

The background of the slide features a dark, abstract design with several bright, white light rays or beams emanating from the right side and fanning out towards the left. The rays create a sense of depth and movement. The text is centered over this background.

Team 6 Technical Presentation: Load Cells

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History

- In the 1930s the first bonded resistance wire strain gauge was developed
- In 1938 the commercialization of the bonded resistance strain gage was introduced
- In addition to being used to measure strain, it was applied to measure many quantities that can be related to strain, such as force, pressure, acceleration, and torque., which was a sensor for measuring static and dynamic strains.
- Load cells are most popular in the weighing industry

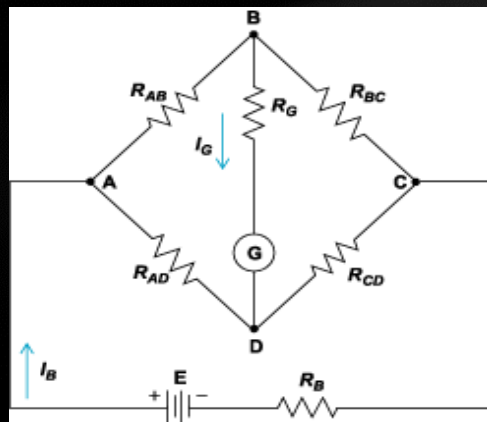
What is a load cell?

- A transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured.
- Converts force into a measurable electrical output
- This electronic output can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used.

How does a load cell work?

- Customarily built using resistive bonded foil strain gauges
- Strain gauges are essentially resistors built using standard semiconductor etching techniques and are bonded to a metallic member
- at least four strain gauges are configured in a Wheatstone Bridge configuration with four separate resistors connected in a Wheatstone Bridge Network like figure 1

Figure 1



How does a load cell work? Cont.

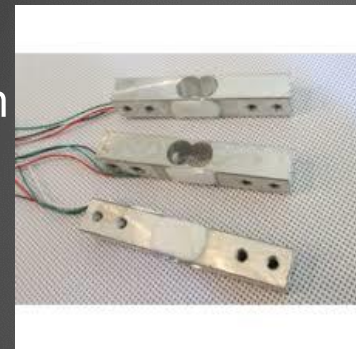
- An excitation voltage - usually 10V is applied to one set of corners and the voltage difference is measured between the other two corners.
- At equilibrium with no applied load, the voltage output is zero when the four resistors are closely matched in value.
- When the metallic member is stressed by an applied force, the resulting strain causes a change in resistance in one or more of the resistors.
- The change in resistance results in a change in output voltage.
- This small change in output voltage can be amplified and measured
- <http://www.rdpe.com/ex/hiw-sglc.htm>

How is a load cell made?

1. An intricate pattern is machined to optimize stress & strain on the mechanical member
2. Surface roughness is controlled through surface polishing to ensure rough edges are removed prior to bonding a strain gauge
3. Scoring is done to make alignment marks to line up multiple strain gauges that are bonded to create the Wheatstone bridge
4. Bonding agent is applied with matching temperature coefficients to the metal being used
5. Even pressure is applied on the strain gauge during the curing process to avoid lumpiness along the bond
6. The strain gauge is cured at an elevated temperature to cure the bonding agent and temper the bond
7. A coating is applied to protect the strain gauges and wiring from moisture, humidity, and environmental effects

Types of load cells

- Strain gauge load cell
 - Through a mechanical arrangement, the force being sensed deforms a strain gauge
 - The strain gauge measures the deformation as a change in electrical resistance
 - Strain gauge converts the load acting on them into electrical signals
 - The electrical signal output is typically in the order of a few millivolts and requires amplification
 - Typically consists of four strain gauges in a Wheatstone bridge configuration
 - Strain gauge load cells are the most common in industry
 - Four strain gauges are used to obtain maximum sensitivity and temperature compensation
 - Two of the gauges are usually in tension and two are in compression



Types of load cells

- Hydraulic load cell
 - Uses conventional piston and cylinder arrangement
 - The piston is placed in a thin elastic diaphragm.
 - The piston does not come in contact with the load cell.
 - Mechanical stops prevent over strain of the diaphragm when loads exceed a certain limit.
 - The load cell is completely filled with oil.
 - When a load is applied on the piston, the movement of the piston and the diaphragm arrangement increases the oil pressure, which produces a change in the pressure on a Bourdon gauge connected with the load cells.
 - A Bourdon gauge measures pressure
 - Used in applications where electrical power may be dangerous.



Types of load cells

- Pneumatic load cell
 - This load cell is designed to automatically regulate the balancing pressure
 - Air pressure is applied to one end of the diaphragm and it escapes through the nozzle placed at the bottom of the load cell
 - A pressure gauge is attached with the load cell to measure the pressure inside the cell
 - The deflection of the diaphragm affects the airflow through the nozzle as well as the pressure inside the chamber



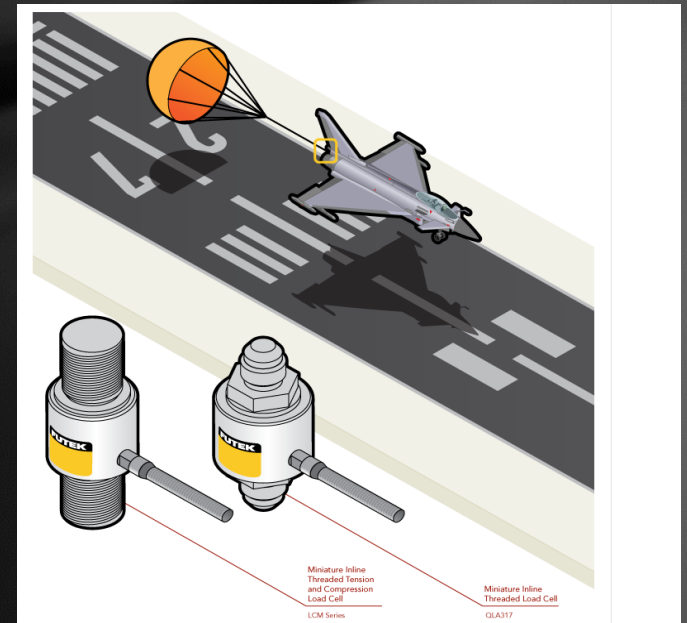
Types of load cells

- Piezoelectric load cell
 - Piezoelectric load cells work on the same principle of deformation as the strain gauge load cells, but a voltage output is generated by the basic piezoelectric material
 - The voltage output is proportional to the deformation of load cell
 - Most applications for piezo-based load cells are in the dynamic loading conditions, where strain gauge load cells can fail with high dynamic loading cycles.



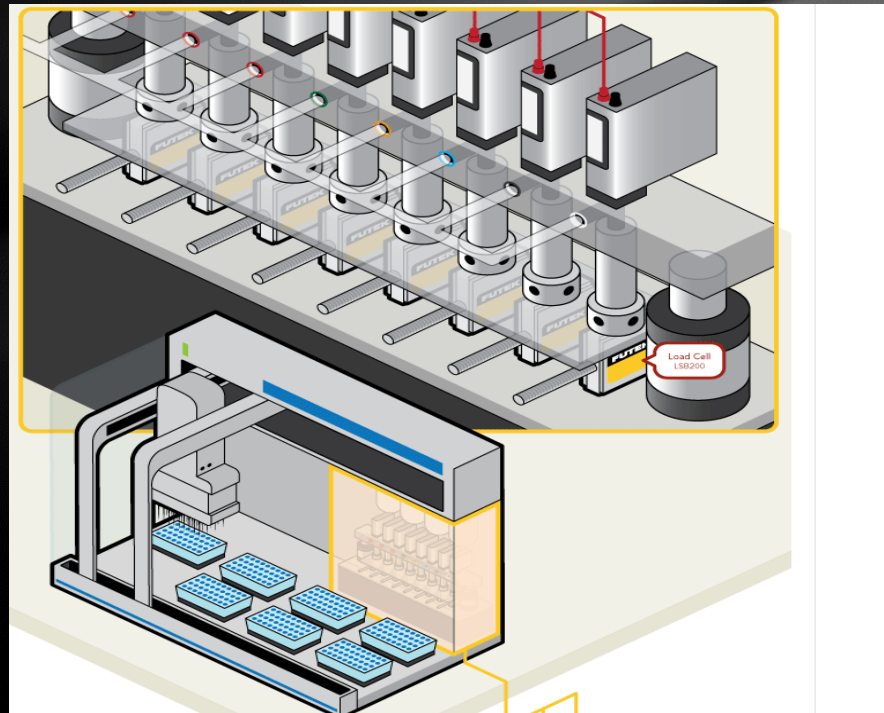
Applications-Parachute Deployment

- Military aircrafts deploy parachutes for rapid decrease of speed upon landing
- Utilizing In-Line Load cells allows test engines to audit the force applied to that parachute
- Engineers need to audit the tensile forces to pick appropriate cables
- Load cells measure the tension applied to the cables



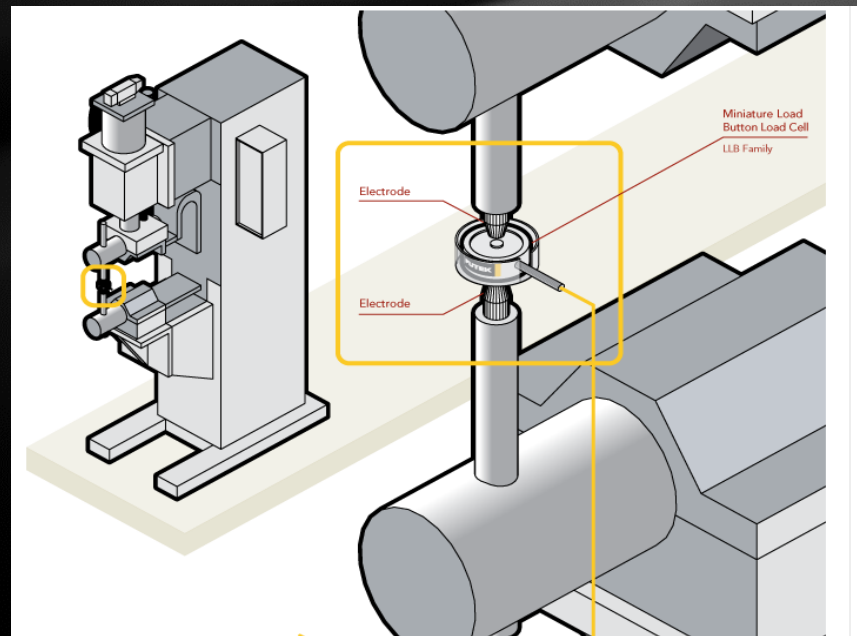
Applications-DNA Synthesis

- Bio-medical engineers need precise and capacity range sensitive load cells to measure exact amount of fluid
- Load cells are mounted under the base of fluid dispenser
- Load cells measure down to the microgram the fluid as it exits the dispensing tube
- Once the allotted amount of fluid has been released, valve will close



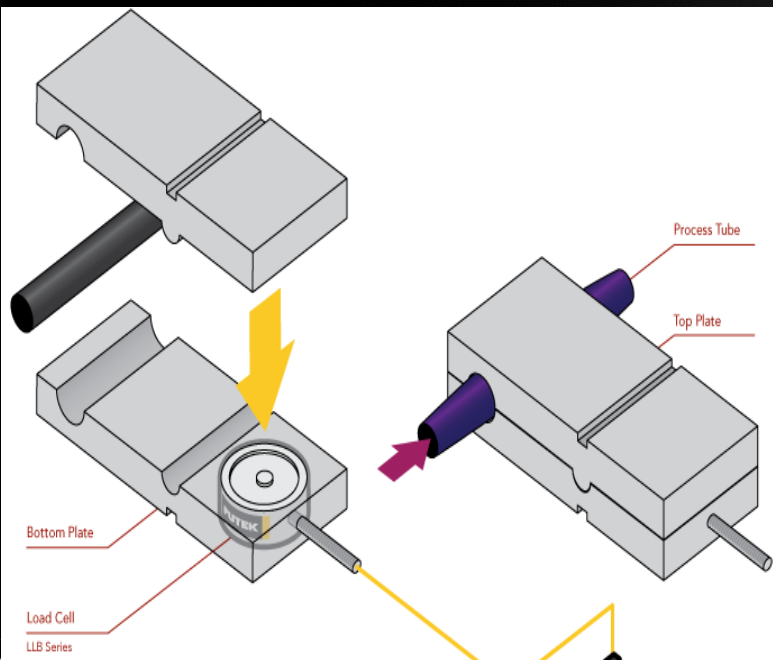
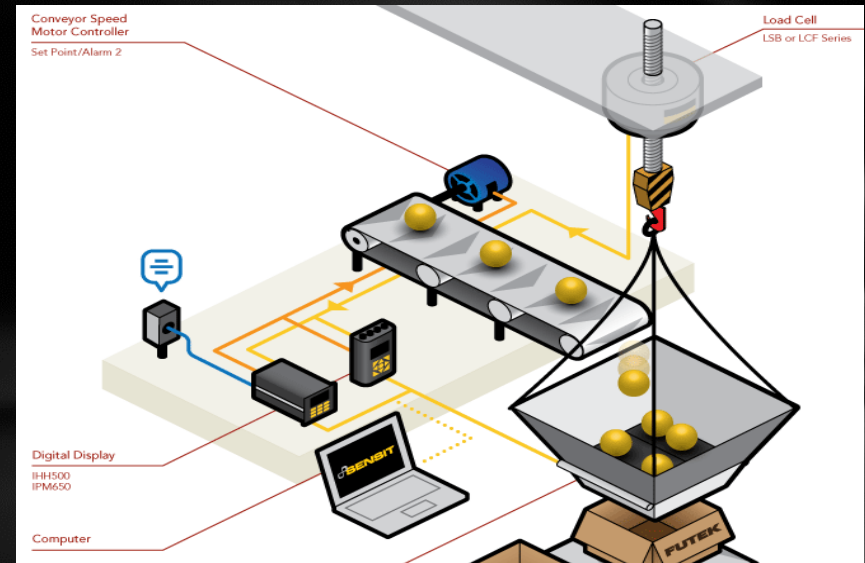
Applications-Resistance Welding

- Resistance Spot Welding is a process in which pieces of metal are joined together
- Heat is used to combine the metal pieces
- Electrode applies forces
- Load cell is placed between the electrodes to calibrate the force applied



Other Applications of load cells

- Container Filling
- Helicopter Pedal Force Testing
- Tube Expansion Measurement
- Landing Gear Drop Test



Selection guidelines

- When you measure forces or loads, in addition to the capacity and size of the load cell, a number of application requirements need to be carefully considered.
 1. Operating Temperature Conditions
 2. Duration of measurement
 3. Absolute Accuracy Required
 4. Direction of loading
 5. Mounting Options
 6. Output required
 7. Measurement Speed
 8. Total cost of operation

SPECIFICATIONS					
PARAMETER	VALUE				UNIT
Rated capacity—R.C. (E _{max})	1, 3, 5, 7, 10, 15, 20, 30, 50, 75, 100, 150, 200***				kg
NTEP/OIML accuracy class	NTEP	Non-Approved	C3*	C6**	
Maximum no. of intervals (n)	5000 single	1000	3000	6000*****	
Y = E _{max} /V _{min}	10000	1400	6000	10000	Maximum available 20000
Rated output—R.O.	2.0				mV/V
Rated output tolerance	0.2				±mV/V
Zero balance	0.2				±mV/V
Zero return, 30 min.	0.0330	0.0300	0.0170	0.0083	±% of applied load
Total error (per OIML R60)	0.0200	0.0500	0.0200	0.0100	±% of rated output
Temperature effect on zero	0.0023	0.0100	0.0023	0.0014	±% of rated output/°C
Temperature effect on output	0.0010	0.0030	0.0010	0.00058	±% of applied load/°C
Eccentric loading error	0.0049	0.0074	0.0049	0.0024	±% of rated load/cm
Temp. range, compensated	-10 to +40				°C
Temp. range, safe	-20 to +70				°C
Maximum safe central overload	150				% of R.C.
Ultimate central overload	300				% of R.C.
Excitation, recommended	10				VDC or VAC RMS
Excitation, maximum	15				VDC or VAC RMS
Input impedance	≥15±20				Ω
Output impedance	350±3				Ω
Insulation resistance	>2000				MΩ
Cable length	1****				m
Cable type	6 wire, PVC, single floating screen				Standard
Construction	Plated (anodize) aluminum				
Environmental protection	IP65				
Platform size (max)	400 x 400				mm
Recommended torque	Up to 30 kg: 7.0 35 kg and above: 10.0				N*m



Questions?