Humankind has had a need to measure things dating back to antiquity. Units of length were often associated with body parts, a hand, a finger, a knuckle, a foot, a cubit and others. One person's foot would likely be different from another's, but the measurements likely presented a rough idea about the specified length. And maybe for such early applications, that would have been good enough. The Great Pyramid of Giza used the Royal Cubit (elbow to fingertip) for its construction. The construction team standardized on this same unit of measure, and it seems to have worked out just fine.

The measurement of time started around 500 B.C. to establish the 7 hours for canonical prayer in monasteries. These seven were midnight, sunrise, 9am, noon, 3pm, sunset and bedtime. Our ancestors counted the days with the shadow of the sun and also by the stars… They counted time with candles, hourglasses and water clocks.

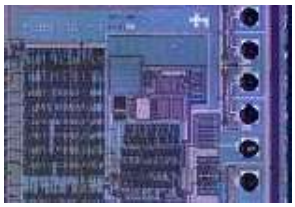
The need to measure weight was important in commerce. An early unit of mass what a grain… the mass of a grain of wheat or barleycorn. The karat used in the weight of gemstones is a derivation of the carob seed. These ancient measurements were certainly not global standards. However, the weight of 1000 grains of barleycorn in one town were probably pretty close to the weight of 1000 grains of barleycorn in another town. They could chip away at a rock until it weighed 1000 grains (and other weights) to fashion a weight standard that could be easily carried around. It was likely good enough.

Measurement of vibration and impact was not in demand until the mid-20th century. As machinery continued to develop, there was a growing need to make them quieter and more efficient. The need to measure vibration/shoch spurred the development of the accelerometer.

Pertinent to this paper is the measurement dynamic physical motion, measuring things that move under force such as vibration and impact shock. The need to measure vibration/shock is a fundamental concern for the accelerometer, and a large section of the modern accelerometer market is based on piezoelectric technology. Shown below are some relatable examples.

One would think it important that the payload survive the trip into space. During design and development (and application) of a rocket, accelerometers are mounted at several key points. Engineers can monitor these data and modify designs to provide a 'smoother' voyage. Once the vibration/shock environment has been characterized, ground based test labs can recreate the same environment. Maybe they design the payload to survive double the worst case of the expected rocket vibration, hopefully maximizing its chance of survival on the trip upward.

Helicopters are basically machines trying to shake themselves apart. Accelerometers can be used to measure the normal vibration at various stages of flight. The data can be monitored to determine whether the helicopter is vibrating within its normal limits, or whether something 'extra' is detected that might call for diagnostics and service.



Accelerometers can be used to test for the absence of vibration. Some equipment processing requires extremely stable mounting. Some of these applications might be holography and photolithography for dense layouts. Sometimes very slight vibrations can ruin the result. A truck driving past a building can actually produce such vibration. The accelerometer can provide the confirmation that the mounting was indeed stable (no vibrations) to validate the process.

Pacemakers - Many modern pacemakers use accelerometers to continuously monitor the physical activity level of the patient. If the heart beats too slowly (bradycardia), then the pacemaker needs to react. In this application, the accelerometer is part of a team of sensors that determine whether the patient is likely running, swimming, biking, or laying idle, and then the pacemaker issues the appropriate pulse cadence. These are called rate-active pacemakers.

Railroad cars - A company pays to ship their product on a train, and finds it damaged on arrival. Some train systems have accelerometers mounted in the cars to show whether there was any damaging vibration/shock during the trip. When they prove that the ride was uneventful, their insurance companies potentially save a lot of money.

Vibration/shock measurement is important for so many products and services. This is only a miniscule portion of them.