Mettis Trainer Bend Sensor Technology

The purpose of this is whitepaper to provide a brief description of various competing technologies so that the reader may have a basis of understanding that will permit them to compare the Flexpoint Bend Sensor with other sensing technologies.

There are many sensing technologies available in the market today and some of them may compete with the Bend Sensor in some markets. This description relates only to the sensor types that most commonly apply to Bend Sensors.

We will first provide a brief description of the different types we will be examining:

- **Force Sensing Resistors (FSR)**
- **Piezo Sensors**
- **Strain Gauges**
- **Capacitive Sensors**

Force Sensing Resistors; as the name implies these sensors are used to sense force. These generally consist of a two layer construction. On one layer there is a screen printed resistive pad and on the second layer there are interdigitated conductive traces. Each layer is printed on separate sheets of film. These two sheets are then put one on top of the other so that the conductive traces are in contact with the resistive material. When the two layers are compressed together the resistive material connects the conductive traces together and the harder you compress them together the less the resistance becomes.

Piezo Sensors; the name comes from the Greek Piezo which means pressure. A Piezo material, when a pressure is applied, deforms and as a result of that deformation a temporary electrical current is generated. That current is the measured output.

Strain Gauges; strain is the amount of deformation in a material when a force is applied. When a material is stretched or compressed the cross sectional area changes. So in the case of a strain gauge a fine wire is used and arranged in a grid pattern and bonded to a carrier which in turn is mounted to the object one wishes to measure. As the object is stretched or compressed the wire in the strain gauge is similarly affected. The change in cross sectional area is directly proportional to the resistance change in the strain gauge. These changes are very small. They are on the order of 0.1%. The bond between the object being measured and the strain gauge is very critical given the small amount of change and the small displacements being measured. If there is any slippage then the measurements are not valid.

Capacitive Sensors; are two conductive plates and the capacitance is dependent on the distance between them. If the distance changes so does the capacitance or there is a disruption in the field by a conductive object.

Bend Sensors; The Bend Sensor is a single layer of material. The Bend Sensor ink is screen printed on that film. Various conductive traces are printed to facilitate connection to the desired device. As the sensor is bent the resistance increases, depending on the bent radius, that change can be as much as 1000%. (Note: There must be movement for the Bend sensor to be actuated).

The following is a table that gives some comparative information about each of the sensor types with respect to the Bend Sensor.

Sensor type	Output	Construction
Force Sensing Resistor	Decreasing resistance as load increases. About 75% decrease typical.	Minimum two layer/sheet screen printed, assembled. Less affective in pre-curved or highly curved applications.
Piezo electric	Voltage as the crystal is deformed. Only gives an output when the system is in motion. Will not give current status if deformed or un-deformed.	The piezo crystal is sandwiched between two metal plates
Strain Gauge	Either an increase or decrease in resistance due to tensile or compressive strain. 0.1%. Accuracy is very high. Cost and application can be expensive.	A grid of wire adhered to a carrier.
Capacitive	Change in voltage/change in capacitance	Two conductive plates with a nominal spacing between. In seating applications Bend Sensors sense weight rather than electrical interruptions less susceptible to electrical interference.