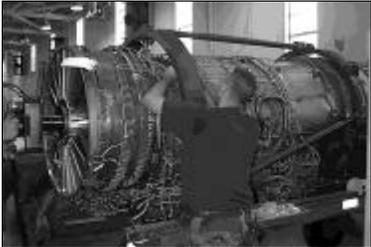


CASE STUDY - Wrenching/Ratcheting

TASK TITLE: Wrenching/Ratcheting

Task Description:	<p>Wrenching/ratcheting involves installing or removing nuts and bolts. These tasks can be done at a variety of heights and angles. Socket, box-end, and open-end wrenches are employed. Wrenches can vary in size from small hand wrenches to large, two-handed torque wrenches.</p> <p>Typical jobs in which wrenching/ratcheting is performed include (not necessarily limited to):</p> <ul style="list-style-type: none">• assembly• general maintenance <p>Wrenching may be performed on flat or upright surfaces directly on aircraft, equipment, or bench tops.</p>
Job Performance Measures Most Often Impacted by Wrenching/Ratcheting:	<ul style="list-style-type: none">• Constant torque• No errors (e.g. missing bolts, incorrect bolts)• Speed of completion of the job
Typical Employee Comments about Wrenching/Ratcheting:	<p>Employees typically report fatigue and discomfort in the hands/wrists/arms, shoulders/neck, and back/torso.</p> <p>Primary: The primary body parts affected are the hands/wrists/arms and shoulders/neck</p> <p>Secondary: In some cases, the back/torso can also be affected.</p>
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	<ul style="list-style-type: none"> Work location is too high (see Figure 1.1)  <p>Figure 1.1</p>	123. Raise the person <ul style="list-style-type: none"> use a step stool or ladder provide a fixed platform provide an adjustable platform or scaffolding 	✓ ✓	✓	low low high	med med med	med med high
		32. Lower the work piece/work surface <ul style="list-style-type: none"> modify existing table provide an adjustable height work table 	✓	✓	low high	med med	med high
		112. Provide support for the arms <ul style="list-style-type: none"> Rest arms on near-by surfaces Provide arm rests which clamp on to adjacent work surfaces when prolonged work is anticipated 	✓	✓	low med	med med	med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	<ul style="list-style-type: none"> Work location is too far away 	103. Provide extensions for tools <ul style="list-style-type: none"> provide extensions and angles on wrenches in order to access bolt with minimal reaching 	✓	✓	med	med	med
		38. Move closer to the work location <ul style="list-style-type: none"> remove obstructions 	✓		low	med	med
	<ul style="list-style-type: none"> Work space or access is limited 	117. Provide support for the upper body		✓	med to high	med	med
		63. Provide a padded, compressible surface to lay on	✓		low	med	med
		103. Provide extensions for tools <ul style="list-style-type: none"> provide extensions for ratchets to increase access 	✓		med	med	med
		77. Provide a tool with an appropriate handle angle <ul style="list-style-type: none"> provide angled or off-set wrenches for tight spaces 	✓		med	med	med
	<ul style="list-style-type: none"> Repeated arm movements required for task 	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	<ul style="list-style-type: none"> • Use of manual tool for high force or repeated torquing (see Figure 1.2) • Torque specifications require high forces  <p style="text-align: center;">Figure 1.2</p> <ul style="list-style-type: none"> • Tool is too heavy • Inadequate maintenance of tools can increase force requirements 	66. Provide a power tool <ul style="list-style-type: none"> • use a power tool whenever feasible (use manual tool at end of cycle if final torque check is required) 	✓	✓	med	med	high
		76. Provide a tool which requires minimal force to use <ul style="list-style-type: none"> • provide ratcheting tools with multiplying gears to reduce forces • increase handle length on wrench to improve leverage 		✓	high	med	med
		59. Provide a lighter weight tool <ul style="list-style-type: none"> • use tool of minimal weight 		✓	med	med	med
		34. Maintain hand tools/power tools <ul style="list-style-type: none"> • increase frequency of periodic maintenance and inspection 		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	<ul style="list-style-type: none"> Carrying tools and containers of nuts and bolts 	48. Provide a cart <ul style="list-style-type: none"> to eliminate carrying 	✓	✓	med	med	med
		47. Provide a carrying container for tools/supplies <ul style="list-style-type: none"> provide a hip pouch to eliminate carrying in hand 	✓	✓	med	med	med
	<ul style="list-style-type: none"> Wear or corrosion of components 	33. Maintain bolts and screws <ul style="list-style-type: none"> use penetrating oil, if allowable to help reduce resistance 		✓	low	med	med
3. High speed, sudden shoulder movements	<ul style="list-style-type: none"> Work pace/work volume causes high speed arm movements while manually torquing bolts 	66. Provide a power tool <ul style="list-style-type: none"> use power tool whenever possible for high torque applications, power tools which are self supporting (do not have to be held in position by the person) are preferred 		✓	high	med	med
		13. Encourage ergonomic work techniques <ul style="list-style-type: none"> use smooth movements avoid rushing 	✓ ✓		low low	med med	med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
	<ul style="list-style-type: none"> Work location is too low 	124. Raise the work piece/work surface <ul style="list-style-type: none"> provide a fixed table to support work piece raise the assemble (e.g., engine) using a hoist or other support device. 	✓	✓ ✓	med high	med med	med high
	<ul style="list-style-type: none"> Work location is blocked or is in an inappropriate orientation 	31. Lower the person <ul style="list-style-type: none"> provide a chair/stool to sit on 136. Rotate the work piece <ul style="list-style-type: none"> rotate the work piece manually provide a fixture to allow the work piece to be rotated 	✓ ✓	✓ ✓	med low med	med med med	med med med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On		
			✓ Minor Modification	✓ Major Change		Quality	Productivity	
5. Bent wrists/repeated wrist movements or repeated forearm rotation	<ul style="list-style-type: none"> Manual wrenching can require awkward wrist and forearm movements (see Figure 1.4)  <p style="text-align: center;">Figure 1.4</p> <ul style="list-style-type: none"> Work location is too high 	66. Provide a power tool <ul style="list-style-type: none"> use power tool whenever possible use power tool to do the majority of the torquing (when necessary, use manual wrenches only for final torque check) 		✓	med	med	med	
			✓	med	med	med		
		✓		low med high	med med med	med med high		
		✓		med high	med med	med high		

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	<ul style="list-style-type: none"> Work location is too low Work location is blocked or is in an inappropriate orientation 	124. Raise the work piece/work surface <ul style="list-style-type: none"> provide a fixed table to support work piece provide an adjustable table for work piece 31. Lower the person <ul style="list-style-type: none"> provide a chair/stool to sit on 38. Move closer to the work location <ul style="list-style-type: none"> remove obstructions 136. Rotate the work piece <ul style="list-style-type: none"> rotate the work piece manually provide a fixture to allow the work piece to be rotated 	✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓	med high med low low med	med med med med med med	med high med med med med
6. Repeated manipulations with fingers	<ul style="list-style-type: none"> Rarely occurs 	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	<ul style="list-style-type: none"> Wide spans on tools such as pliers or channel locks can cause finger and thumb hyperextension 	13. Encourage ergonomic work techniques <ul style="list-style-type: none"> use two hands when possible 89. Provide an appropriate handle grip span on pliers-type tools <ul style="list-style-type: none"> provide a tool with a handle span less than 3" use crescent wrenches or appropriately sized sockets 	✓ 	✓ ✓	low med med	med med med	med med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	<ul style="list-style-type: none"> • Tool or work piece must be manually supported, held or steadied • Tool is too heavy or not balanced • Handle diameter is too large 	118. Provide support for the work piece <ul style="list-style-type: none"> • to support work piece 		✓	med	med	med
		54. Provide a high friction gripping surface <ul style="list-style-type: none"> • provide a tool handle with a compressible grip surface • wrap tool handle with friction tape 	✓		med	med	med
		116. Provide support for the tool <ul style="list-style-type: none"> • provide a tool balancer for bench work 		✓	med	med	med
		59. Provide a lighter weight tool		✓	med	med	med
		88. Provide an appropriate handle diameter <ul style="list-style-type: none"> • provide a power tool with a handle diameter of 1"-1.5" (2.5-3.8 cm) 	✓		med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	<ul style="list-style-type: none"> Torque specifications require high forces 	76. Provide a tool which requires minimal force to use <ul style="list-style-type: none"> provide ratcheting tools with multiplying gears to reduce forces increase handle length to improve leverage on manual tools 		✓ ✓	high med	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	<ul style="list-style-type: none"> Manual torquing causes high speed movements Use of power tools or impact wrenches exposes worker to vibration 	66. Provide a power tool <ul style="list-style-type: none"> use power tool whenever possible use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening) 74. Provide a tool that minimizes exposure to vibration/impact/torque <ul style="list-style-type: none"> provide pulse tools instead of impact wrenches 		✓ ✓ ✓	med med med	med med med	med med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	<ul style="list-style-type: none"> • Tool handle has hard edges • Work station or work piece has hard or sharp edges 	9. Eliminate exposure to hard edges <ul style="list-style-type: none"> • provide a tool with a round, smooth handle with no ridges or edges • provide a handle of at least 5" in length • wrap tool handle 9. Eliminate exposure to hard edges <ul style="list-style-type: none"> • lay a blanket or cushion over hard edges 					
				✓	med	med	med
				✓	med	med	med
			✓	low	med	med	
			✓	low	med	med	med
11. Hands and fingers exposed to cold temperatures	<ul style="list-style-type: none"> • Work area is too cold 	93. Provide appropriate gloves 105. Provide portable heaters		✓	med	med	med
			✓	low	med	med	

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	<ul style="list-style-type: none"> Rarely occurs (see question #15) 	N/A					
13. Twisting of the lower back	<ul style="list-style-type: none"> Work location is blocked or is in an inappropriate orientation (see Figure 1.5)  <p>Figure 1.5</p> <ul style="list-style-type: none"> Work space or access is limited 	<p>136. Rotate the work piece (bench work)</p> <ul style="list-style-type: none"> turn the work piece manually provide a fixture to allow the work piece to be rotated <p>63. Provide a padded, compressible surface to lay on</p> <ul style="list-style-type: none"> Provide a pad/mat <p>117. Provide support for the upper body</p>	<p>✓</p>	<p>✓</p>	<p>low med</p>	<p>med med</p>	<p>med med</p>
			<p>✓</p>		<p>low</p>	<p>med</p>	<p>med</p>
				<p>✓</p>	<p>med</p>	<p>med</p>	<p>med</p>

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On		
			✓ Minor Modification	✓ Major Change		Quality	Productivity	
14. High speed, sudden movements	<ul style="list-style-type: none"> Corroded or stuck fittings 	66. Provide a power tool <ul style="list-style-type: none"> use power tool whenever possible 		✓	high	med	med	
		33. Maintain bolts and screws <ul style="list-style-type: none"> use penetrating oil, if allowable to help reduce resistance 	✓		low	med	med	
		13. Encourage ergonomic work techniques <ul style="list-style-type: none"> use smooth movements avoid rushing 	✓ ✓		low low	med med	med med	
15. Static, awkward back postures	<ul style="list-style-type: none"> Work location is too low 	124. Raise the work piece/work surface <ul style="list-style-type: none"> provide a fixed table to support work piece provide an adjustable table for work piece raise the assembly (e.g., engine) using a hoist or other lift device) 	✓	✓ ✓ ✓	med high high	med med med	med high high	
		<ul style="list-style-type: none"> Work location is too far away 	38. Move closer to the work location <ul style="list-style-type: none"> remove obstructions 	✓		low	med	med
		136. Rotate the work piece <ul style="list-style-type: none"> rotate the work piece manually provide a fixture to allow the work piece to be rotated 	✓	✓	low med	med med	med med	

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	<ul style="list-style-type: none"> Chair or stool provides inadequate back support 	115. Provide support for the lower back <ul style="list-style-type: none"> adjust back rest to support lower back pull chair forward and lean back while working attach a small pillow to back rest to support lower back provide chair with lower back support 	✓ ✓ ✓	✓	low low low med	med med med med	med med med med
16. Lifting forces	<ul style="list-style-type: none"> Rarely occurs (if it occurs, see Lifting case study) 	N/A					
17. Pushing or pulling	<ul style="list-style-type: none"> Torque specifications require high forces 	76. Provide a tool which requires minimal force to use <ul style="list-style-type: none"> provide power tools which can meet the necessary torque specification provide ratcheting tools with multiplying gears to reduce forces increase handle length to improve leverage and enable a balanced two-hand grip 		✓ ✓ ✓	med high med	med med med	med med med
18. Whole body vibration	<ul style="list-style-type: none"> Rarely occurs 	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	<ul style="list-style-type: none"> • Standing surface is hard 	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	<ul style="list-style-type: none"> • Kneeling causes external pressure to the knee • Work piece has hard edges 	95. Provide appropriate knee protection	✓		low	med	med
		9. Eliminate exposure to hard edges <ul style="list-style-type: none"> • lay a blanket or cushion over hard edges 	✓		low	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	<ul style="list-style-type: none"> Work location is too low 	124. Raise the work piece/work surface <ul style="list-style-type: none"> provide a fixed table to support work piece provide an adjustable table for work piece raise assembly (e.g., engine) using a hoist or other lift device 31. Lower the person <ul style="list-style-type: none"> provide a chair/stool to sit on provide knee pads, if kneeling is required provide a pad or cushion to kneel on 	✓		low	med	med
				✓	high	med	high
				✓	high	med	high
			✓		low	med	med
			✓		low	med	med
			✓		low	med	med
22. Standing foot pedal	<ul style="list-style-type: none"> Rarely occurs 	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	<ul style="list-style-type: none"> Light levels are too low 	22. Increase light levels <ul style="list-style-type: none"> Provide light levels at the task of 50-100 foot-candles (500-1000 lux) for wrenching tasks if necessary, provide a task light which is easy to adjust 	✓	✓	high low	high med	high med
24. Intensive visual tasks, staring at work objects for long periods	<ul style="list-style-type: none"> Rarely occurs 	N/A					