Ultrasound is used more often than any other medical imaging modality because compared to the alternatives it is fast, safe, portable, and inexpensive. Moreover ultrasound has evolved symbiotically with advances in integrated electronics to allow increasingly higher image quality, along with enhanced functional information, like color flow, perfusion, tissue-strain, and elasticity imaging. It has now become possible to incorporate in compact instruments capabilities that were only available in full size consoles a decade ago.

Imagers consist of a sensor that both transmits and receives ultrasound, an electronic beamformer to create focused beams of energy, a mid processor to convert these into grey scale images or functional information, and a display module for output. User interface and control elements complete the units. Three key technologies drive ultrasound miniaturization. First, integrated electronics that allow more processing per volume and per watt are important for both the analog front end as well as the digital beamforming and mid processing units. Second, advances in CPU, and now GPUs, along with simpler software platforms allow many of the functions that used to be done in dedicated hardware to be done in software. Third, the migration of beamforming into the probe shrinks the cable diameter and distributes processing and power consumption.

Several examples from recent progress will be used to illustrate these points: the introduction of laptop, tablet, and hand-held imagers; automatic image optimization to simplify the user experience, and automatic physiological parameter estimates. Recent studies show that in some cases the diagnostic utility of small ultrasound imagers matches results from the larger and more costly consoles. Ultrasound imaging will be adopted in more point-of-care and rural settings. Spurred by technological innovations, the ability of ultrasound to address quality, access, and cost issues will likely increase its utilization worldwide.

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Learning Objectives:

1. Be able to describe the operation of the major parts of an ultrasound imager.
2. Appreciate recent advances in probes and microelectronics.
3. Understand how engineering specifications impact the diagnostic workflow.