

#### University of Idaho

#### DESIGN REVIEW THE LONGSHOTS

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# **PROJECT INTRODUCTION**



- Client is NightForce Optics
- Scopes are adjusted using turrets/lead screws
- Screws need to fit tight tolerances to be suitable for use.



### **PROBLEM STATEMENT**

- Currently lead screws are burnished and tested by hand and the torque specs are defined as what feels good to the workers.
- Our job is to quantify the torque values that "feel good" and create an autonomous machine that burnishes to those values.
- The minimum acceptable backlash for the threads is around 0.0001", so our machine must also measure to see if the threads meet that requirement.



### **DESIGN VALUE PROPOSITION**

- Allows client to repurpose up to 2,000 labor hours
- Eliminates human factors involved with hand-burnishing
- Reduces wasted materials and machining time
- Increases accuracy of backlash measurements





### SPECIFICATIONS

- Maximum size 2ft by 2ft
- Maximum weight 50 lbs
- Burnish acceptable turrets at similar or increased rate to current process
- User Friendly
- Easily modified to future requirements



### **PROJECT OVERVIEW**

- Workflow
- Burnishing
  - Torque Sensing
- Backlash
- Coding



#### **PROJECT LEARNING - WORKFLOW**



#### Magazine

Pros: Simple, Inexpensive, Easily changed

Cons: More labor intensive to load



#### Hopper

Pros: Little labor necessary to load

Cons: Complicated, expensive, could damage threads



#### **PROJECT LEARNING - WORKFLOW**





Turntable

Pros: Controlled movement of work

Cons: Uses motor to rotate the table

#### Racetrack

Pros: Simple - no motor or rotating mechanism Cons: Can be jammed more easily



### **DESIGN CONCEPTS - WORKFLOW**



- Fed via magazine
- Burnishing accomplished with direct drive stepper and linear actuator
- Stepper motor used to turn turntable
- Ejection accomplished using an angled plate



### **DESIGN CONCEPTS - WORKFLOW**



- Fed via magazine
- Turrets are stopped at stations using servos
- Turrets slide through machine



### **DESIGN CONCEPTS - WORKFLOW**



- Fed via magazines
- Different station for each turret size
- Reduces changeover time



## **PROJECT LEARNING: BURNISHING**

- Threads must be burnished to a specific torque value currently known as "feels good"
- Avoiding axial forces on threads is best
- Torque sensing is a critical part of burnishing
- 6 different lead screws need burnished



#### **DESIGN CONCEPTS - BURNISHING**



- Horizontal
- Pros: less axial weight on threads
- Cons: workflow of horizontal turrets would be difficult



- Vertical
- Pros: less forces, easier workflow
- Cons: axial force on threads



#### **DESIGN CONCEPTS - BURNISHING**



- Pulley Drive
- Pros: location of motor, less axial weight on threads
- Cons: Added variability



- Direct Drive
- Pros: less variables, enables potential torque measurement
- Cons: Space constraint, weight distribution



### **TORQUE SENSING**

- Use stepper voltage and current to find torque
  - Higher the Torque, Lower the Speed
  - PWM to change speed
    - Encoder to adjust PWM based on load
- Pros vs Cons
  - Accuracy
  - Repeatability
- Conclusions





### **PROJECT LEARNING - BACKLASH**

- Definition/Description
- Major Causes
- Tolerance 0.0002"-0.0004" (5.08um-10.16um)
- Current measurement system





### **PROJECT LEARNING - BACKLASH**

#### **Precision Components**

- Contact Displacement Sensor
- Laser Displacement Sensor
- High Precision Actuator





# **DESIGN CONCEPT - BACKLASH**

- Immobilizing Actuations
- Precision Actuation/Measurement





# DESIGN CONCEPT - BACKLASH





# **FINAL DESIGN CONCEPT**

- Vertical Burnishing
- Direct drive burnishing
- Turntable workflow
- Laser position sensor
- Use stepper voltage and current to find torque





#### **Einal Decidn Concent**





#### CODING

```
main{
  switch (turrets)
  {
     case 1:
       turret size one
       break;
     case 2:
       turret size two
       break;
     case 3:
       turret size three
       break;
     case 4:
       turret size four
       break;
     case 5:
       turret size five
       break;
     case 6:
       turret size six
       break;
  }
}
```



#### CODING

```
void turntable(table)
{
    if (table = 1)
        table turns;
    else
        table stops;
}
```

```
void burnishing(turns,height)
{
  turntable(0);
  height lowers to turret, = 0;
  stepper turns CCW while height raises;
  if (turns < 3)
  {
     if (height = 1)
       turns = turns + 1;
       stepper reverses CW;
     elseif (height = 0)
       turns = turns + 1;
       stepper reverses CCW;
     else
       continue until height is either 1 or 0;
     }
  else
     stepper stops;
    height goes to 1;
  turntable(1);
}
```



#### CODING

```
int backlash(clamp,back actuat)
{
  int pass fail;
  clamp = 1;
  lower back_actuat to turret;
  calculate backlash
  raise back actuat;
  return pass_fail;
}
int ejector(pass fail)
{
  if (pass fail = 1)
    return 1 to actuate;
  else
    return 0 to do nothing;
}
```



#### POTENTIAL PROBLEMS/ PROPOSED SOLUTIONS

- Backlash
- Coding
- Changeover

# BUDGET



Capstone Project Budget Project:												
Last Updated												
3	• Year								1	tem		-
Expense Items	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total			
Gas	1	Ľ							s	25		1
		19 10	20 82				)				ş .	
Supplies / Parts / Services:							j. j				1000	
Misc		19 					j. j		\$	22		
Sensors/Switches		19 10							\$	28		
On/Off		29 10	\$ 11						\$	11		
10 position	1		\$ 8						\$	8		
Hardware	1	5 0							\$	20		
Linear Motion actuator	1		\$ 141						\$	141		
Linear actuator	1		\$ 70						\$	70		
Stepper motor	1		\$ 83						\$	83		
Micro controller	1		\$ 232						\$	232		
Raw Materials	1			\$ 200					\$	200		
Drill Chuck				\$ 50					\$	50		
Hex bits		-	s)	\$ 20		2			\$	20		
									\$	-		
						s;			\$	-		Expense
		-1									5 814	Subtotal



#### **SCHEDULE** Schedule - Gantt Chart





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# **QUESTIONS?**