becoming a major product or good in all societies. It is no longer regarded as being free, if ever it was, but it is now tradeable explicitly, in new forms of market place. Value is added to it or taken from it as it is processed, the ultimate product and access to it reflecting the various forces and agencies which have moulded it. Access to information is becoming an all important issue and a new social differentiation between information-rich and -poor is becoming significant from school age onwards (Papert, 1980). The proliferation of hardware is

having both decentralising and integrating - **decentegrating** as we have coined the term here - influences on cities, spatially and in terms of socioeconomic and temporal organisation. Rapid advances as in the network city, the network planning agency, and the network university as we will see in the next section, are characteristic impacts of this technological change.

The decentralising effects of computers and their minaturisation are clearly reinforcing the growth of individual interests and are speeding up the break-up of big government, in one sense at least, through privatisation. Planning in its comprehensive, mid 20th century form, is being disbanded, being replaced by the multi-agency, multi-initiative area-based approaches to investment, negotiation and political action. This is a very dramatic force in western societies at present, and it is being reinforced by the use of information technology for simple routine monitoring rather than for strategic planning. In developing countries, such forces are clearly at work, but working in more global, aggregate terms, and here, as in the West, ideological change is being fostered and aided by technological change.

The surprising thing about these changes is that they have been only dimly anticipated at best, and simply unanticipated at worst. Perhaps the most dramatic example of this is the quote from Donald Michie (1971), a leading expert in artificial intelligence in Britain, who writing in 1968 said : "For many years, only the rich will be able to install terminals in their private houses....". This sentiment which was widely held until the late 1970's puts the rate of technological change and its many surprising and novel features in perspective. Several unusual and even 'shocking' issues comprise the present picture. The emergence of new roles of computer user

- in particular the end-user of general purpose software, and the emergence of a multitude of software products, proliferating so quickly that it is difficult to find any clear advice on their appropriateness, were never anticipated in any fashion. In particular, the emergence of spreadsheet type programs and data base management systems heralds an era of software specifically spinning off from computer development and availability, rather than from the implementation of traditional and prespecified techniques and methods. Manheim's (1987b) third computer revolution with its emphasis on the end-user and decision support systems is one image of this.

Qualitative computing, again seen best in spreadsheet, wordprocessing-like software, was also largely unanticipated as evidenced in the almost exclusive concentration in computing on numerical computation until 10 years or so ago when graphics, voice, text and other forms of data processing began to emerge significantly. Another feature of computing involves its enhancement through interfacing with conventional man-machine systems. The development of expert systems which use computation to elicit rational and expert dialogue does not depend on formal models of design or decision, but on using the power of the computer to prompt, correct, remind etc. already expert users about appropriate strategies in applying their expertise to relevant problems.

The idea that information technology involves less direct cost or outlay is also being rapidly dispelled. There may be the occasional situations where machines replace labour and costs are thus cut, but in general, costs increase although unit cost in production can fall dramatically. Information technology provides much greater opportunities for designing

and producing better products and services, but the capital involved in doing so and the labour intensity of the initial software design are very great. Computer mapping may be as labour intensive as hand-drawn mapping, but the potential for producing much higher quality maps, their transmission, the way they can be stored, the way they can be integrated with other digital data and such like, all emerge from the technology. Digital maps are as hard to originally produce as any other forms of map, but, once computerised, can be subject to almost infinite variation. Such variation leads to the creation of a market place for such software products, and this enables extremely sophisticated user orientated design of such products to be enabled.

But it is the speed of change which is the most daunting. Moscovitz and Mammen (1986) argue that : "Staying abreast of technological developments is a full-time job", while the same problem exists with respect to software. Continuous minaturisation and specialisation of hardware, the proliferation of information services and opportunities through networking, as well as the proliferation of software with an increasingly high ratio of software designers to end-users, especially in the planning field, all combine to make the present period of transition one of great culture shock. Conditions vary, of course, between the developed and developing world, and different types of training are required, but the shock of transition is equally great in whatever world one exists.

These points can be quickly demonstrated with respect to current changes in hardware, software and orgware. Minaturisation and the proliferation of small computers has occurred at the same time in developed and developing countries, and in both contexts, new end-users have appeared. Networking presents a bewildering array of new choices to users and designers wherever

such possibilities occur. In developing countries, there is often no prior exposure to computers before many systems are introduced together, but this is little different from developed countries, where new, non-traditional users have provided the rapid expansion in computer use occasioned by minaturisation and networking. Software products, especially high-level general purpose software like spreadsheets, are continually changing and new familiarisation is forever required. Training in such tasks may be easier in developed countries, but the 'newness' of the tasks is the same wherever such software is introduced. Special purpose software, such as geographical information systems, requires very detailed training and is especially rich in content. Differences in capital finance available, general educational attainment and organisational structures may suggest differences in training between developed and developing countries, but, in general, the type of training is likely to be similar; it is the context and ability to ensure such training takes place and is useful in practice that mark the differences.

So far, there has been little thought given to appropriate orgware for information technology, although progress towards the electronic office and cottage appear much slower than was originally anticipated for practical rather than technical reasons. The organisation of new technology is difficult as it has the potential to break existing habits quite radically, but the technology - hardware and software - can date very quickly leading to financial difficulties in replacement, loss of skill through obsolete software and changing expectations. All this, combined with a volatile and changing task environment, makes definite recommendations for education and training difficult, especially with respect to task-specific software. Training or rather raising awareness in end-users or in analysts is fairly

easy to prescribe for, but training for technical professionals will always be tricky. Specific hardware and software products can take up much time with respect to skilled learning, and, as yet, it is not clear how transferable such learned routine behaviour is. Thus, in one sense, the rather gradual introduction of information technology into routine rather than strategic planning functions is a more robust strategy in that a reasonably sound if low-level base is being built up.

There is also a generation problem involving information technology training. At the awareness level, the need to inculcate things like keyboard skills and basic computer literacy should be short-lived, as individuals emerge who have acquired such skills as a matter of course in the information society. A small problem may always remain to be addressed, but, in general, awareness-like training will become less necessary. The real problem lies in acquiring a skill base, more than enough to be able to load and operate a spreadsheet or word-processing package. For example, even to send electronic mail at present, it is necessary to be familiar with an operating system, and although this is a routine task, it is never as straightforward as it might appear. To engage in online bibliographic search, or to be able to creatively merge and integrate general purpose software modules to pursue some more complicated planning task, does require a lot of exposure to such packages and their manipulation. Some general purpose software should be picked up by users with special training, but training in special purpose software such as SASPAC or MINITAB (A Statistics Package) is in itself only suitable for specialist professional users.

The emphasis in training then should be based on ensuring that some skills which are imparted do survive technology and software change. Training in

particular packages should probably be provided (and usually is) by those who have designed and/or market the product. There is, of course, a risk in acquiring any such software, especially that linked to hardware, and it is necessary to spend much time thinking through the issues raised here before embarking on purchase and major training, which could be obsolete in a matter of years. The need for advice centres which help resolve such uncertainties should be a major component of the introduction of information technology into most social contexts, planning in particular. At this point, we will begin to recount some examples drawn from our own experience in an academic context involving the way education and training can, have and should evolve with respect to the introduction and use of new information technology.

HARDWARE SHOCK

The sheer volume of computer equipment, the ability to access it through networks, the need to continually learn how to use new operating systems, all combine to produce extremely labour intensive activity in the development and use of information technology. This cannot be emphasised too much. Users can easily find themselves spending all their working time interacting with the new technology because the opportunities presently available are so great and because no stable limits have yet emerged with respect to the use of such technology. The best way to illustrate the shock which is induced by the development of new hardware is with respect to my own department and university, where there has, like many others, been dramatic development in hardware over the last 7 years.

In British universities in the 1960s and 1970s, the computer centre was a highly centralised unit, maintaining usually one, but sometimes two or more

coupled mainframe machines, and operating a batch processing service with some advisory programming support. Most programs were entered on punched cards or occasionally punched tape with a turn-around of jobs usually once or at most twice a day. Sometimes for shorter, educationally orientated teaching jobs, a cafeteria system was operated in which users loaded their own jobs and collected their own output from printers under the supervision of an operator. However, the general system meant that the user was remotely stationed with respect to the computer and that non-interactive processing was the order of the day. By the mid 1970s, terminals were making their appearance, thus facilitating some interactive use. Teletypes were more usual than VDUs, but by the late 1970s, VDUs were beginning to replace all modes of input.

In mid 1979, computing in Cardiff was organised between the two university colleges, as a joint service based around an ICL mainframe with some interactive lines to teletype terminals. In the Department of Town Planning, one teletype machine was available, but most work was submitted using batch processing, on cards, and much work was done at the Computer Centre itself rather than in the Department. Most of the emphasis in teaching and research was upon statistical and forecasting techniques. There was little emphasis on graphics or information systems, and in Manheim's (1987b) terms, the situation which is depicted in Figure 4 represents computing as it was organised during the first and second computer revolutions based on transactions processing and management information. Most of the activity in planning involved numerical work.

In late 1979, the College acquired two VAX minicomputers to replace the

mainframe installation. One of these machines was dedicated to research, the other to teaching, each supporting up to 96 users. Users were scattered over central Cardiff, being linked interactively with the machine over public telephone lines. Four lines were available in the Department, two to VDUs, two to lineprinters/teletypes. No campus network then existed, so terminal lines were reserved either for research or teaching. The picture is illustrated in Figure 5 and it implies the beginnings of some specialisation. A teaching classroom had become available centrally for the College, microcomputers had been acquired heralding the move into graphics on the one hand and text processing on the other, and some emergent networking possibilities were being discussed. The period 1980-1981 saw the total demise of punched cards, again entirely unanticipated by the general user.

The next main development came in 1983 when a campus package switching exchange was developed. By this time, additional VAX computers, for research and teaching, for CAD and for development had been added, and the need to access any one of these from each terminal had become well-established. Moreover, in Britain, the micro-revolution was in full flight and the dual use of micros for mainframe terminals and vice versa was being widely canvassed. Figure 6 illustrates the situation in the Department of Town Planning in the summer of 1983, with machines acting as terminals to the VAX computers, a separate micro classroom, and a network of micros used for word processing also having been established. The notion of linking any of these machines together was by then the common procedure used in transferring software between machines for different types of processing. During this period, considerable experience was being gained in graphics at the micro level, and general experience in microcomputing was also used in being able to advise on the secretarial word processing facility which was

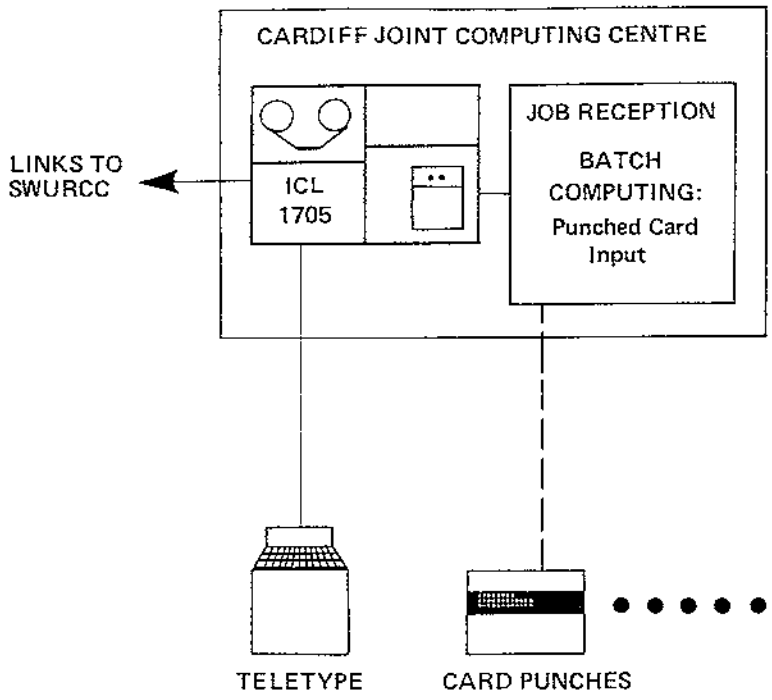
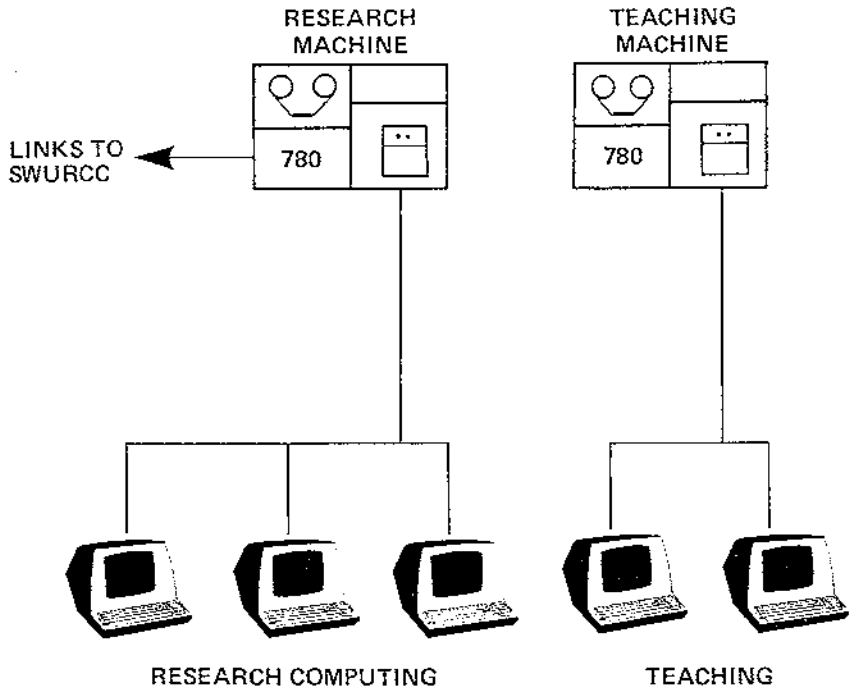


Figure 4 : Hardware in the Department of Town Planning, UWIST, in mid 1979





RESEARCH MICROCOMPUTING
BASED ON FREE-STANDING
64K SUPERBRAINS

Figure 5 : Hardware in mid 1980

set up at this time.

The last stage in the evolution of the present infrastructure began in mid 1984, with the establishment of the local area network based on rings linked to the central switching exchange. Attached to the network are a whole variety of devices, mainly VAXs and MicroVAXs, but printers, terminals and such like peripherals all connected via pads. Considerable specialisation now exists and each teaching department has its own terminal classroom supported by one of the MicroVAXs. The situation in the Department of Town Planning is shown in Figure 7, where it is clear that considerable specialisation has occurred relative to the situation shown in Figure 6. The teaching classroom doubles as a microcomputer laboratory, while research graphics and cartography, microcomputing teaching, general purpose statistical computing, word processing for staff and secretarial use have all emerged as distinct functional areas. Within microcomputing, there is further specialisation with BBC Micros being used as VAX terminals and graphics devices, IBM-PCs or clones being used to support standard general purpose software, such as spreadsheets and word processing.

Comparison of Figure 4 with Figure 7 illustrates the change which has occurred in a matter of 5 or 6 years. The future will clearly be much closer to Figure 7 than the past was, and thus this period makes a profound discontinuity in the development and proliferation of information technology hardware. It is difficult to portray the differences which the new technology brings, but the ability to network computers dramatically increases the type of processing and information available to any single user. Figure 8 illustrates the network of computers available to 15 teaching departments for some 2500 students in my own university. Even at the time of writing, two additional MicroVAXs are being purchased as well

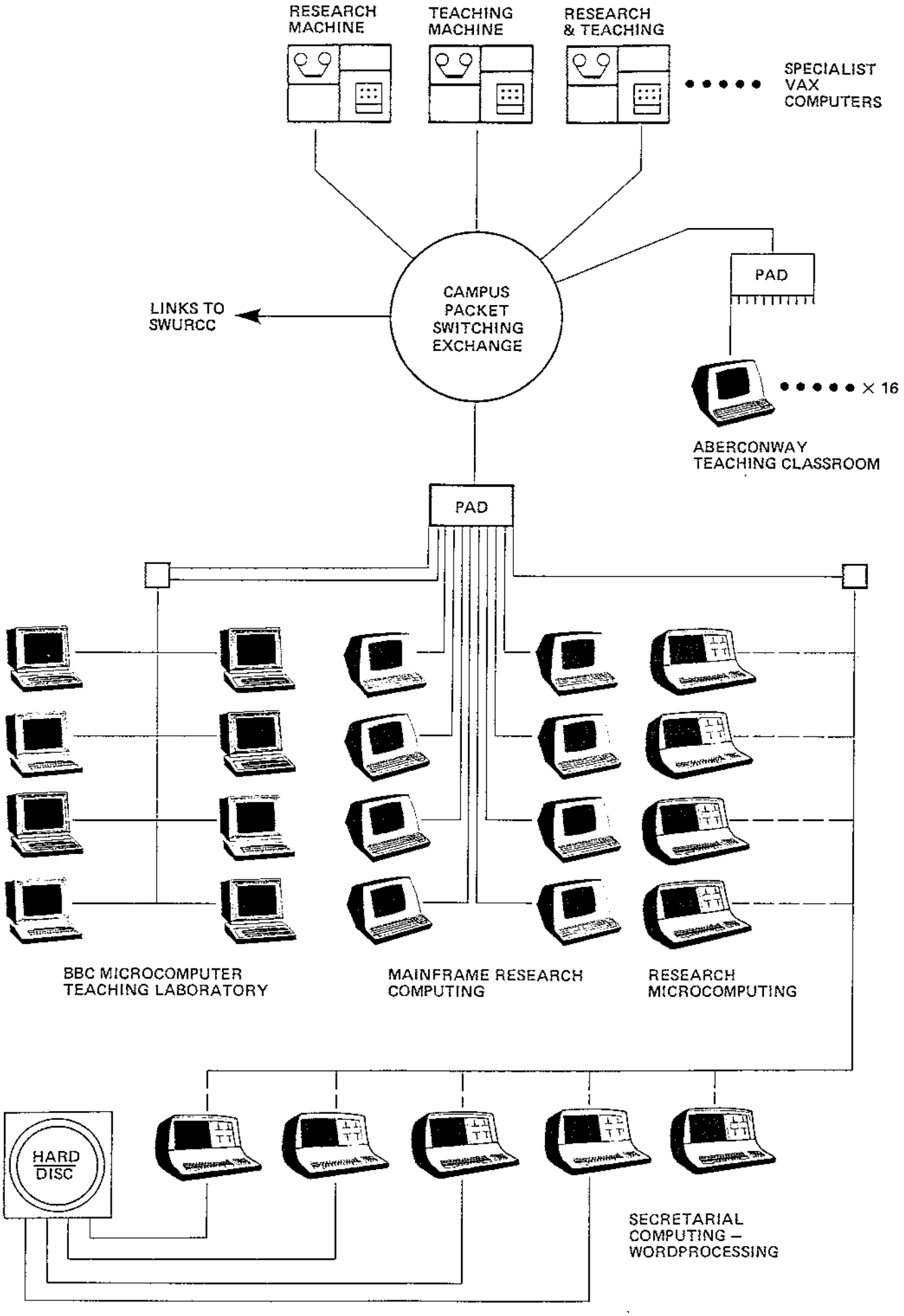


Figure 6 : Hardware in the Department of Town Planning, UWIST, in mid 1983

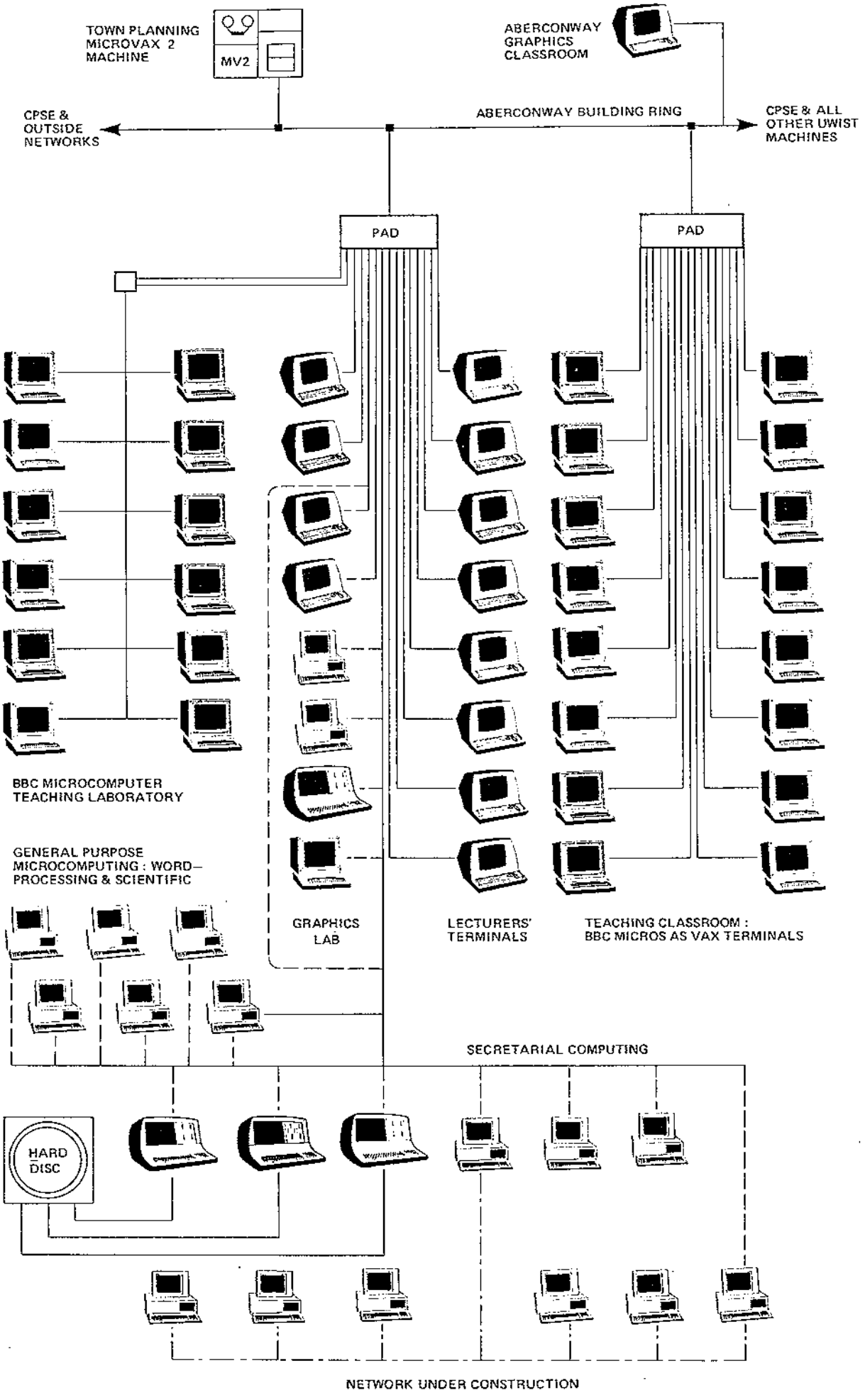


Figure 7 : The Present (mid 1987) Configuration of Hardware in the Department of Town Planning, UWIST

as a host of new workstations all to be attached to the network.

In one sense, the opportunities now available have not yet been absorbed or appreciated by the vast majority of users. For example, a whole range of information services ranging from help and advisory facilities in programming to online bibliographic library search, and electronic mail now exist, but only a small fraction of users are cognisant of this. Phone facilities, job transfer between users and machines, mail to other universities using the Joint Academic Network (JANET), and the ability to access data banks such as census data etc. now all exist, but learning how to access them and how to use the associated software is an extremely labour intensive activity. We will return to this point in the next section when we examine the range of software now available, but it is clear that a major task in the immediate future will be devising the appropriate organisation - orgware - which will enable the potential of this technology to be fully realised. This is most apparent in areas of routine information processing, where most of the technology remains unexploited and where secretarial use of the technology is mainly for typing rather than information management and filing.

To imply that there is deep culture shock in the introduction of information technology requires some elaboration. There is clear shock involved in the introduction of new hardware and software, but this is soon rationalised as users adapt by learning or by shutting out new opportunities. But with so much new hardware in the market place, and so much interchangeability between these products, those involved in deciding on new hardware do face major uncertainties. After being involved in computing as an end-user and high level programmer since the mid-1960s, I still find it difficult to decide on new technology, short of sitting down

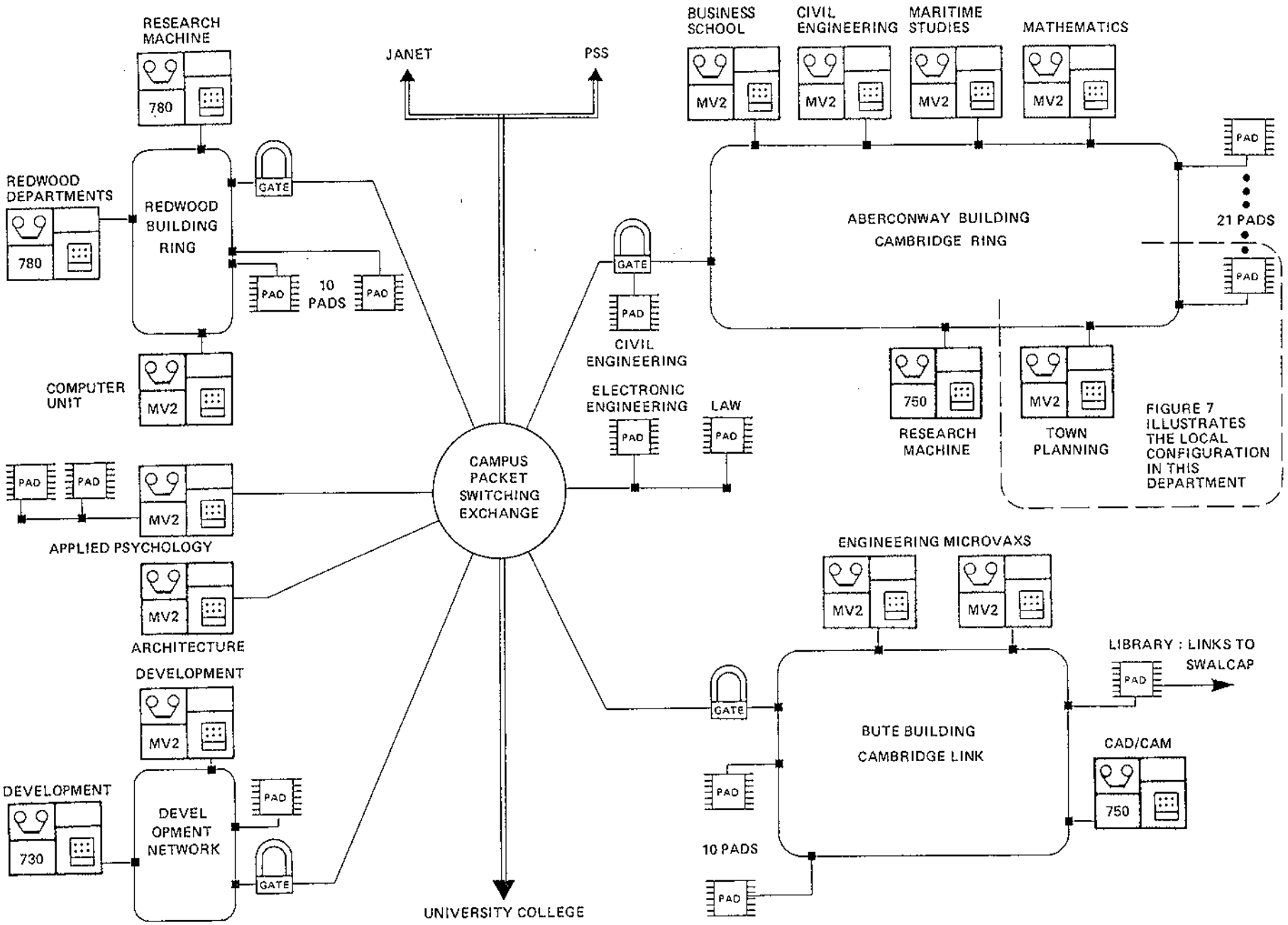


Figure 8 : Information Technology and the Local Area Network in UWIST mid 1987

and conducting my own intensive evaluation which might take many days. Advice and training in this area is almost non-existent, but it is essential if better decision-making about such technology is to be invoked.

There is an urgent need for limits to be set on the type of education and training relevant for different types of planner in different roles. At present, most of our students are introduced to computing in a formal structured fashion, rather than being exposed to the infrastructure more casually. The sort of computer use which characterises engineering students is not a feature of planning education, but there is a lot to be said for introducing planning students to general purpose software, networking opportunities, and even games, at a very early stage. This clearly increases awareness, but it also provides the right style of environment to enable technical-professionals who comprise the planning students being trained, to engage in the kinds of interactive computing which is increasingly necessary to synthesising diverse but standard software relevant to a variety of planning tasks. Moreover, the need to train planners to use a range of information services can be easily developed in the sorts of computing environment pictured in Figures 7 and 8, simply by exposing students to mail, phone and bibliographic services.

Hardware shock - compare Figures 4 and 7 - can be considerable, but if there is no tradition of information processing, it can be daunting. For example, in some developing countries, the gradual evolution of computer systems is not a feature of the evolution of information technology. Suddenly, technology equivalent to that displayed in Figures 5 or 6 comes on stream where none had existed before. For example, a joint project between UWIST and the University of Technology Malaysia (UTM) sponsored by the British Council, involved developing an applications software package

of standard planning techniques along the lines of the UDMS (UNCHS, 1983) software. This was originally developed for an IBM-PC environment using a portable COMPAQ micro which was transported to and from Malaysia for the project (Webster, 1986). The Planning School at UTM did not have access to any micros in 1986, but by mid-1987 an elaborate laboratory consisting of 10 IBM-PCs had been established, fully provided with all the standard software - LOTUS 1-2-3, DBASE III etc - required to operate the applications software. From a situation of nothing, a picture akin to Figure 6 emerged overnight and all the problems of rapid training of staff, then students, to make best use of the technology have suddenly occurred. A similar situation could well exist at the Institute of Technology, MARA, in Kuala Lumpur, where another UWIST project with the Transport Centre presently depends on the availability of only one micro. Any sudden change of the kind occurring at UTM could transform this project and open up possibilities not considered hitherto. Yet if hardware shock of the kind described here can be daunting, software shock - the existence of new forms of software for which there is no prior expertise - can be even more dramatic. To this, we will now turn.

SOFTWARE SHOCK

Models of the emergent decentralised or decentegrated information technology hardware illustrated in Figures 7 and 8, do enable some clarity and understanding of what is likely to be the norm in the medium term future, to be gained. In contrast, there are no such models of the organisation of software in general, and certainly none in specific task-orientated fields, such as planning. In some senses, the development of software is much more diverse than that of hardware, largely because hardware is general purpose, software is invariably specific, at least in

its application. Traditional software, such as that operating on mainframe machines, a decade or more ago, of which much survives in a more modern form, depends largely on the field of application, and often on its frequency of use. For example, development control systems although based on information systems principles are specific to routine planning tasks, while the whole range of forecasting, modelling, design and graphics presentation and cartographic methods are specifically orientated towards narrow and easily definable functions.

New tasks, however, have emerged. General purpose software, which can be applied innovatively to a whole range of new and traditional tasks are being extensively developed, particularly in a micro-computing/end-user context. Much of this software is business management orientated based on various forms of accounting systems, but a variety of new tools - spreadsheets, data base management systems, text processing packages, even micro-based presentational-draughting-publishing packages - are now available. These systems appear to be applicable in many contexts, and a creative synthesis of such software in pipeline processing form would appear to open up their application to many more specialist tasks. It is tempting given the pace of such development, to see whole fields such as planning, to be ultimately composed of end-users and systems development programmers. However, although some of these potential applications are likely to be useful, many can only be approximated by such general purpose software and although useful pedagogically, can never replace purpose-built software. We will return to this point later by way of examples.

One change which is a consequence of the increasing significance of general purpose software, is that designers of software are no longer users; end-

users now represent a whole class of new users of high level sophisticated technical applications software. But in planning, this change has not and is unlikely to have a major effect. In Figure 3, for example, most of the channels where information technology serves to integrate planning functions - in information system design itself, in forecasting, design, analysis and in expert-systems interfaces, graphics and input processes, fairly specialist software is required despite the increased use of general purpose packages at various stages. In fact, it is useful to look at the type of software required in a variety of these planning tasks, with respect to the model of software types and user roles elaborated in an earlier section. We defined three types of software - general purpose, small task-specific and large task-specific, and three kinds of user - the new non - or a technical end-user, the technical-professional and the analyst of which the end-user essentially represented use of software in a management-policy role, the technical-professional, a strategic but problem-solving role, and the analyst, a high level programming or even systems development role.

We can define such software types further in terms of typical software items available to staff and students in my own academic environment. General purpose software can be further subdivided into that which is entirely commonsense orientated such as word processing, data base management and spreadsheets (Wordstar 2000, DBASE III, and LOTUS 1-2-3/LOTUS Symphony are examples), and that which is more technically founded such as statistical packages (MINITAB and SPSS-X are examples). Small system task-specific software relating to modelling, cartography and possibly design include examples such as MICROTRIPS - a package to enable traffic distribution and assignment modelling to be developed, MICROPLOT - a computer cartography package, and AUTOCAD - a graphic (3-D) design

package. Large task-specific software can be just larger versions of the same. SASPAC is an example of an elaborate package used to access small area statistics data at ward and parish level from the Census of Population, ARC/INFO is an elaborate terrain, thematic and cadastral geographic information system useful in part in a variety of spatially information and mapping contexts.

Software types can be defined more easily than user/developer roles in software applications and design. Here, the same person can act out many roles in different tasks, as well as during the same task. For example, in designing a population projection program, an individual can act at the analytical level mainly, but in presenting output, may use standard mapping and information data base packages, while frequently requesting high level help facilities requiring information in an online context. It would indeed, in planning, be rare for the technical professional to not also act as end-user and just occasionally as analyst. For example, there are several applications of forecasting, modelling and evaluation using spreadsheets (Ottensmann, 1984), but although planners might act as end-users in learning about spreadsheets, they would need to act as technical-professionals in coupling spreadsheets and data base management packages together to effect useful applications in forecasting. Indeed, the interfacing may require a more analytical role.

To clarify these points, it is worth examining the software which is available to myself and colleagues in teaching planning students about information technology at UWIST. In Figure 9, we have attempted to classify the software in use in the Department of Town Planning, according to the three types and roles defined. The arrows on the charts show the

way in which software types and roles can be mixed in developing information technology, with respect to various planning tasks. Although there is a mild correlation between specificity of role and type - end-users mainly using general purpose software and analysts using large system task-specific software - it is not easy to be definitive about the linkages between roles and types. New linkages are being forged all the time. Increasingly, planning teachers are using types of software across the whole range, often within specific tasks and often in entirely different tasks, hence roles. We do not have any specific structure of roles and tasks any student undertakes in our courses, and, indeed, our purchase of the software in Figure 9 has been somewhat **ad hoc**. Nevertheless, the burden of our education lies upon training planners in the technical-professional role across a range of tasks involving the range of software types. It is the middle line of Figure 9 which marks the really essential area of training. Indeed, as the amount of relevant software continues to grow explosively, we can spend all our time available in avoiding analytical teaching and concentrating on technical-professional roles, assuming that the end-user role will look after itself. A lot of innovation in training and teaching is possible here. We have hardly broached the questions of how to teach such roles effectively, but already we feel that it would be easy to a fill a one year course entirely devoted to information technology in planning, with training in various forms of packaged software, thus acknowledging the labour intensity of such training. In essence, then, it would appear that training planners as analysts is unlikely to constitute the main priority (Batty, 1984).

The shock of being exposed to so much diverse software can be overwhelming. Our students are rarely exposed to more than 40 per cent of the software indicated in Figure 9, but the time required to become familiar with say,

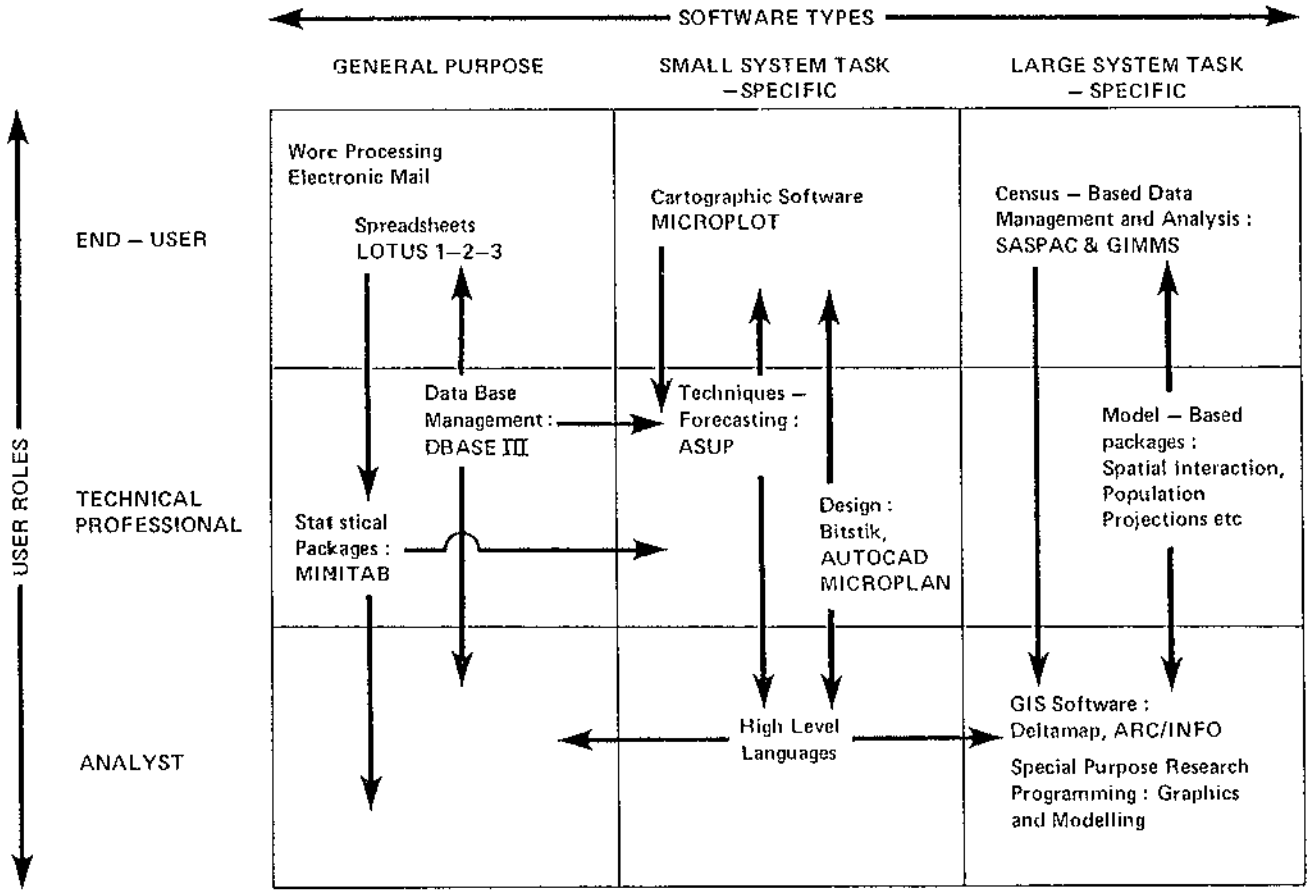


Figure 9 : Software Types Concatenated with User Roles

word processing, spreadsheets, data base, cartographic input, census access, spatial interaction modelling, and graphic design packages could easily swamp everything else in a year's course. Great familiarity is required to cultivate the requisite expertise and there is the ever present problem of software becoming obsolete through new products or at least, new generations of the same product becoming available. The ratio of products to users in planning is very high, but the environment in which such access is possible, is also rich in hardware opportunities. For example, Figure 7 indicates that 62 workstations (micros and networked terminals) are available to 150 students and 20 faculty in the Department of Town Planning in UWIST. With some 20 or so general purpose and small task-specific software products now available, no one staff member can become proficient in more than 3 or 4 such packages. In fact, attitudes towards this diversity and amount of software are ambivalent. Many feel the pressure to attempt to know them all but increasingly, choices need to be made about what people specialise in as end-users and technical professionals. The shock of realising the need to change attitudes towards software use and expertise is slowly sinking in. We face a real dilemma in information overload.

Learning about general purpose and any other variety of packaged software will be the major training task in all contexts of information technology use in planning, but experts in analysis and programming will still be required to design appropriate software at all levels and to advise the technical-professional about possibilities in applications. In fact, no general purpose software is likely to be as good as more specific one-off designed software until the demand for such software forces designers to define the appropriate market for the package. And in the last analysis, the quality of application will be influenced by the abilities of the

professionals and analysts involved. One problem increasingly faced by professionals is in their exploration of the appropriateness of standard software. General evaluations are not easy and often only possible after a high level of training by which time the individual is locked into its use. Combined with the volatility of the organisational and task environment of planning, the everchanging hardware context and the traditional constraints of skill and finance, it is hard to generalise about training apart from identifying the common elements required, and the most robust software available.

EXPERIENCES FROM EDUCATION AND TRAINING

It is tempting to use all the ideas introduced in this paper to suggest a programme for education and training in a variety of academic and practice-based contexts. But this assumes we have a clear view of what is required and as we have argued, the current shock of new technology and the volatility in ideas and practice it has and continues to bring, makes a detailed and definitive scheme out of the question. Of course, it is essential for training to be robust and broad-based to withstand the ever present threat of almost immediate obsolescence and to stress principles, even if conducted in the context of applications. Rather than synthesise the various themes introduced here, we will simply begin to conclude this paper with some experiences of teaching students and staff from both developed and developing countries in various software packages involving the range from general purpose to large scale task-specific applications.

The background to our education in information technology to planners at UWIST is one of providing a fairly broad-based exposure to information technology in terms of the different hardware illustrated in Figure 7, and

the various roles and software types indicated earlier. However, the emphasis is mainly on the technical-professional and end-user roles. Although some students receive a course in programming, most of the emphasis is on statistical computing using MINITAB, census access using SASPAC and the computer cartographic package GIMMS, and on demonstrations of modelling software and mapping of local area data. Some micro-based packages involving planning techniques and data base design are also introduced. End-user support is minimal, students being left to their own initiative in developing word processing and spreadsheet applications. Training in CAD (Computer Aided Design) is minimal, although a good deal of conventional urban design training is offered. In essence, the focus is on learning about standard software rather than on any analytic software design. We have described the courses we offer elsewhere (Batty, 1984). Here it is appropriate to describe three typical applications involving students from developed and developing countries.

A course entitled **Microcomputer Packages** is offered to our beginning graduate students, which introduces them to the range of planning techniques involving analysis, forecasting and modelling using standard general purpose, graphics orientated software. This is supplemented by the programs developed by Ottensmann (1985), and a related project has been based on the UDMS software (UNCHS, 1983) which covers a similar range of techniques. This software running under CPM on Superbrains was not very successful, being full of bugs and with no graphics capability, and it was decided to develop a tailor-made portable package synthesising these various software packages for operation in an "IBM-PC" MS-DOS environment. The package was based on four techniques: population projection, employment forecasting, spatial interaction and site potential analysis, and was

organised to display the model workings and results graphically. A simple expert system-like user interface was provided to enable users to access the various techniques from a standard hierarchically orientated menu system.

The package entitled **Applications Software for Urban Planning** (ASUP) was developed on a portable COMPAQ machine under MS-DOS, and was supported by a grant from the British Council which enabled its author (Webster, 1986) to develop the package for use in Malaysia at the University of Technology (UTM) in Johor-Bahru. An innovative feature of the package was the way the data input was organised using DBASE III which enabled successful input and updating at a high level of end-user access. This was coupled to ASUP and the interactive element of the package was translated into Malay in the winter of 1986-1987. In the summer of 1986, when it was developed, the department at UTM had only the portable COMPAQ on which to develop this but by mid-1987, had acquired a network of some 10 micros on which the package had been implemented. Indeed, a spur to the acquisition of this information technology was the collaborative arrangement and the existence of this package. Teaching opportunities have not yet been realised in UTM, but an important resource tailored to the local context now exists. Problems still exist in the software, but perhaps the biggest constraint to development is the fact that the graphics interface is still device-dependent.

The second package developed in-house in UWIST is now device-independent in the graphics sense and entirely portable in the IBM-PC (and clone) environment. This package involves a residential location model based on spatial interaction concepts and was originally developed by this author on a VAX 780 in Melbourne University in 1982. The package is entirely

graphics orientated using the PLOT 10 graphics language, and it has been successively ported to the UWIST VAXs with GINO graphics where it has been running for student demonstration since 1983. The model package involves data input, display and exploration, calibration of the gravity model, and predictions, with an emphasis on map display interfaces. The model has been applied to Melbourne, Reading, Barry, Cardiff and Singapore, which range from 8 to about 50 zones. It is used in courses involving urban modelling (Batty, 1976) and originally evolved from such teaching to second year undergraduate planning students (Batty, Bracken, Guy and Spooner, 1985).

The model in the VAX FORTRAN form was not very portable but recently, in November 1986, it was successfully converted to WATFOR-PC using GKS (WATFOR) graphics available for the IBM-PC. This was accomplished in the University of Hong Kong Computer Centre and now the program, in a slightly slimmed down form, runs successfully on any IBM-PC (standard machine) with mono graphics output. Essentially, it is graphically device-independent in the IBM-PC environment. It runs on an Amstrad 1512, on an OPUS II and such like PC clones. The package has been usefully ported to the Institute of Technology MARA Transport Centre in Kuala Lumpur where it is being developed for the Klang Valley Region (Longley, 1987). The model has been through many versions, but it is now entirely portable being first demonstrated at the Asian Productivity Council's Seminar on Strategic Planning for Urban Growth in Hong Kong in November 1986. In fact, this would not have been possible in 1982 when it was developed in Melbourne. Developments in microcomputing and in languages in the interim have solely enabled this.

The last project is a one-off piece of software developed also at the Institute of Technology MARA Transport Centre by Spooner (1986) in the summer of 1986 under British Council sponsorship. Essentially, this involves the construction of a bus information system for the Kuala Lumpur metropolitan area (Federal Territory) in which data is input and updated using DBASE III, and analysed and presented using the spreadsheet LOTUS 1-2-3. Information on bus frequency and routes is ingeniously coded in DBASE III which is then accessed by LOTUS 1-2-3. The graphics capabilities of LOTUS 1-2-3 are used to display the route network, but the synthesis of DBASE and LOTUS although clever remains problematic, thus demanding considerable analytical expertise, not simply acquired through end-user or technical-professional training. Spooner, the author, knew the software inside out and was able to make some rather innovative linkages not normally possible by non-analytically orientated users. Nevertheless, there are still considerable problems in its use and extension. The coupling of standard software in this way is cumbersome and there is no real substitute for a tailor-made package in this case. Rudimentary applications can be made using such general purpose software, but there are severe limits in usage.

Finally, our students do not get much practice in large system task-specific programs based on geographical information systems or such like. They experience SASPAC and some mapping, but very little programming. Twenty years ago, there was more on computer programming in British planning schools, and it is somewhat ironic that there has been a gradual deskilling as more and more standard software has come to fill the gap. This represents a mixed blessing, but it does reinforce the need for extreme care in the design of training programmes based on standard software. The field is diverse, local conditions are very different, and

what is possible tends to determine what sights are set for such training. However, practice does vary in western countries. In the US, many universities are now insisting on basic computer skills in all courses, and this is bound to lead to different professional responses in time. But as yet there is no standard practice nor even a consensus about what the best training should be.

CONCLUSIONS : PROBLEMS AND PROSPECTS

Such a long paper as this one warrants a brief conclusion as many of the themes have already been spelt out. The variety, diversity and complexity of the environment in which information technology is now an integral part, dominates any proposals for education and training at present. It is an open question as to whether the ideological change combined with technological change, indicated earlier in this paper, will settle down, thus making the picture of impacts on society clearer, or whether as some commentators argue, such change is a natural feature of the society we are moving to. In any event, proposals for training must be separated into those designed to provide more robust and long-lasting skills in information technology, and those related to specific software-hardware which will inevitably become obsolete. In some senses, these issues are independent of who is being trained and at what stage, for in this period of transition, many groups involved in planning practice and education will need to be trained in the same tasks and skills. Although we have mainly concentrated on academic training in this paper, many of the proposals and issues broached are applicable to practice-based situations.

What is certain is that there is much training to be done for the technical-professional role. Raising awareness in end-users and

inculcating deeper skills in analysts are easier tasks to define. But in the middle ground where professional planners are involved in day-to-day and strategic problem-solving and design, there are many training issues to be dealt with pertaining to how planners interact with the whole continuum of software types and creatively synthesise these various types with respect to their technical expertise. This is an area where urgent research is required, but it exists within the wider organisational context in planning which also has to be explored with respect to information technology. The design of appropriate orgware implicit, for example, in Figures 4 to 8, is a major task in all areas of application, not just planning, but planners need to be trained in the organisational skills required to use the technology in the best way. These challenges are widespread in society at present, and will remain in the forefront for a generation or more.

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