Need for relevance in management information systems: what the NHS can learn from industry

Enid Mumford

Information systems are no longer associated mainly with data processing; they are increasingly seen as a management tool and an aid to action. This means that the costs of failure are much greater, and these costs are incurred when expensive systems are not used or are inadequately used. Surveys have shown that in as many as half of systems there are large gaps between users' expectations and the system's performance.¹

The increased cost of failure is leading to a rethink of approaches and strategies for the design of information systems. When computers first appeared in offices in the late '50s and '60s their costs and limitations meant that they were often introduced in an authoritarian manner: "This is what we can provide and you must have it." Then, as user resistance was encountered, strategies changed to a soft sell approach: "This is what we can offer and it is just what you want." Overselling of poor systems led to user scepticism, and designers began to realise that they needed to talk to users before producing a product: "We think we know what you want but we'd like to discuss this with you." This led to the practice of interviews with individual users, which is still popular. These interviews were often followed by the development of a simple prototype that the users could experiment with before the final product was created.

The quasiparticipative approach is now increasingly used: "We think we know what you want, but we'd like you to help us design the system to make sure we get it right." This usually requires users to spend time defining their information needs. It is an approach that pays off as a clear and correct specification of information needs has been found to be a critical factor for successful design of management information systems. A more progressive approach, which I favour, takes participation a stage further. Users are asked as a group to identify the problem that they would like a computerised system to tackle; to specify their information needs; to set objectives for the new system; and to redesign departments and jobs so that the total system can work effectively and achieve the organisational mission.²

Much attention is rightly being focused on the design and implementation of computer based systems, and systems are often evaluated on the extent to which these two stages are successfully completed. But there is a third, equally important stage: the extent to which systems are successful once they are implemented. I will concentrate on this third stage and the reasons why many systems cease to be used in an effective way. This analysis has to be based on behavioural and organisational rather than technical or financial factors.

An important reason for lack of use is that the information provided is not seen as important or relevant by the group that inputs or accesses it. A technical systems design group is often unwilling to accept this. The group has spent hundreds of hours designing and implementing the system and there is a

great reluctance to accept that it is not providing what is required.³ At the design stage computers are usually viewed as machines that will reduce uncertainty by providing more accurate and timely data. It is both challenging and threatening when uncertainty is increased because there is a doubt that the users will either want the new system or use it when it is in place.

There are many reasons why users are reluctant to use new computer systems. These can be ergonomic (it is difficult to input or access the data; the system responds too slowly) or motivational (it is boring and time consuming; those who do the input do not benefit from the output). I will concentrate on the problem of relevance.

Design of information systems for NHS

The NHS is introducing a complex set of computer systems as part of its resource management programme. The information it is proposing to generate will come from many different subsystems and will be brought together by a central system such as Casemix. This will enable the costs of activities and services to be more accurately determined than they are at present.

Many different groups must be motivated to enter information into the system and access it regularly, and this requires that they believe the system to be of value. Consultants and the members of their clinical directorates will use the information to plan and manage clinical resources. Other groups will use information relevant to their specialties in the same way. There are now programs for planning nurse rostering and assisting nurses to care for patients; for monitoring the use of operating theatres; and for keeping records of the work of departments such as pharmacy and radiology.

All of this requires an integrated information system more complex than most industrial companies have yet achieved. It also requires many different groups with different needs to be prepared to use the system, and to use it regularly and accurately. This means that the system must provide a range of information that each group finds relevant and useful, which, as industry and commerce have shown, is no easy task. Industry has often been able to coerce clerical and shop floor staff into using poorly designed computer systems, although this is becoming more difficult as systems move up the management hierarchy. This is not an option for the health service, where there are several powerful groups, such as doctors, who can refuse to use technology that they regard as taking up valuable time for inadequate rewards. Relevance is therefore important for success in the health service. The subsystems used by particular groups must be able to provide the information that each group regards as essential in furthering its work mission and major work interests. If this does not happen these systems will probably fall into disuse. A case study from industry provides an illustration of how this can happen.⁴

Will doctors be using computers for management as well as clinical work in the future?

The lesson of XSEL

XSEL was part of the Digital Equipment Corporation's first attempt in the US to move into artificial intelligence and build an expert system. Bravely it decided to use this new concept to try and solve one of the company's major difficulties—that of configuration. When computers are manufactured numerous different parts have to be brought together and assembled, and because there are so many parts often some are missed out or assembled incorrectly. Thus when a customer receives a new machine it may not work, causing a serious deterioration in the relation between customer and supplier. Attempts to solve this problem with configuration have failed and it was thought that an expert system, acting as an electronic aide memoire, could be the answer.

In the early '80s an expert configuring system called XCON was built and installed in Digital's manufacturing plants. This provided a graphic display of how different parts should fit together. It was very successful and was welcomed by the engineers building the computers. Unfortunately, it did not solve the problem completely because this originated in the sales offices. Each salesperson had to detail all the parts in a system ordered by a customer; firstly, to give the customer an accurate estimate of how much the machine and peripherals would cost, and, secondly, to send a specification to the manufacturing plant stating exactly what the customer wanted. Most of the sales staff were not engineers and the specifications were often inaccurate and caused mistakes in assembly that the manufacturing staff could not identify. Incorrect estimates also meant that the customer could refuse to pay extra when the error was identified. These configuring errors cost Digital many millions of dollars each year, and as a result an expert system for use by sales staff was developed (XSEL). In its mature state XSEL contained 15 000 configuring rules.

XSEL was designed with much user participation. The design group contained both technical experts and members of the sales force and met regularly during the design and implementation stages and for some time after the system was installed. Design was an iterative process with the sales people specifying their information needs, the technical members building an embryonic system for them to test, and this process continuing as XSEL grew until the system was regarded as fit to hand over to the sales offices for day to day use.

Although only a group of sales people could participate in the design process, Digital kept all the sales

offices informed of what happened at the design meetings. When there were arguments over strategy that could not easily be resolved the sales offices were consulted. Because of the participative approach, when XSEL was ready for implementation the sales offices were enthusiastic and very willing to use it. The system was non-threatening—no one was going to lose their job because of it—and it would prevent salespeople making embarrassing and costly mistakes.

Despite initial enthusiasm the system gradually ceased to be used. The sales force reverted to using their own knowledge and the configuration mistakes increased. Digital tried to solve the problem by enhancing XSEL. Training was improved and efforts were made to see that all salespeople received it; the system's interface was made easier to use and the speed of response was improved. But XSEL continued to be neglected.

What can be learnt from the XSEL case study?

I have been working with Mark Keil, a researcher from Harvard Business School, to find out why XSEL became disused. We believe that the problem was motivational, not technical. After the initial enthusiasm had worn off the sales force became less motivated to use XSEL because there were few benefits in doing so. XSEL merely added an extra administrative task, which removed staff from selling. This problem is partly caused by the fact that the success and salary of staff is determined to a large extent by selling prowess. Sales targets (Digital goals) are set with bosses for the following year. In addition, job satisfaction comes from the excitement of chasing and winning a big order. The company is increasingly emphasising the need for long term relationships with customers and for good after sales service, but the goal system does not steer people in this direction.

The key function for sales staff was producing a quote for customers. The configuring problem, although it caused so many problems for Digital, was of much less interest to the salesperson as it was less directly related to getting a sale than the quotation process. Although configuring errors caused serious difficulties, these occurred in the manufacturing plants. By the time the customer had discovered that his or her new system had several vital cables missing the salesperson was directing his or her attention at another customer. If the system could have produced quotations for customers or if the Digital assessment system included accuracy in configuring as something that was measured and taken into account in performance reviews, the configuring task might have had greater importance for the sales force. Instead, configuring was low down in the salesperson's list of priorities and the system fell into disuse.

Relevance in information systems

The case study shows the importance of understanding how the staff view work priorities before designing an information system. These priorities will include the criteria on which staff are evaluated for formal rewards such as pay and promotion and for informal rewards such as the esteem of colleagues. They will also include those aspects of work that provide the most personal satisfaction. The system must fit important personal goals or it is likely to fall into disuse. The question now is how to identify these key personal goals.

Systems designers cannot guess what aspects of work have high relevance for individuals, particularly senior managers. A participative approach in which future users share the design task with technical experts is therefore essential. The ETHICS methodology

assists this by providing a set of analytical tools and processes which help users to participate effectively.*

With the ETHICS methodology the group first defines its work mission by asking "Why does our group exist and what is it trying to achieve?" and determines what important tasks it must undertake to achieve its mission. Secondly it considers what the group needs to improve effectiveness, job satisfaction, and efficiency in achieving its mission and what future changes are likely to affect its ability to achieve the mission. Thirdly, the group defines its information requirements—that is what information will contribute most to the achievement of the work mission and the key tasks associated with this. Most importantly, the group focuses on information it regards as essential to do existing key tasks better or introducing new tasks; to give the group high job satisfaction and high morale; to solve problems where missing or late information causes mistakes; and to assist the group to manage change more easily. The group then defines what information would be highly desirable and what would be useful for these purposes.

Members of the group who have key roles are asked to do an analysis of their own needs and information requirements as well as the group analysis. The statements of essential information should show what a computer based information system must provide if it is to be used. It is particularly important that managers' needs are met.

A participative approach enables the members of a group to rethink what they should be doing and how they can work together most effectively and efficiently. It enables information needs to be carefully defined irrespective of whether this information is provided by a computer or in other ways. It also gives staff a sense of ownership of the new system, and staff will recognise that the system can be of practical assistance. The system should therefore be relevant and continue to be used once the first novelty is over.

Participative design in the health service

If the health service wishes to use computer systems to improve its management it must get people to recognise what their essential information needs are. These will be related both to work goals and to personal goals such as career progression. Acceptable systems will provide information that users regard as critical to success, and the fit between the system and its users must also endure over time even though interests, rewards, and controls may change.

Although all health service staff are dedicated to improving health care, individuals may interpret their contribution to this in different ways. Hospital doctors, for example, may require information that assists their research as well as their treatment of patients. Those who see themselves as managers as well as doctors will want information about the use and cost of resources, but these doctors may be in the minority. These two needs can cause a serious conflict of interest, and this is supported by American experience. According to Quam, price based competition in the American health service is seen as diminishing the quality of patient care, and she argues that the British approach may cause a similar reaction as it lacks a strategy to improve clinical practice and does not have a means for ensuring that attempts to lower costs do not harm patient care.⁷ She suggests that a clinical database is needed that enables data on patient demography, diagnoses, clinical findings, and treatments to be

*A teaching package for the ETHICS methodology, which contains a video, case study, and work book, can be obtained from Dr David Allen, North West Regional Health Authority, Gateway House, Piccadilly South, Manchester M60 7LP (tel 061 236 9456).

collected. Hospitals should then introduce policy changes on the basis of this research information.

Such an approach requires doctors to devote time and effort to identifying clinical and other information needs before software is acquired. Though some hospitals are spending much time helping clinical directorates and other groups to clarify their important information needs, others are not. When people are overworked and short of resources there is a natural reluctance to spend time in meetings analysing information needs for something that has yet to happen. But this can lead to purchase of expensive systems that become disused; coercion has never proved satisfactory for ensuring that people use computers, and, as the XSEL case shows, even if there is initial good will in the long term there is likely to be a reversion to old methods of handling information. This would be extremely expensive and inefficient for the health service.

The NHS is a complex organisation. The needs of many different groups have to be identified and balanced for its effective operation, and inevitably there will be conflict between some groups. One new problem is the need for excellent cooperation between hospitals and regional health authorities in what is to become a buying and selling relationship. There is also the continuing requirement of cooperation between medical staff and administrators. All of this requires good management and clever computer systems. Computer software must be able to cope with considerable variety if it is to produce the information that different NHS groups regard as essential.

Doctors want clinically relevant systems that improve medical care and assist clinical management, but the danger in the NHS approach is that the emphasis will be on financial measures.⁸ The present rush to get computers in and working in the health service is a recipe for expensive disaster. Medical and other staff must carefully and comprehensively analyse their essential information needs. They must also look carefully at the software and ensure that clinical needs take precedence over accounting needs. They should then select and evaluate the software that provides the best fit with their needs. All this will take time.

The British health service is not only changing its organisation; it is changing its culture. Yet there is still much uncertainty concerning the advantages of the proposed changes, particularly the move to a pervasive computer technology. Clearly these changes require a

I asked a small group of doctors in a well known teaching hospital, advanced in its computerisation, what they thought of the new computer systems. Some of the answers are given below.

"On balance I'm ambivalent, although their arrival is inevitable. I'm concerned that I won't understand them and I'll have to rely on others for information."

"There is a risk of losing clinical control through computers. They are good for routine lab tests."

"They are good for use in offices—for example, as word processors. But hospital computers are likely to have little impact on medical staff. They are OK for finance and costing but they can't be operated effectively for patient management. Also we can't find computer experts who understand the needs of doctors. This means that adequate software is not available."

"What computer systems? I can't imagine that they will be of any help."

"An awful lot of money is being spent and I haven't seen any obvious benefits."

"I think they'll be useful once they are running but I'm apprehensive about the change over period. I worry about the amount of work this will generate, on top of my normal work."

partnership between doctors and hospital managers, but if they are to succeed and be relevant doctors must play a major part in their design. Unfortunately, there is still much confusion and lack of knowledge among doctors even in hospitals where computerisation is advanced (box). My message to doctors is that if you want to influence these systems spend time working out your clinical information needs and ensure that the system is relevant to them.

- 1 Lytinen K. Stakeholders, IS failures and soft systems methodology. *Journal of Applied Systems Analysis* 1988;15:61-81.
- 2 Mumford E. *Designing human systems: the ETHICS method*. Manchester: Manchester Business School, 1983.
- 3 Winograd T, Flores F. *Understanding computers and cognition*. New Jersey: Ablex, 1986.
- 4 Mumford E. *XSEL's progress: the continuing journey of an expert system*. New York: Wiley, 1989.
- 5 Quam L. Improving clinical effectiveness in the NHS: an alternative to the white paper. *BMJ* 1989;299:448-50.

(Accepted 10 April 1991)

Women and scuba diving

J E Cresswell, M St Leger-Dowse

Scuba diving is becoming an increasingly popular sport, and the British Sub Aqua Club estimates that there are 5000 female non-commercial divers in Britain. Doctors are increasingly being asked to advise patients about the risks associated with diving, and, with the growing number of women divers, this must include an assessment of any risks during pregnancy or associated with the menstrual cycle or oral contraceptives. In this paper we review the current knowledge on the potential risks for women associated with diving.

Body fat and decompression sickness

Cognitive changes occur with various phases of the menstrual cycle,^{1,3} and in theory a woman's ability to make safe decisions during diving could be affected by her menstrual state, although to date no studies have been conducted to assess this. Repeated exposure to hyperbaric pressure seems to have no effect on hormone regulation, ovulation, or menstruation, though there has been only one formal study.⁴ In this study two women were subjected to 5 atm (507 kPa) pressure—that is, 40 m of sea water—for 20 minutes seven or eight times during their menstrual cycle.⁴

Most knowledge of decompression sickness in women comes from the American Space Programme and relates to altitude decompression sickness, which may not be a good model for diving. Several altitude studies have found that women form fewer nitrogen bubbles than men for a given exposure^{5,6} but seem to have a higher incidence of altitude decompression sickness,^{5,8} to have more delayed onset of symptoms,⁵ and to be more likely to suffer the more serious type II bends.⁵ One retrospective study of diving decompression sickness presented in 1978 at the National Association of Underwater Instructors International Conference of Underwater Education in the United States showed a 3.3-fold greater incidence in women compared with men.⁹ But a more recent survey¹⁰ and results from studies currently being undertaken by Fife in Texas, US show no differences between men and women in their susceptibility to decompression sickness. Women have on average 10% more subcutaneous fat than men, and it has been suggested that this could influence their susceptibility to decompression sickness (B E Bassett and E H Lanphier, unpublished data). Fat can hold up to five times more inert gas than aqueous tissue and is slower to absorb and eliminate it. This has been put forward as a theory to explain the tendency for women to have a delayed onset of decompression sickness, especially with dives of long duration,¹⁰ although to date there has been no evidence to confirm this, and some reports deny any correlation between percentage of body fat and altitude decompression sickness.⁵

In one study all of the women who developed altitude decompression sickness were in the first 14 days of their menstrual cycle,⁵ and this has been

supported by a recent study which showed an inverse correlation between the number of days since the start of the last menstrual period and the incidence of altitude decompression sickness.¹¹ It has been speculated that the haematological effects of the early contraceptive pill may increase a woman's susceptibility to decompression sickness by encouraging microsludging of the blood peripherally (Bangasser, unpublished data), but again this has not been formally assessed.

Diving in pregnancy

There has been little work done on diving in pregnant women, though two authors have speculated on an increased risk of vaginal infection in women who dive while pregnant.^{12,13} Several retrospective studies have suggested that diving during pregnancy is associated with an increased risk of fetal abnormality,^{14,14a} and Betts showed that diving below 30 m during the first trimester was associated with a rate of abnormality of 16%,¹⁵ although the number of women in this study was small. In contrast Bangasser found no abnormalities in a retrospective survey of 72 women who had dived while pregnant.⁹ A long term retrospective study of the effects of diving during pregnancy is currently being undertaken both in Britain and in the United States.

Some studies in sheep have shown that maternal decompression sickness in late pregnancy is associated with increased fetal morbidity and mortality, whereas dives that did not cause decompression sickness had no effect on the fetus.¹⁶ Bolton-Klug *et al* found no effects of diving on fetal development during organogenesis in sheep.¹⁷ Gilman *et al* found a fetal anomaly rate of 5.3% in hamsters after untreated decompression sickness, reducing to 0.9% in those treated with hyperbaric oxygen.¹⁸ Some animal studies have, however, suggested that hyperbaric oxygen treatment may be toxic to the fetus.¹⁹ There have been conflicting reports about the effects of hyperbaric oxygen on fetal outcome in non-diving pregnant women,^{20,23} but unpublished reports from the Soviet Union suggest that the treatment is successful in pregnant women with cardiovascular problems.^{14b}

Advice for women divers

Early reports from animal studies suggested that the fetus was relatively resistant to decompression sickness,²⁴ but this was later challenged.²⁵ Recent work in sheep and goats suggests that although the fetus produces fewer bubbles than the mother, bubbling can occur in the fetus even when the mother shows no signs of decompression sickness.²⁶ Any circulating nitrogen in the fetus can readily pass into the arterial system.

Women who want to continue to dive when pregnant have been advised on the basis of published²⁷ and

Midlothian, Scotland
EH22 3JF

J E Cresswell, MRCP, clinical
medical officer in community
child health

Torquay, Devon TQ1 1QT
M St Leger-Dowse, freelance
writer

Correspondence to:
Dr J E Cresswell,
Department of Community
Child Health, 15-17 Carlton
Terrace, Edinburgh.

BMJ 1991;302:1590-1