CASE STUDY - Bolting/Screwing	
TASK TITLE: Bolting/Screwing	
Task Description:	Bolting/screwing involves installing or removing nuts and bolts. These tasks can be done at a variety of heights and angles. Both hand and power tools are employed depending upon the task requirements. Typical jobs in which bolting/screwing is performed include (not necessarily limited to): • assembly • general maintenance Bolting/screwing may be performed on flat or upright surfaces directly on aircraft, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Bolting/Screwing:	• Consistent torque • No errors (e.g. , missing bolts, incorrect bolts) • Speed of completion of the job
Typical Employee Comments about Bolting/Screwing:	Employees typically report fatigue and discomfort in the hands/wrists/arms, shoulders/neck, and back/torso. Primary: The primary body parts affected are the hands/wrists/arms and shoulders/neck Secondary: In some cases, the back/torso can also be affected
Suggested Level II Analysis:	Grip Force, Postural Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person • use a step stool, platform or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/worksurface • modify existing table	✓		med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Work location is too far away (see Figure 1.1)	103. Provide extensions for tools • provide extensions and angles on wrenches in order to access bolts with minimal reaching	✓		low	med	med
	 **Figure 1.1**	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	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
	• Work location is blocked or is in an inappropriate orientation	82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		103. Provide extensions for tools		✓	med	med	med
		38. Move closer to the work location • remove obstructions	✓	✓	low	med	med
		136. Rotate the workpiece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		103. Provide extensions for tools		✓	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
	• Wrenching is performed on flat work piece with a pistol-shaped power tool	136. Rotate the work piece • turn the work piece to an upright position • provide a fixture to allow the work piece to be rotated 77. Provide a tool with an appropriate handle angle • provide a power tool that has an in-line handle for flat surfaces • provide power tool with a handle which can be angled/bent for different nut driving tasks	✓	 ✓ ✓ ✓	low med med med	med med med med	med med med med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Torque specifications require high forces • Tool is too heavy	76. Provide a tool which requires minimal force to use • 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 59. Provide a lighter weight tool • use a tool of minimal weight		 ✓ ✓ ✓ ✓	 med med med med	 med med med 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
	• Containers of bolts and nuts are carried	48. Provide a cart • to eliminate carrying	✓	✓	med	med	med
		47. Provide a carrying container for tools/supplies • provide a hip pouch to eliminate carrying in hand	✓		low	med	med
3. High speed, sudden shoulder movements	• Work pace/work volume causes high speed arm movements while manually torquing bolts	76. Provide a tool which requires minimal force to use • use power tool whenever possible		✓	med	med	med
		• for high torque applications, provide power tools which are self supporting (e.g., has a tool support arm)(do not have to be held in position by the person) are preferred. These supports could take the form of support arms, or torque bars		✓	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
4. Head/neck bent or twisted	• Work location is too high (or is overhead) (see Figure 1.2)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/worksurface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		114. Provide support for the head					
		• for long duration wrenching tasks which are overhead, provide a chair with a reclining backrest, a head support and arm supports		✓	med	med	med
	 **Figure 1.2**						
	• Work location is blocked or is in an inappropriate orientation	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		136. Rotate workpiece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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	• Manual wrenching causes awkward wrist and forearm movements	66. Provide a power tool • use power tool whenever possible • use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and final check).		✓ ✓	med med	med med	med med
	• Work location is too high	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding	✓ ✓	✓ ✓	med low med	med med med	med med med
	• Torquing is performed on flat work piece with a pistol-shaped power tool	77. Provide a tool with an appropriate handle angle • provide in-line power tools for flat surfaces		✓	med	med	high
6. Repeated manipulations with fingers	• Tightening small bolts or screws with a small wrench or with the fingers causes repetitive finger movements	66. Provide a power tool • use power tool whenever possible • use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and final check).		✓ ✓	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
7. Hyper-extension of finger/thumb or repeated single finger activation	• Wide spans on tools such as vise grips cause finger and thumb hyperextension	13. Encourage ergonomic work techniques • use two hands when possible	✓		low	med	med
		89. Provide an appropriate handle grip span on plier-type tools • provide a tool with a handle span less than 3"		✓	med	med	med
		• use crescent wrenches or appropriately sized sockets	✓		low	med	med
	• Using power tool causes repeated single finger trigger activation	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Power tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a welding tool of minimal weight		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	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
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a power tool with a handle diameter of 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • provide power tools which can meet the necessary torque specification		✓	med	med	med
		• provide ratcheting tools with multiplying gears to reduce forces		✓	med	med	med
		• increase handle length to improve leverage		✓	med	med	med
		• provide tools with torque releases to minimize forces required to control the tool		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Power tool causes impact and torque to the hand	34. Maintain hand tool/power tools • provide regular maintenance and lubrication for tools	✓		low	med	med
		76. Provide a tool which requires minimal force to use • provide tools with torque releases to minimize forces required to control the tool		✓	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
		• provide torque reaction mechanisms to absorb torque associated with rotary power tools used for bench work		✓	med	med	med
	• Manual torquing causes high speed movements	66. Provide a power tool • use power tool whenever possible		✓	med	med	med
		• use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and checking).		✓	med	med	med
	• Power tools produce hand/arm vibrations	34. Maintain hand tool/power tools • provide regular maintenance and lubrication for tools	✓		low	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping		✓	med	med	med
		• attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5")	✓		low	med	med
		• Provide a pulse controlled tool if possible. Avoid impact-type power tools (such as impact wrenches) whenever possible		✓	high	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	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length		✓	med	med	med
	• Workstation has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
	• Work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	med to high	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
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand • Work area is too cold	7. Direct cold air away from the hands • direct exhaust air away from hands • provide tool which does not blow cold air on the hands 93. Provide appropriate gloves • Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task	 ✓	 ✓ ✓ ✓	 med med med	 med med med	 med 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	• Work location is too low (see Figure 1.3)	124. Raise the work piece/worksurface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person	✓	✓	med	med	med
		• provide a chair/stool to sit on					
	 **Figure 1.3**						
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece (bench work)	✓		low	med	med
		• rotate the work piece manually		✓	med	med	med
		• provide a fixture to allow the work piece to be rotated					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece (bench work)	✓		low	med	med
		• turn the work piece manually		✓	med	med	med
		• provide a fixture to allow the work piece to be rotated	✓	✓	med	med	med
		• remove obstructions prior to performing task					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • provide a pad/mat	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/worksurface • provide a fixed table to support work piece		✓	med	med	high
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	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
	• Chair or stool provides inadequate back support	82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		117. Provide support for the upper body • provide a device to support the head and upper body while the person is working		✓	med	med	med
		115. Provide support for the lower back • adjust back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
17. Pushing or pulling	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • 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		✓ ✓ ✓	med med med	med med med	med med med
18. Whole body vibration	• 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	• Standing surface is hard	86. Provide an appropriate anti-fatigue		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection					
		• provide attachable knee pads	✓		med	med	med
		• provide a pad or cushion to kneel on	✓			med	med
	• Workstation or workpiece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	med to high	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	• Work location is too low (see Figure 1.4)  **Figure 1.4**	124. Raise the work piece/worksurface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
		• provide knee pads		✓	med	med	med
		• provide a pad or cushion to kneel on	✓		low	med	med
		8. Distribute intensive activities throughout the process	✓	✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
22. Standing foot pedal	• 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	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot candles (500-1000 lux) for wrenching tasks • provide a task light which is easy to adjust	 ✓	✓ ✓	high med	high med	high med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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