

# REDUCING HEALTH CARE COSTS THROUGH SURGICAL MODERNIZATION



## Design of a Highly Constrained Shoulder Joint Displacement Data Acquisition System

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### Problem Statement

This investigation aims to provide extremely accurate bone-on-bone stability data involving the *glenohumeral* (shoulder) joint. The data obtained from this highly controlled experiment will then be used to validate a detailed virtual model, making improved, less expensive surgical practice possible.

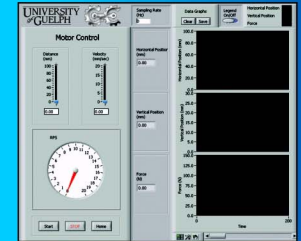
### Positional Sensor

- Linear Variable Differential Transformer (LVDT)
- Extremely accurate measure of linear Translation
- Highly precise, robust mechanical apparatus
- A/D conversion provided by MintDrive<sup>II</sup>



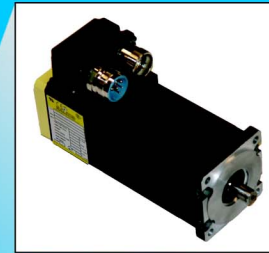
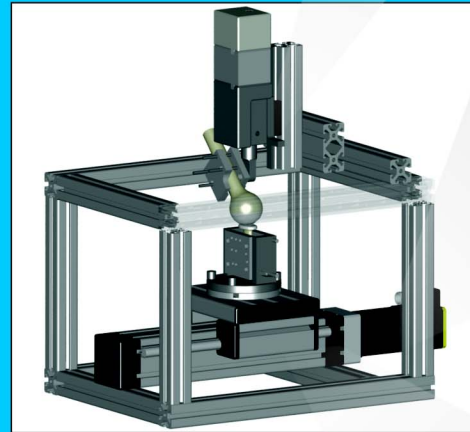
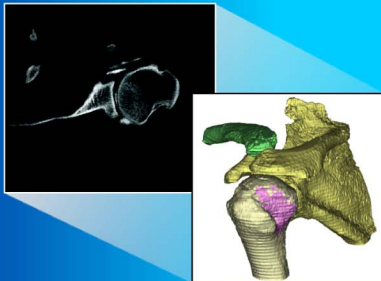
### Graphic User Interface

LabVIEW is a user-friendly, high-level data acquisition/processing language from National Instruments. Using "virtual instruments," many sensors/devices can be monitored and their outputs clearly displayed. This project uses ActiveX components built into LabVIEW to control the Baldor motor assembly and to acquire data from the sensors.



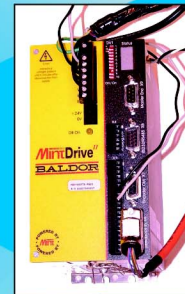
### Background Information

Shoulder joint injuries are the most common musculoskeletal injury. It is the joint's incredible versatility and mobility that predisposes it to failure. Due to its vast range of motion, dislocation of the relatively small contact area between the *humeral head* (upper arm) and the *glenoid fossa* (shoulder blade) is common. In this dislocation, the bone-on-bone interaction is so intense that a wedge-shaped lesion is often created on the posterior aspect of the humeral head. It is this defect, known as the Hill-Sachs lesion, which provides a pathological focal point for this study.



### Drive System Information

- Baldor Brushless Servo Motor with MintDrive<sup>II</sup> Control
- Highly precise, 14-bit resolution for motor speed/torque and sensors
- Motor control and sensor input/output combined in one unit
- Motor provides 2.09Nm torque
- Highly accurate mechanical components



### Economic Information

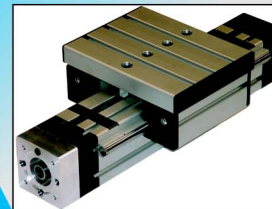
- Approximately 10,000 shoulder-related surgical procedures performed in Canada annually
- Total direct cost is approximately \$10,000 including hospital stay, surgery (including all professionals present), and medical supplies
- Economic cost of lost productivity during waiting period (up to 2 years) is vast
- Estimated costs per year due to shoulder surgeries is approximately \$100,000,000
- Shoulder surgeries due to Hill-Sachs Lesions account for an estimated \$5,000,000

### Virtual Design in SDRG I-DEAS

- SDRG I-DEAS used for virtual design of mechanism
- Extremely powerful, accurate parametric modelling of physical systems
- Extensive testing performed in virtual environment assures proper function
- Various design ideas explored, optimal Design chosen

### Ball Screw Unit

- 5mm pitch, 100mm travel
- Cost-effective alternative to linear motor
- Accurate distance translation when Combined with motor assembly



### Conclusions & Results

The results of this investigation show it is possible to acquire highly constrained, accurate data on shoulder stability. A better understanding of shoulder injuries and a more concise model of the shoulder joint complex will be direct results of this data. Using this new information, the medical industry has the potential to save significant public funds, while decreasing the likelihood of repeated surgical procedures for those suffering from shoulder-related problems such as the Hill-Sachs lesion.

### Acknowledgments

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