

Augmented Reality – Technology Opportunities in Maintenance and Support

**2018 Council of Logistics Engineering
Professionals**

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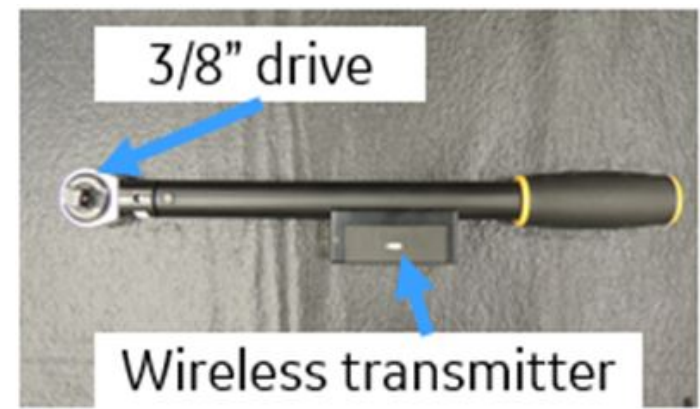
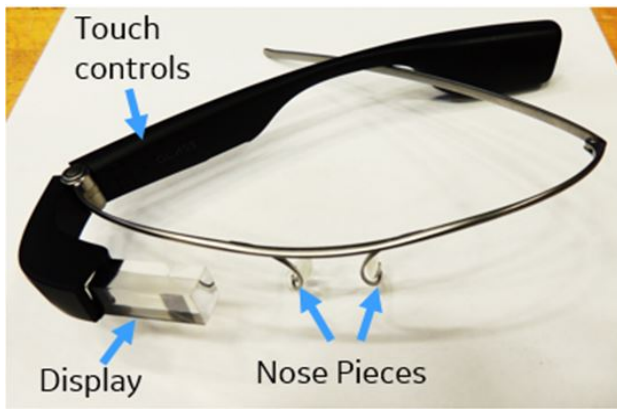
Wearable Technology

- **Goals:**

- Assess the utilization of wearable technology to (1) minimize errors (2) improve product quality, and (3) increase mechanic efficiency during assembly and maintenance of gas turbine engines.

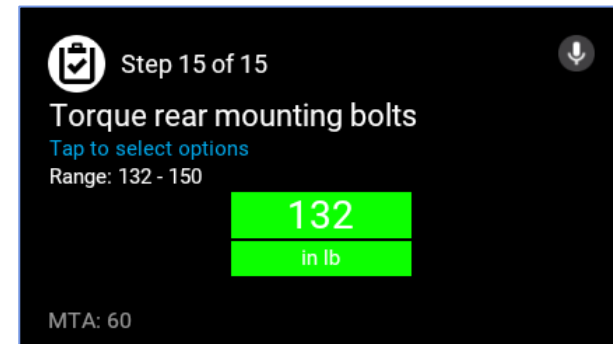
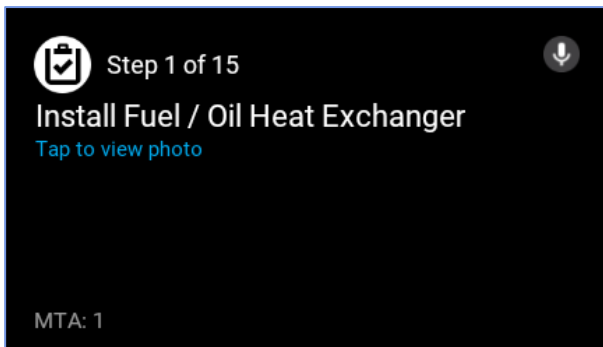
- **Technologies Employed:**

- Google Glass Optical Head Mounted Displays
- Upskill Skylight Industrial Augmented Reality Hardware
- Atlas-Copco Saltus MWR-85TA Torque Wrench



Wearable Technology

- Technology provides mechanics with
 - Step-by-step task instructions
 - Supplemental images, videos, animations, and “see what I see” video calling functionality
 - Real time torque being applied by torque wrench with a go / no-go indication



- Torque values and pictures are captured at critical steps

Wearable Technology

- **Overview of Pilot (10/3/16 – 3/31/17)**
 - **Location:** GE Aviation Customer Training and Education Center (Cincinnati, OH)
 - **Engine:** CF34-8C
 - **Hardware:** Google Glass, Upskill Skylight Software, Atlas Copco Torque Wrench
 - **Participants:** Fifteen GE Aviation Development Assembly Mechanics
 - **Time:** Each mechanic spent eight hours with the pilot team

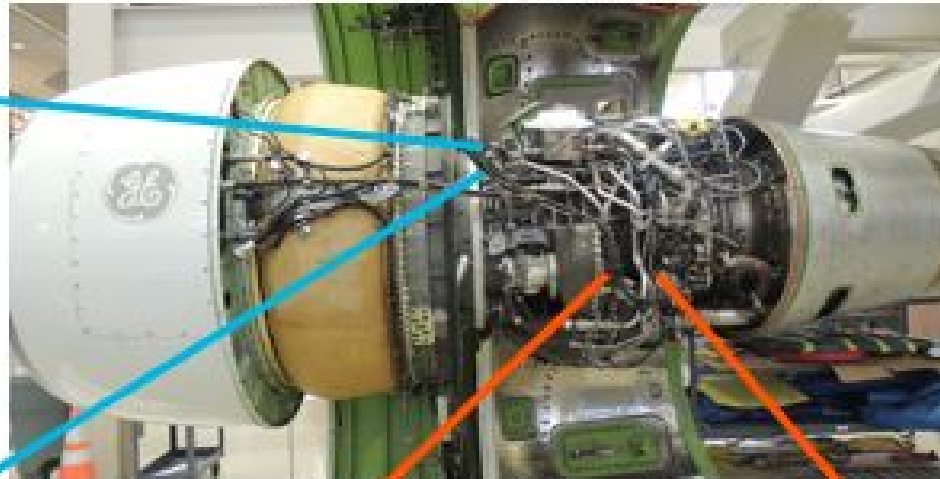


Wearable Technology

- **CF34-8C Line Replaceable Units (LRUs)**
 - Main Fuel Pump (Moderate Complexity)
 - Variable Geometry Actuator (Low Complexity)

CF34-8C LRU Locations for Pilot

VG Actuator



Main Fuel Pump



Wearable Technology

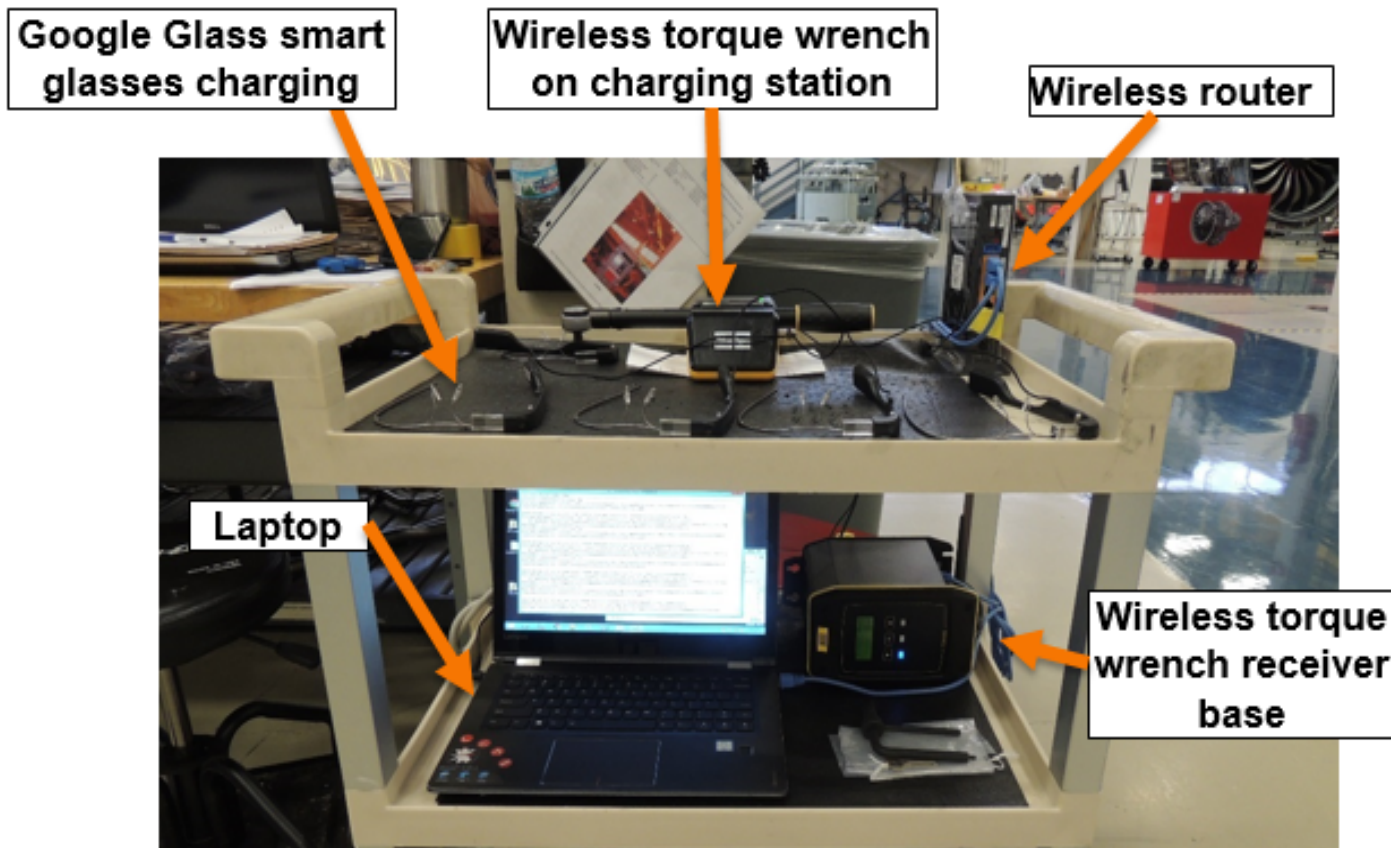
• Pilot Testing

- Upon arrival, mechanics take survey to capture demographic data
- Mechanics complete two maintenance tasks without wearable technology
 - » Survey taken to establish baseline data; task times are recorded
- Training on wearable technology
- Mechanics repeat maintenance tasks using wearable technology
 - » Survey taken to establish comparative data; task times are recorded










Wearable Technology

- Wi-Fi interconnects system
- Skylight server runs from laptop
- Can be integrated into existing IT infrastructure



Wearable Technology

- Example of what is seen through Google Glass display (Upskill Skylight software)

	<p> 1.25' open end wrench 1.25' offset open end wrench 1/4 x 5/16' ratcheting box-end wrench 1/4' torque wrench ~250 in/lb 3/8' torque wrench ~54 ft/lb capacity</p> <p>(more...) 3 of 4</p>	<p> Step 1 of 15 Install Fuel / Oil Heat Exchanger Tap to view photo</p> <p>MTA: 1</p>
	<p> Step 15 of 15 Torque rear mounting bolts Tap to select options Range: 132 - 150</p> <p>66</p> <p> Torque value is too low.</p>	<p> Step 15 of 15 Torque rear mounting bolts Tap to select options Range: 132 - 150</p> <p>132 in/lb</p> <p>MTA: 60</p>

Wearable Technology

- **Relevant demographic data**

- 14 of 15 were licensed FAA A&P mechanics
- Work experience as mechanics ranged from 8 – 28 years
- 13 of 15 had experience both as flight line mechanics and in engine assembly
- 10 of 15 required corrective lenses
- 1 of 15 had previous experience with wearable technology



Wearable Technology

- **Time Data**

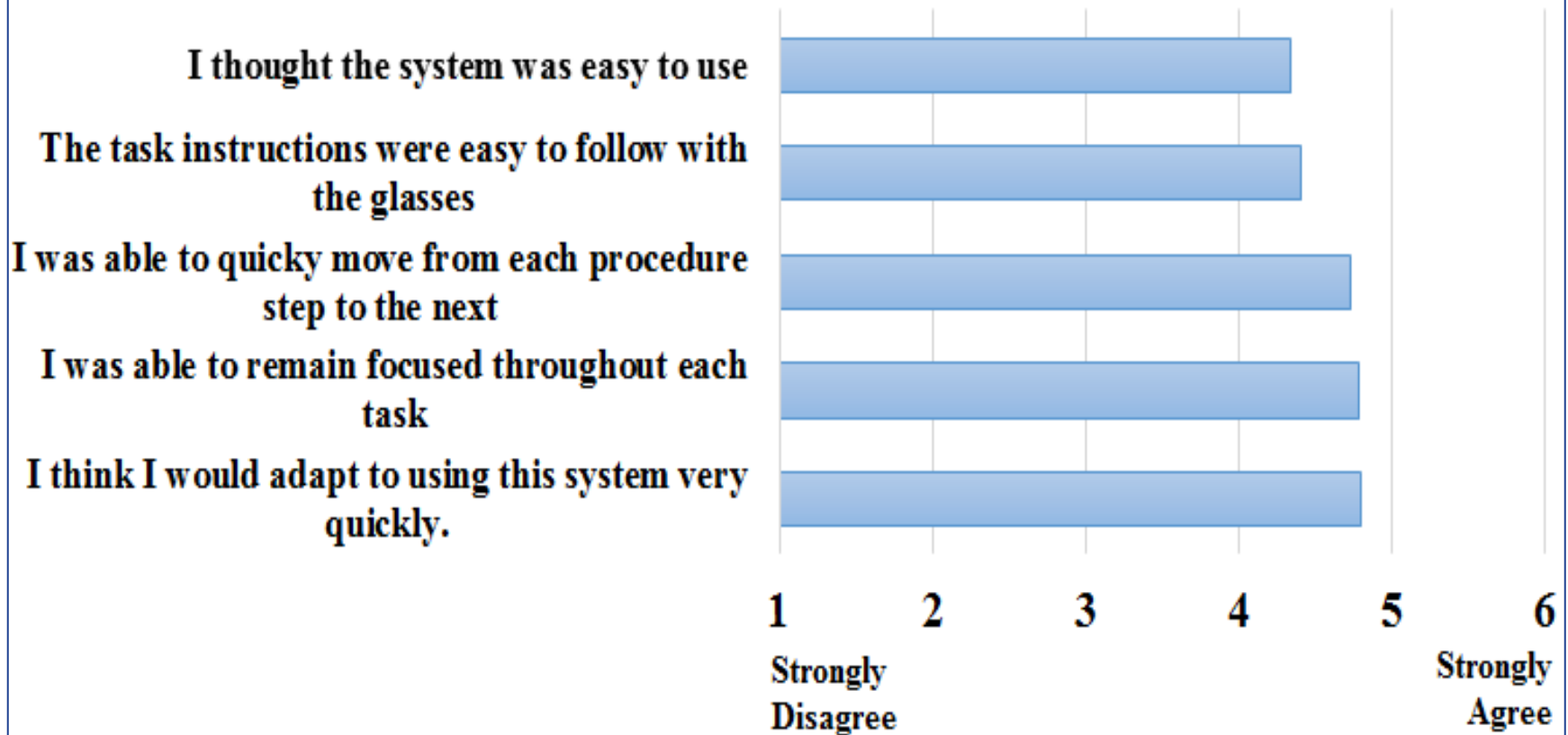
- Variable Geometry Actuator – 7.7% increase in efficiency
- Main Fuel Pump – 11.6% increase in efficiency

Component	Without Wearable Technology	
	Mean (Min)	Standard Deviation (Min)
<i>Variable Geometry Actuator</i>	43.02	9.92
<i>Main Fuel Pump</i>	51.46	12.75
Component	With Wearable Technology	
	Mean (Min)	Standard Deviation (Min)
<i>Variable Geometry Actuator</i>	39.7	11.31
<i>Main Fuel Pump</i>	45.49	8.36

Wearable Technology

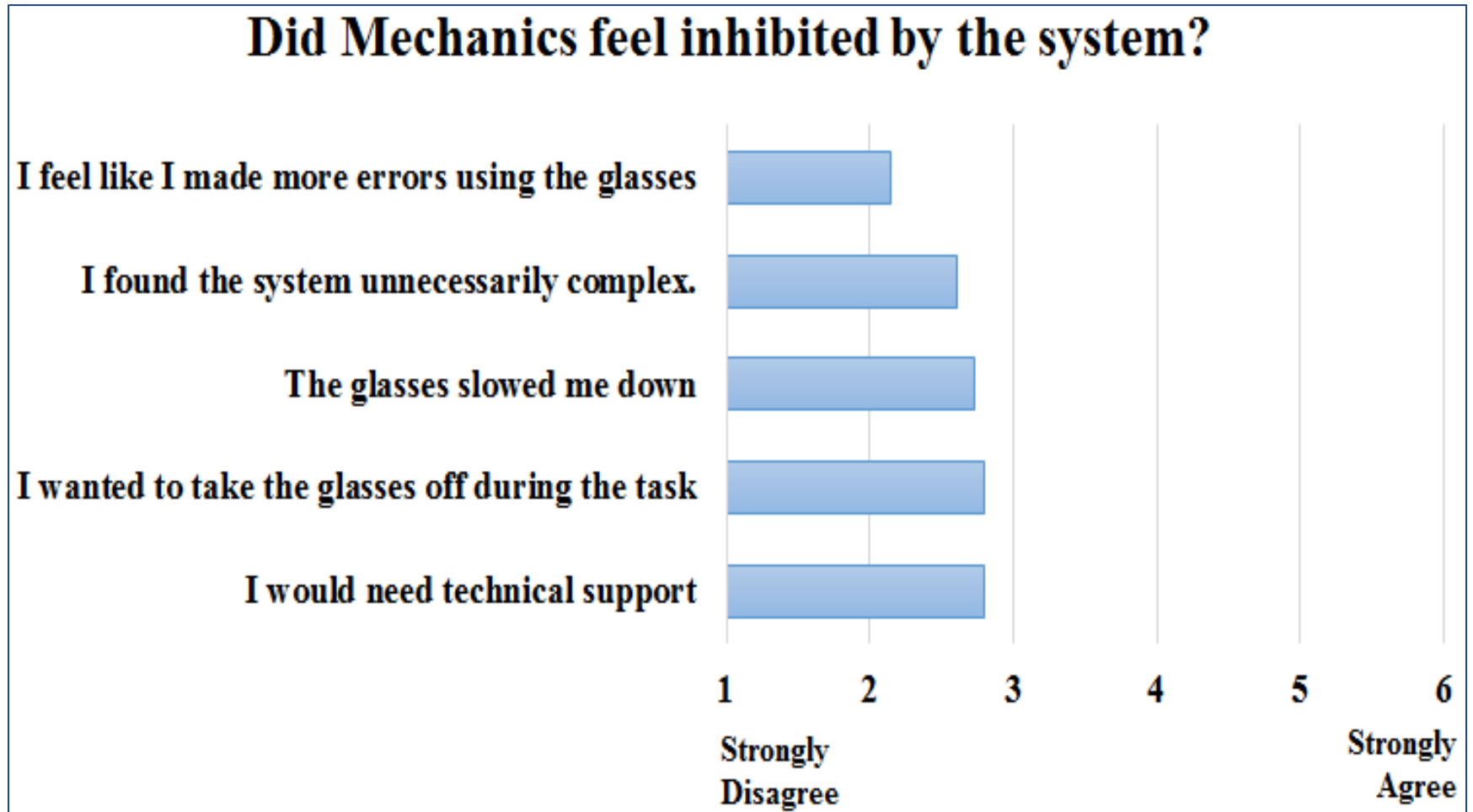
- Self-Ratings of Performance with the System

Self-Ratings of Performance with the System



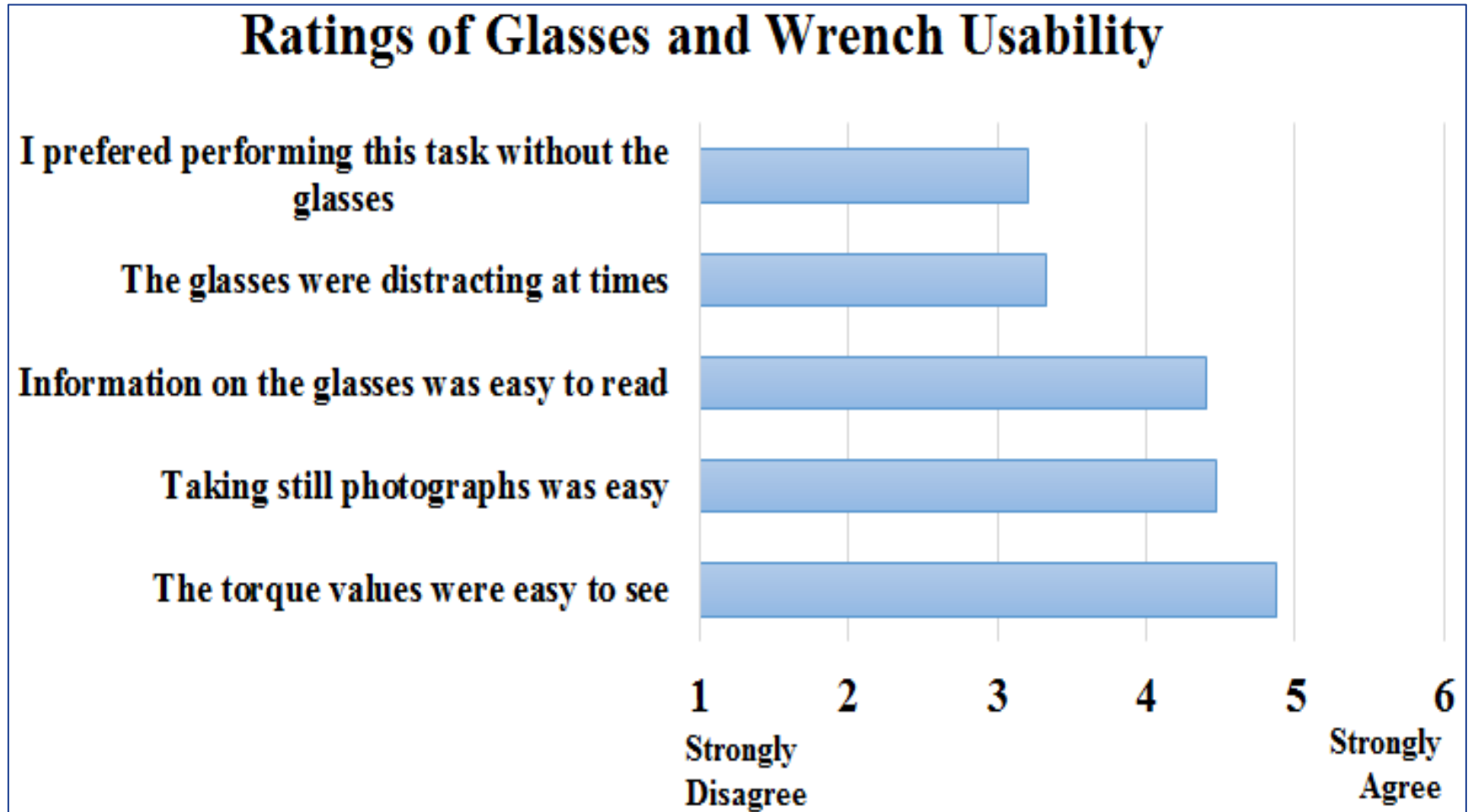
Wearable Technology

- Did Mechanics feel inhibited by the system?



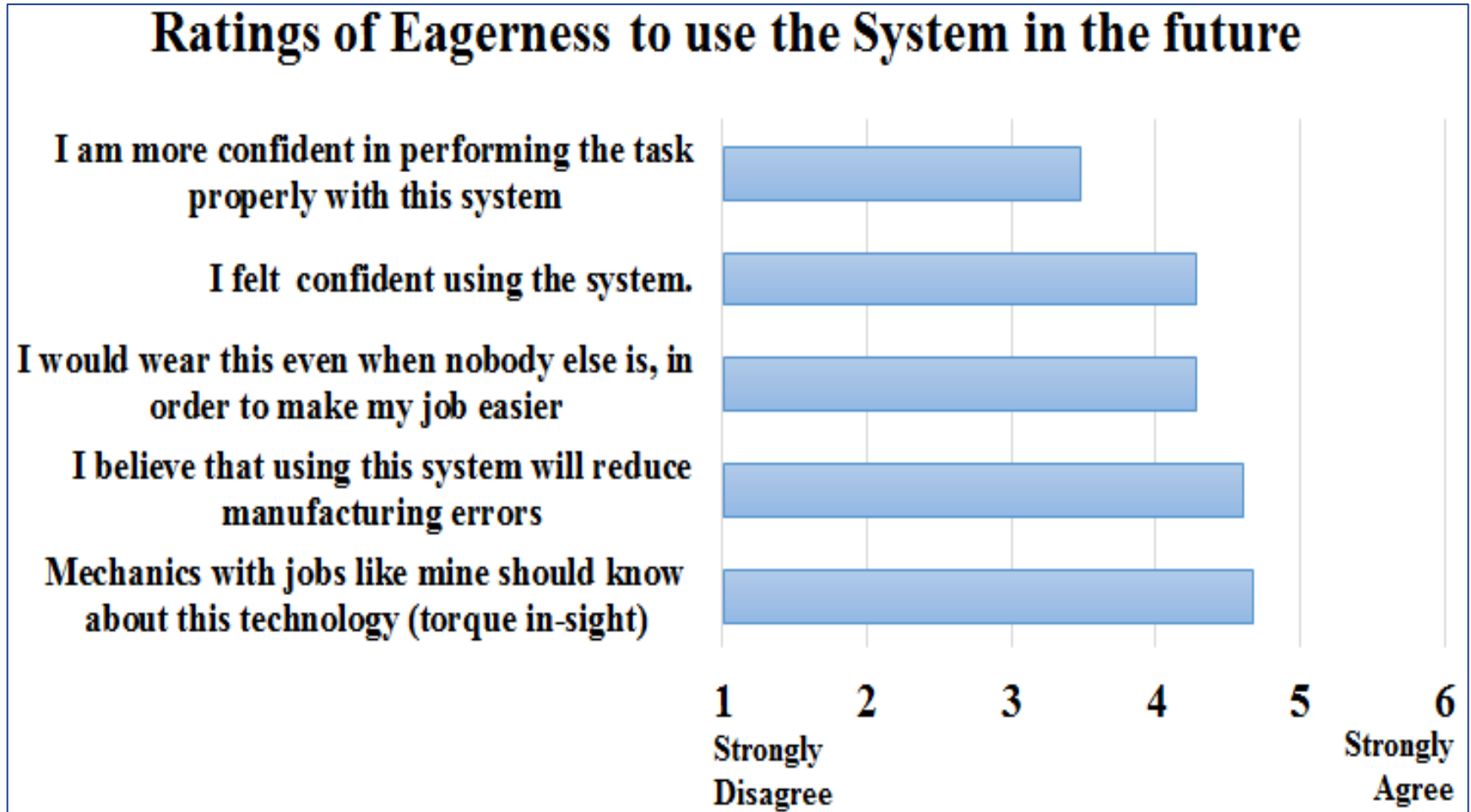
Wearable Technology

- Ratings of Glasses and Wrench Usability



Wearable Technology

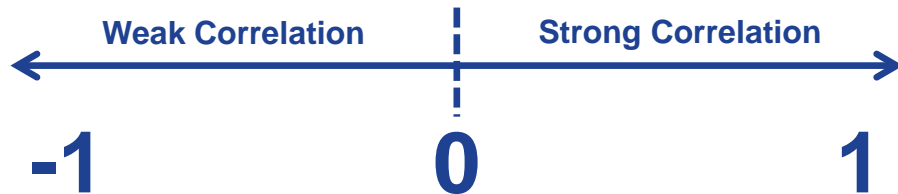
- Ratings of Eagerness to use the System in the future



Wearable Technology

• Spearman's RHO Analysis

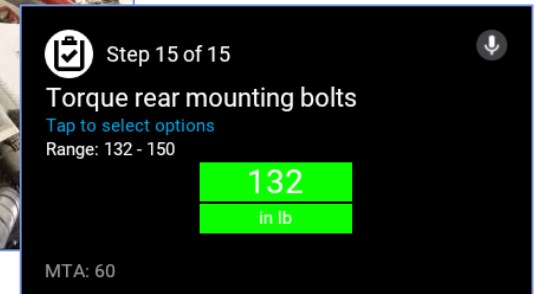
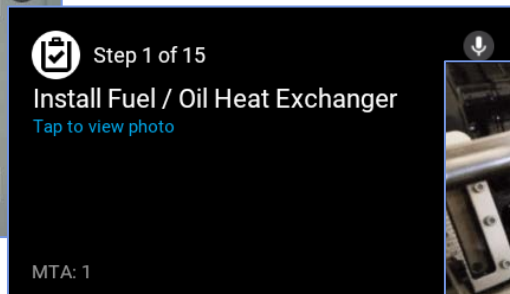
- Measure of correlation
- Value of 1 indicates strongest level of correlation
- Value of -1 indicates weakest level of correlation



Variable #1	Variable #2	Spearman's ρ
<i>Correlations between demographic survey and satisfaction with wearable tech glasses</i>		
I am usually eager to adopt new technologies	Satisfaction with using wearable tech glasses	.72
I consider myself to be proficient with technology	Satisfaction with using wearable tech glasses	.63
I think there is technology available to help make my job easier	Satisfaction with using wearable tech glasses	.58
I am usually eager to adopt new technologies	Satisfaction with using wearable tech operating system	.54
I consider myself to be proficient with technology	Satisfaction with using wearable tech operating system	.51
I think there is technology available to help make my job easier	Satisfaction with using wearable tech operating system	.68
<i>Correlations between demographic survey and satisfaction with wearable tech torque wrench</i>		
Years of experience as a mechanic	Satisfaction using the wearable tech torque wrench	-.62

Conclusion

- Wearable technology was found to be a viable method of minimizing errors, improving product quality, and increasing mechanic efficiency during the assembly and maintenance of gas turbine engines.





imagination at work