

## **FIXTURE DESIGN WITH SENSORS**

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**Abstract:** The paper presents inspection fixture using ultrasonic sensors for abrasive disc – MQP at WPI, part sensing for turbine vanes, various sensors and their applications, force measurement for fixture stability.

### **Introduction**

Goal in manufacturing is to achieve highest quality at the lowest cost. To achieve this we have adapt to emerging technologies.

The sensors play an important role in achieving high accuracy;

The various sensors that can be used in fixturing and their applications are studied;

The future trends of sensor based fixturing are investigated.

### **Need for sensors in fixturing**

Assemblies – To measure the dimensional variation in the assembly (auto body). Inspection – Use the fixture as an integrated inspection device. Fool proofing – To make sure the part is not loaded into the fixture incorrectly. Part sensing – To verify the part is positively located in the fixture.

### **Sensor location optimization. Single fixture Systems**

The impact of sensor location on the effectiveness of fault-type discrimination and manufacturing variation reduction.

Classification and diagnosis:

Three axis measurements at each of three sensor locations, provide nine sensor variable measures. Diagnostic matrix is used to represent the set of diagnostic vectors. Optimal sensor location obtained by maximizing the distance between each dominant eigen vector, obtained for each of the tooling faults.

## Multi-Fixture Systems

An optimal sensor configuration for a multi-fixture assembly of sheet metal parts, efficient distribution of limited sensing resources to multiple measuring locations in assembly.

Assembly sequence is decomposed into sequence single fixture sub problems and sensor placement is optimized.

### Metal forming inspection fixtures

Coordinate measurements are obtained by sensors built into the fixture that can be utilized in estimating geometric parameters of manufactured part.

The goal is to eliminate part transportation and machine downtime for inspection. The decision on how many sensors to use and where to place them is based on, statistical analyses.

### Automated inspection system

An automated inspection system to measure thickness and quality of resin based abrasive discs and rings. Fixture to hold wide range of rings and discs for inspection.

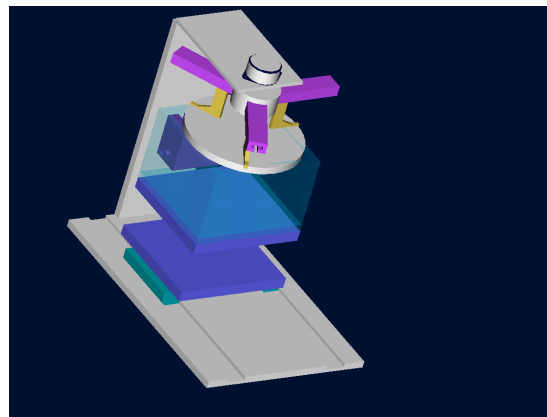
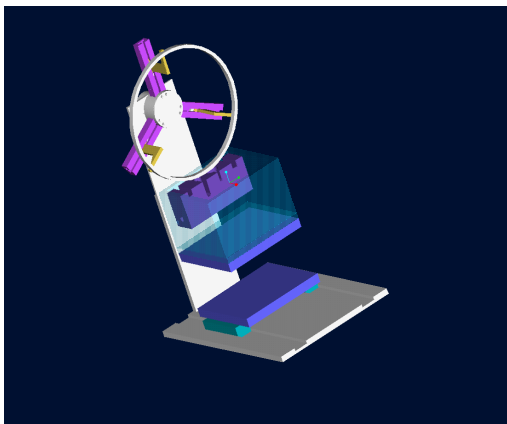
Thickness measuring mechanism;

Data acquisition system to get data from the system.

### Ultrasonic inspection

The sound velocity through the part is used as a measure of quality assurance. Material velocity is used to calculate the thickness of the discs rings. A fixture device is built with a stepper motor, so it can hold rings and discs. As well rotate the fixture to the required test positions.

### Inspection system



Very reliable and accurate.  
The total cycle time is reduced.  
The fixture can hold a range of discs and rings.  
The material velocity is used as a quality assurance for internal flaws.

**Special case (Aerospace)**

Tough material  
Complex turbine vane  
High accuracy  
4 axis EDM

**Potential Sensors**



Non Contact:

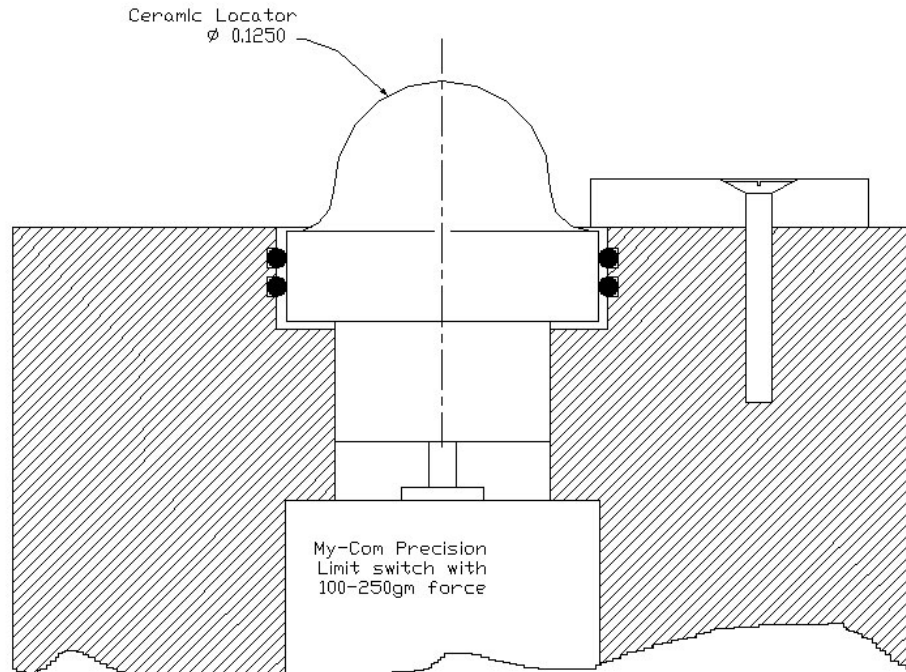
- Proximity
- Fiber Optic
- Ultrasonic

Contact:

- Precision Limit Switches
- Continuity test

**Solutions.Fiber optic sensors**

The ceramic locator is drilled and the fiber optic sensor is inserted. The surface of the locator is reground back to the original shape to make it spherical.



### Precision limit switches

The limit switch is placed underneath the ceramic locator. The retention force on the limit switch is enough to hold the locator up. The actuation can be as low as a micron.

### Conclusions

Sensor based fixtures can be used for location verification  
Sensor based fixturing is not a solution for fixturing problems  
Most of the locating problems can be fixed by proper design of clamps  
Due to the incorporated sensors there may be some issues like accuracy, rigidity...  
Can be used for error proofing  
Wide scope for application in various areas

### Bibliography

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