A review of speedometers and the criteria to be considered before accepting ‘frozen’ readings and other marks

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Abstract
Various mechanisms have been used to drive speedometers and other instrument gauges. This paper reviews the mechanisms used; in particular stepper motors which have become the most common type in the last decade or so. Stepper motors require power to drive the needle to any indicated position, including to return it to zero. Hence if power to the instrument is lost as a result of a collision there is no power to move the needle and it should be left at the reading shown at the moment the power was lost. However, not all stepper motor instruments are the same and before accepting the reading a number of criteria need to be considered to give a level of confidence in the result.

Keywords
Collision Investigation, Stepper Motor, Speedometer

Introduction
Speedometers have been essential instruments since cars started to travel above walking-speed. As well as having an instrument to inform the driver of their speed, in some countries early cars were required to have a large external speedometer to inform other road users (and most notably the police) of the speed of the car. Not surprisingly, those external speedometers were soon abandoned!

In the vast majority of instruments since introduced, the speedometer and other main instruments have been of the analogue type, having a circular dial with a centre-mounted needle (or ‘pointer’). There have been many types of mechanism used to drive the needle but the greatest change has been in the last decade during which there has been an almost universal adoption of instruments driven by stepper motors.

The types of instruments that are likely to be encountered are described in this paper and the likelihood that residual (‘frozen’) readings are representative of the pre-impact reading is considered.

The instruments fall into two main groups: mechanically-driven types, and electronic/electrical types.

i. Early speedometers were mechanically-driven. Initially, complex chronometric (clock-type) movements were used. However, for many years up until the 1990s, an eddy-current type of instrument was used, based on a design by Otto Schulze dating from 1905. Many instruments of that type are still in use today. They are mechanically driven via a cable that is turned by the transmission, or by the front wheel in the case of many motorcycles. At the other end of the cable, within the instrument, is a magnet (generally housed within a steel cup). The magnet rotates within an aluminium (‘reactor’) cup which is attached to the needle’s spindle. The eddy-currents created by that rotation cause the aluminium cup to rotate against the resistance of a hair-spring. The faster the magnet rotates, the greater the rotational force applied to the cup and hence the reading increases.