Information technologies are developing at a fast pace and these technologies have many facets. When introduced into the health service delivery arena, many impacts can be seen which will impinge on the planning and design of health buildings.

There are a number of strands of development in IT to be observed in the UK which fall broadly into the following groups:

- Data processing and transmission using computers
- Communication systems – email and pager systems
- Filmless imaging systems
- Bio sensors
- Expert systems
- Automated transportation
- Video conferencing / telemedicine

Examples of such technologies can be found in use now in health care delivery, both used separately and in combination. The frontiers of each technology group are moving forward enabling more combinations and more automation.

Data processing developments are well established for patient process management and monitoring providing, for example, workload data, clinic booking procedures around doctors individual work patterns; just in time stores and supplies management; pathology test results directly to wards. There are mapping systems for analysing patient travel in relation to service delivery location. Single cable building and energy monitoring systems are becoming common place with operatives working from lap top computers. The next step is the setting up of patient clinical information systems such as the electronic patient record (EPR).

Location and pager systems are becoming much less expensive and are extending to patients as well as staff. Both voice bleep and vibration systems are common and may depend on single fibre optic cable transmission or on wireless antennae. Patients need not necessarily wait in outpatient waiting areas but can be paged from the cafeteria when their turn comes. Inpatients can move around areas without traditional nurse call systems such as the garden.

Filmless imaging systems obviate the lost Xray film as images can be called up to monitors in any location from an image archive. Images can be viewed within the hospital, transmitted for second opinion to a tertiary care centre and can be transmitted to primary and community settings.

Pathology images can be acquired and viewed using similar technology.

Bio sensors developments will allow patient condition monitoring to become much more widespread than in high dependency and intensive care nursing units. In future the patient at home may have their condition monitored with automated warning systems operating remotely and instructions on what to do coming into play as condition changes. These systems can also be connected with mobile automated pathology testing.

Expert systems are artificial intelligence software programmes that can be combined with other systems. For example pathology results can be transmitted to GPs through a network and an expert system can then call attention to any results falling outside normal ranges. Expert systems can be used to change clinical practice by arranging more complex pathways through computer ordering systems for choices that fall outside desired practice.

Automated transportation systems, particularly the pneumatic tube for pathology samples and drugs, are back in fashion now that reliability of arrival is ensured through bar coded address systems. The use of robots to deliver supplies is another area of development.

Video conferencing techniques provide telemedicine opportunities. Growing systems in the UK successfully link minor injuries units with full Accident and Emergency departments in giving clinical advice. Specialist diagnosis can be orchestrated by GPs for patients in primary care settings distanced from hospitals, through video transmission for specialities such as dermatology. Futuristic developments along this line are robotic surgery although surgery through video conferencing advice from a specialist to a surgeon undertaking a procedure exists now. Telemedicine advice in the areas of pathology and radiology is progressing fast.

So we have the possibility of a shift in conventional planning relationships by making:

- Connections by networks rather than physical proximity.
- Possible location of patient, doctor, equipment and technician in different countries, regions, cities or buildings.
- Records and reports available simultaneously to several people in many places.
Uptake of IT possibilities

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<th>What Can IT Enable?</th>
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The issue for planners and designers is to distinguish between what IT can enable and what is actually likely to be taken up. Constraints fall into three groups: cultural, technical and economic. Perhaps the most difficult are the cultural factors ranging from concerns about maintaining patient confidentiality to insecurity about personal ability and skills to cope with IT systems.

Technical factors range from basic network breakdown, to managing back up and standby systems, to managing large on site computer installations. Installations are easier in new build than in retro fit situations and current thinking is that mainframe installations etc are better off site and managed by computer specialist companies. Emerging technologies such as voice recognition are in use in some situations but are not considered sufficiently developed to be user friendly enough yet in the UK.

The economic or affordability argument must be seen as part of a total resource management approach. Many systems are very expensive but the question must be posed of whether the health service system can afford not to install IT systems. In all systems there should be a value added component whereby the system does more than what was previously done manually, in terms of influencing changes in practice or accommodation requirements.
Practical problems

Some practical problems arising in the UK have been identified, such as systems that do not talk to each other, loss of trained staff and systems that are built around an individual. In the first case we understand that the incompatibility of systems has been overcome in the US. In the UK there are concerns about the back up services of software support as companies change ownership with great frequency.

Taking the EPR as a case study, there are some pilot demonstration hospitals in the UK. The strategy in a 1200 bed hospital on two sites, was to develop an integrated set of applications organised around doctors and nurses needs. At a cost of 1.5 – 2% of the hospital revenue budget the key issues addressed were:

- Input issues – getting data in easily
- Integration of intelligent systems in order to change clinical practice
- To improve output and analysis

Voice recognition is not used for data input yet but wireless terminals allow bedside data input. Examples of changes in practice are to provide active support for decisions through information pathways on drug prescribing organised to encourage use of generic drugs and a consequent reduction in the annual drug bill; the discouraging of routine chest Xray in cases where the Royal College of Radiologists recommends against.

Existing case notes are scanned in as patients are re-admitted and expectations are that everything will be digital in 5-10 years achieving a paperless hospital in 10 years. A comprehensive picture of the patient episode is being developed from inputting the referral letter to sending the discharge letter by email. An accurate picture of the workflow through the hospital can be gained and analysed.

Taking filmless imaging as a case study a Picture Archiving and Communications system (PACS) has been set up in a 500 bed tertiary care hospital with 150 work stations in the imaging unit, outpatients department, wards, operating theatres and seminar areas. Images are taken on a reusable phosphor plate and transferred to digital storage. One of the technological advances is that the image contrast can be modified to improve quality, resulting in a need for fewer retakes. Images are managed through both active image and archive image stores. New images are transferred simultaneously to both stores. The active image store holds images for immediate use; images taken in the last ten days, historical images of inpatients and historical images of the days outpatients.

### Filmless Imaging

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<th>Image</th>
<th>acquisition transport display archiving database</th>
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<td>New image</td>
<td>active image store – 10 days archive</td>
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<tr>
<td>Active image</td>
<td>new images historical images of in-patients historical images of today’s out-patients</td>
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Advantages are that apart from no lost films, images are always in the correct orientation and date order and contrast can be manipulated while viewing. This hospital provides tertiary care so is not using teleradiology, but is in the situation that it could be one referral centre for image interpretation. The main frame computer supporting this system was fitted into an existing plant room space with some difficulty. Current thinking is that the computer support is better supplied by specialist computer companies from a distance.
Impact of IT developments

The new technologies can provide advantages particularly in access to services for patients. The patient need no longer always travel to the hospital to access specialist care but specialist advice can be made available at a distance with GP and specialist discussing the same clinical information including radiological and pathological images at a distance. The patient may only have to travel to hospital centres when their diagnosis and treatment requires specialist equipment and skills. However, although IT can enable new ways in delivering services, it is probably not the main decision making driver in service delivery planning, which will be more firmly centred around the tension between access for patients and the concentration of skills and equipment.

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Changes in service delivery patterns will change the nature of the hospital itself which may become a centre which houses specialist equipment and skills for diagnosis and treatment and provides care just for the very sick. Within such a framework the most obvious space reductions in the UK hospital will occur in waiting areas and storage areas. Waiting spaces adjacent to each outpatient clinic need only be large enough for patients immediately to be seen, as each patient can be given a bleep on arrival and move around the public areas of the hospital such as the cafeteria or retail outlets until called. Main stores for supplies will no longer be required as the computer based ordering systems, based on topping up user points to agreed levels, mean that stores delivery can be made direct to user points in wards, outpatient departments etc. Patient record storage will reduce over time and so will the space required pulling and storing records prior to outpatient clinics. In many hospitals records are pulled some days in advance of clinics so that checks can be made on completeness of results of tests etc. Electronically based systems will obviate all such space. X-ray films will similarly reduce over time.

In planning and design terms the impact of IT systems is driving change in two main directions. The first is where in future different elements of service might be delivered over the spectrum from hospital to home. The second impact is on the organisation, planning and design of the hospital itself, where adjacency of departments may no longer be an issue.