The immense improvement in ultrasonic B-scan picture quality over the last decade has been matched by the ever finer degree of clinical interpretation placed upon these pictures. Present day resolution capabilities have enabled the clinician to visualise anatomical structure of the order of a few wavelengths (typically $\lambda = 0.5 \text{ mm}$ for abdominal B-scanners). Since the information is of such a highly detailed character it is imperative that a greater understanding of the interaction of ultrasound and human soft tissues should be attempted. Typical sector B-scan pictures (see figure 1) often depict more than just a simple map of the anatomical placement of tissue structures. These 'extra' information, best described as B-scan anomalies, are often classed as unwanted 'artefacts' and disregarded when evaluating the information content of the picture. Although this is often justified, useful diagnostic information occasionally can be gained by a more rigorous appraisal of the anomalies.

**Reflections and Reverberations**

Clinical awareness of the complexity of ultrasonic sector scans has been noted by Cosgrove et al where the specific example has been reported of echoes appearing as mirror artefacts following reflection at the diaphragm. Information apparently arising from interfaces above the diaphragm are routinely displayed on B-mode sector scans of the right lobe of the liver. The apparent structure can be confusing and lead to misreporting especially when one considers that lung tissue is strongly attenuating to ultrasound ($40 \text{ dB/cm/MHz}$) and no echoes can usefully be obtained from it.
An explanation of this phenomenon depends upon the diaphragm acting as an acoustic mirror. Given the appropriate geometry, an ultrasound pulse can be reflected from the diaphragm back into the liver, and the back-scattered echoes associated with some anatomical structure be re-reflected back to the transducer. This is most easily demonstrated when a large acoustic scatterer, such as an hepatic lesion, is positioned close to the diaphragm. Due to the curved geometry of the diaphragm several complex situations can arise. In Fig.1 two longitudinal sector scans of the human liver are illustrated, both of which exhibit echo complexes above the diaphragm which are similar to the parenchymal echoes associated with normal liver tissue. In Fig.1a an apparent blood vessel is existing across the diaphragm for which there is no visible acoustic structure, within the liver, to relate to. The ray tracing indicates that the 'parabolic' geometry of the diaphragm could result in an apparent image of a blood vessel imaged in cross-section. To further complicate the situation, angulation of the diaphragm is likely to give rise to imaginary images from out of plane acoustic structure - as seems likely in this example. This out of plane imaging is also stressed in Fig.1b where a real blood vessel fails to produce an imaginary image across the diaphragm.

The clinical significance of this phenomenon is apparent when pleural pathology in the right base is imaged, such as pulmonary consolidation or pleural tumours. It is clear that the ultrasonic information obtained under these conditions is clinically meaningful, whereas that normally obtained when the lung is aerated must be ignored.

Although the above discussion illustrates a possible over-interpretation of B-scan information it is more usual for useful information to be missed. A further example of the importance of geometry on acoustic reflection is depicted in Fig.2. Illustrated here is a rectilinear B-scan showing a cross-section of the human neck, performed using a water bath stand off. From the grey scale picture (upper right) we can immediately identify some of the acoustic structure with known anatomy (upper left). A significant amount of acoustic information (lower left) has been labelled 'artefact' in that it does not exhibit an immediate relationship with known anatomy, yet careful consideration of the anomalous structure not only improves our conception of ultrasonic B-scanning but yields extra anatomical information as well as eliminating false conclusions regarding the position of real structure.

First, we notice that doubling the distance between the skin line and the transducer path produces the lower 'artefact'. This is a 'twice around' phenomenon where the acoustic pulse has initially been reflected at the skin surface and further reflected back at the transducer to produce a spurious, delayed transmission