CASE STUDY PROBLEM-SOLVING MATRICES

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The 50 case study problem-solving matrices provided on the following pages link the problems identified with the Level I Ergonomics Assessment Checklist and Checklist Scoring Summary to strategies or options which you may use to control ergonomics hazards. The matrices are presented in Table 1 below.

Table 1
Directory of Case Study Problem-Solving Matrices

Case Study			
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CASE STUDY - Abrading	
TASK TITLE: Abrading	
Task Description:	Abrading involves the use of a manual (sandpaper, file, etc.) or powered (pneumatic/hydraulic hand sanders) tools to remove or shape material. Additionally, the parts can be fixed (in a vise) or supported (mounted on a structure). Typical jobs in which abrading is performed include (not necessarily limited to): • aircraft maintenance • sheet metal repair • facility maintenance • model shop
Job Performance Measures Most Often Impacted by Abrading:	• Surface finish • Speed of task completion.
Typical Employee Comments about Abrading:	Due to the wide variety of work situations, employees may complain about discomfort or stiffness in any of the following areas: shoulders/neck, hands/wrists/arms, back/torso, or legs/feet. The primary body parts affected are typically: shoulders/neck, hands/wrists/arms and back/torso The secondary body parts affected are typically: legs/feet.
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	• Work location is too high	123. Raise the person					
		• provide a step stool	✓		med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface	✓		med	med	med
	• Work piece must be manually supported, held, or steadied	118. Provide support for the work piece					
		• provide a clamp to place work piece at the desired height and orientation	✓		med	low	med
	• Abrading tool power supply hose/cord must be manually supported, held or steadied	113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		med	low	low
	• Work location is too far away (see Figure 1.1)	38. Move closer to the work location					
		• remove obstructions	✓		med	med	med
		• get on top of the work (and provide knee pads)	✓		low	med	med
	Figure 1.1	41. Move work piece closer to body	✓		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
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
	• Abrading is performed on a flat work surface	136. Rotate the work piece • turn the work piece to an upright or angled position	✓		low	med	med
		77. Provide a tool with an appropriate handle angle • provide a tool with a grip which is oriented vertically while the tool is in use		✓	med	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-in materials	• Worker must apply downward pressure	133. Replace abrasive/cutting material frequently	✓		low	high	high
		34. Maintain hand tool/power tools • minimize force	✓		med	med	med
		66. Provide a power tool • provide a tool with the capacity to handle the required work without causing the operator to over exert		✓	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
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work surface is too high	123. Raise the person					
		• provide a step stool	✓		med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface	✓		med	med	med
	• Work surface is too low	124. Raise the workpiece/worksurface					
		• raise part with a hoist		✓	med	med	med
		• raise on adjustable table		✓	med	med	med
		32. Lower the worker					
		• provide a stool (see Figure 1.2)	✓		med	med	med
		Figure 1.2					

Hands/Wrist/Arm

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	• Work location is too high	123. Raise the person • provide a step stool • provide an adjustable platform	✓	✓	med high	med med	med med
		32. Lower the work piece/work surface	✓		med	med	med
	• Work is in an awkward location or orientation	136. Rotate the work piece • manually turn the work piece to an upright position • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
	• Abrading is performed on a flat work surface	136. Rotate the work piece • turn the work piece to an upright or angled position • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		77. Provide a tool with an appropriate handle angle • provide a tool with a grip which is oriented vertically while the tool is in use		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					

Hands/Wrist/Arm (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	• Use of tool with single trigger concentrates stress	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)	✓		med	med	med
8. Hand/grip forces	• The type of tool is not appropriate for the amount of material that must be removed	133. Replace abrasive/cutting material frequently	✓		low	high	high
		34. Maintain hand tools/power tools	✓		low	med	med
		66. Provide a power tool • provide a tool with the capacity to handle the required work without causing the operator to overexert		✓	med	med	med
	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture or clamp which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible, high friction surface		✓	med	med	med

Hands/Wrist/Arm (Cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		• wrap tool handle	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with an appropriate handle diameter between 1"-1.5".		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• The tool has not received proper maintenance	34. Maintain hand tools/power tools • perform periodic maintenance on all tools	✓		low	med	med
	• Abrading tools produce hand/arm vibration	74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a tool which minimizes exposure to vibration		✓	med	med	med
		• provide a tool with vibration absorbing materials built into the handles		✓	med	med	med

Hands/Wrist/Arm (Cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Lack of clamping device increases employee contact with vibrating surface	118. Provide support for the work piece • provide a fixture or jig to hold the work piece		✓	med	med	med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5"(12.7cm) in length • wrap the tool handle	 ✓	✓ ✓	med med low	med med med	med med med
	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	 ✓	 ✓	 low med	 med med	 med med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓	med med	med med	med med
	• Air tool exhaust blows on wrist	7. Direct cold air away from the hands • modify the existing tool/add an air diverter • provide a tool which does not direct air to the hands	 ✓	 ✓	 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	• Rarely occurs (Refer to question 15)	N/A					
13. Twisting of the lower back	• Work space is cramped or access is limited	117. Provide support for the upper body • provide a pad/mat • provide a device to support the upper part of the body	✓	✓	low med	med med	med med
	• Work piece orientation is inappropriate	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (Cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work surface is too low (see Figure 1.3) **Figure 1.3**	124. Raise the work piece/work surface					
		• use a hoist		✓	med	med	med
		• raise the worktable with blocks or risers	✓		low	med	med
		31. Lower the worker					
		• provide a stool for low work locations	✓		med	med	med
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back					
		• adjust back rest to support lower back while seated	✓		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	med	med
		• provide a chair with adequate lower back support		✓	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
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 (see Figure 1.4) **Figure 1.4**	86. Provide an appropriate anti-fatigue mat 96. Provide appropriate shoe inserts 52. Provide a footrail or footrest	 ✓ ✓	✓	med low med	med low low	med low low
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
21. Awkward leg postures	• Work surface is too low	124. Raise the work piece/work surface • use a hoist 31. Lower the worker • provide a stool	 ✓	✓	med med	med med	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light					
		• orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (Cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (Cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Assembly/disassembly - internal components	
TASK TITLE: Assembly/disassembly - internal components	
Task Description:	Assembly/disassembly often involves the use of manual or power tools. The characteristic that makes this assembly/disassembly task unique is that the task is being performed on an internal component. The component is in a fixed location (e.g., inside the aircraft wing, wall, or other machine) and access to the part is typically severely limited. In some cases the employee must reach into or work through a small access opening to perform the work. In other cases, the employee must crawl into and work from inside a small compartment. Typical jobs in which assembly/disassembly is performed include (not necessarily limited to): • fuel line maintenance • hydraulics
Job Performance Measures Most Often Impacted by Assembly/disassembly:	• Speed of task completion (as measured against standard) • Integrity of seals • No foreign objects can be left inside aircraft
Typical Employee Comments about Assembly/disassembly:	Employees typically complain about discomfort in the hands/wrists and elbows. Depending on the work location and the type of access, employees may report a variety of complaints from knees (due to kneeling or squatting), shoulders (from constant reaching), and back and neck (from working in awkward postures for prolonged periods. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Grip Force Measurement

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 (see Figure 1.1)	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	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	Figure 1.1						
	• 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
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• remove adjacent access panel if possible		✓	med to high	med	med
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on	✓		low	med	med
		117. Provide support for the upper body		✓	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
	• Manual procedure or tool requires excessive force	76. Provide a tool which requires minimal force to use • provide manual tool to replace "by hand" work		✓	med	med	med
2. Arm forces: Repeated contraction of the arm muscles or holding/carry-ing materials	• Component must be held in place	118. Provide support for the work piece • provide manual clamps/fixtures to hold components in place during assembly or removal	✓	✓	med	med	med
3. High speed, sudden shoulder movements	• Manual procedure or tool requires high speed movements	76. Provide a tool which requires minimal force to use • provide manual tool to replace "by hand" work		✓	med to high	med	med to high
4. Head/neck bent or twisted	• Work location too high or too low.	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding	✓ ✓	✓ ✓	med low high	med med med	med med med
		32. Lower the work piece/work surface • change (e.g., invert) the orientation of the component, or machine.		✓	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 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
	• Light levels are too low for task	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
	• Lack of direct visual access to work location (see Figure 1.2) **Figure 1.2**	84. Provide an adjustable mirror • provide an articulating mirror to provide better visual contact to parts inside the access hole		✓	med	med	med
	• Lack of adequate support for head	114. Provide support for the head • provide neck roll or brace to support head if head must be tipped backward or forward when performing work		✓	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 procedure or tool requires bent wrists	76. Provide a tool which requires minimal force to use					
		• provide power tool to replace forceful work with manual tool		✓	med	med	med
		• provide manual tool to replace hand work		✓	med	med	med
	• Using the wrong type of tool can cause bent wrists	77. Provide a tool with an appropriate handle angle					
		• provide in-line power tools for horizontal surfaces		✓	med	med	med
		• provide pistol grip power tools for vertical surfaces		✓	med	med	med
		• provide power tool with a handle which can be angled/bent for different nut driving tasks		✓	med	med	med
		• use tube gun for tube (e.g., fuel line, hydraulic line) fasteners.		✓	med	med	med
	• Work location is too far away	103. Provide extensions for tools					
		• provide extensions and angles on wrenches in order to access bolt with minimal reaching		✓	med	med	med
		38. Move closer to the work location					
		• remove obstructions	✓	✓	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
6. Repeated manipulations with fingers	• Manual tightening/loosening on small bolts, nuts & screws	66. Provide a power tool.		✓	med	med	med
7. Hyperextension 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
	• Tool requires single finger trigger activation	62. Provide a multi-finger trigger • extend current trigger	✓	✓	med	med	med
		• provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Component must be held in place	118. Provide support for the work piece • provide manual clamps/fixtures to hold components in place during assembly or removal	✓	✓	med	med	med
		• replace pliers with vice grips for holding, squeezing or stabilizing parts during installation	✓	✓	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
	• Tool is too heavy	59. Provide a lighter weight tool • provide light-weight tools		✓	med	med	med
		75. Provide a tool which can be used with both hands • add an auxiliary handle or extension to enable employee to hold/stabilize tool with two hands	✓	✓	med	med	med
	• Lack of friction between hand/fingers and tools or components	76. Provide a tool which requires minimal force to use • provide thin, anti-slip gloves • clean components (e.g., remove dirt, grease etc.) prior to handling	✓ ✓		low low	high high	high high
	• Manual procedure or tool requires forceful grips	76. Provide a tool which requires minimal force to use • provide manual tool to replace hand work		✓	med	med	med
		• provide power tool to replace forceful work with manual 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
	• Power tools produce hand/arm vibrations	34. Maintain hand tool/power tools • provide regular maintenance and lubrication for tools	✓		low to med	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" (3.8 cm))	✓		low	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 tools/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
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
	• Work area has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• lay a blanket or cushion over hard edges • redesign work piece or component to eliminate hard edges		✓	med	med	med

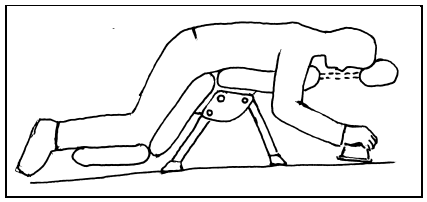
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
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 • provide gloves of the right size and type of material to match the task Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task	 ✓	 ✓ ✓ 	 med med low	 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	• Rarely occurs	N/A					
13. Twisting of the lower back	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • provide a pad/mat • provide a device to support the upper body while working 132. Remove obstructions • remove hoses, carts, access covers	✓ ✓	✓	low med low	med med high	med med high
14. High speed, sudden movements	• Item is stuck in location • Item is difficult to install or remove	74. Provide a tool that minimizes exposure to vibration/ impact/torque • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal • use tool to “pry” instead of pull.	✓ ✓	✓	low med to high low	med 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
15. Static, awkward back postures	• Inappropriate back support	117. Provide support for the upper body • provide padded, portable leaning rests for working in areas which prevent the use of a chair or stool. (see Illustration 1.1)  **Illustration 1.1**		✓	med	med	med
	• Work location is too low	124. Raise the work piece/work surface					
		• elevate with an available hoist	✓		low	med	med
		• provide a stationary platform or ramp		✓	med	med	med
		• provide a height-adjustable work platform		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
	• Light levels too low	22. Increase light levels					
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Component is too heavy	61. Provide a mechanical lift device					
		• use portable lift cart to raise/position component	✓	✓	med	low	med
		• get it close to install point		✓	med	low	med
		• place the part on temporary hangers to avoid lifting while part is being positioned	✓	✓	med	low	med
		142. Use two or more persons to perform the transfer	✓		low	low	low
17. Pushing or pulling	• High forces are required to install or remove the component	74. Provide a tool that minimizes exposure to vibration/impact/torque					
		• use lubricant where feasible	✓		low	med	med
		• modify design of component or subsystem to reduce forces during installation or removal		✓	med to high	med	med
		• "pry" component away instead of pulling	✓		low	med	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
18. Whole body vibration	• Rarely occurs	N/A					
19. Fixed position, standing	• Standing surface is hard	86. Provide appropriate anti-fatigue mat		✓	med	med	low
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee (see Figure 1.3) **Figure 1.3**	95. Provide appropriate knee protection					
		• provide knee pads		✓	med	med	med
		• provide a pad or cushion to kneel on	✓		low	low	low
	• Work area has hard edges	9. Eliminate exposure to hard edges					
		• lay a blanket or cushion over hard edges	✓		low	low	med
		• redesign work piece or component to eliminate hard edges		✓	med	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	31. Lower the person • provide a chair/stool to sit on • provide knee pads • provide a pad or cushion to kneel on	 ✓	 ✓ ✓ 	 med med med	 med med med	 med 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 for task	22. Increase light levels • provide a task light which is easy to adjust • increase room lighting	✓	✓	med high	med high	med high
24. Intensive visual tasks, staring at work objects for long periods	• Task lacks variety	20. Incorporate rest pauses 25. Increase task variety	✓ ✓		low low	med med	med med

CASE STUDY -Assembling/Repairing (bench work)	
TASK TITLE: Assembling/Repairing (bench work)	
Task Description:	Bench work involving assembly and repair typically involves performing precise work on small to moderate sized component. This work often involves tasks such as wiring, cutting, crimping, soldering, melting, coating, drilling, bolting/screwing, and gluing. Additional recommendations may be found in the case studies related to these activities. Bench work can be performed in either a standing or seated posture. **Consider using this case study to identify postural problems and recommendations in any situation where bench work is performed.**
Job Performance Measures Most Often Impacted by Assembling/Repairing (bench work):	• Time required to complete task • Quality of work (e.g., free of defects)-task specific
Typical Employee Comments about Assembling/Repairing (bench work):	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, shoulders/neck and middle back/lower back. The primary body regions of concern are: hands/wrists/arms, shoulders/neck The secondary body regions of concern are: back/torso
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis, Light Measurement

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	120. Raise the chair					
		• adjust the chair upward	✓		low	med	med
		• provide a cushion to raise the person, if the chair will not raise high enough	✓		med	med	med
		• when the chair is raised, a foot rest may be necessary to support the feet	✓		med	med	med
		32. Lower the work piece/worksurface					
		• modify existing table (best if only one person is using the table)	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Reaching for components on the back of the work bench • Components/work piece are located too far away • Components/work piece are located too high	41. Move work piece closer to body					
		• place frequently used components closer to the person	✓		low	med	high
		• infrequently used components should be removed from the workstation or placed at arm's length	✓		med	med	high
	• Reaching over components/clutter	• store smaller quantities of components at the workstation at once	✓		low	med	high

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		32. Lower the work piece/worksurface • Lower component storage containers which are frequently used		✓	med	med	high
	• Tool/workpiece must be manually supported, held or steadied	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		118. Provide support for the work piece • provide a fixture to support the work piece (fixtures which allow the work piece to be rotated into different positions are helpful)		✓	med	med	med
		112. Provide support for the arms • provide adjustable arm supports for high precision or long duration tasks that require the arms to be away from the body		✓	med	high	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 too far away	41. Move work piece closer to body	✓		low	med	med
		38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
	• Orientation of work piece or tool handle causes the arm to be held away from the body. (see Figure 1.1)	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece to an upright position	✓		low	med	med
	 Figure 1.1	77. Provide a tool with an appropriate handle angle • provide a tool with an in-line grip when a vertical tool axis is desired		✓	med	med	med
		• provide a tool which can be angled/bent for different work orientations		✓	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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Manual tool requires high forces	66. Provide a power tool • obtain a power tool which reduces forces and time required		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med
3. High speed, sudden shoulder movements	• See specific case study for more detailed causes and solutions	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/worksurface					
		• raise the worktable with blocks		✓	low	med	med
		• provide an adjustable table		✓	high	med	med
		• provide a fixture (e.g., table-top riser) to raise the work piece into a comfortable viewing position		✓	med	med	med
		• lower the chairs.	✓		low	med	med
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		• provide adequate leg clearance to allow seated postures (e.g., remove obstructions)	✓	✓	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 too high	120. Raise the chair					
		• adjust the chair upward	✓		low	med	med
		• provide a cushion to raise the person, if the chair will not raise high enough	✓		med	med	med
		• when the chair is raised, a foot rest may be necessary to support the feet		✓	low	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece	✓		low	med	med
	• Light levels are too low	22. Increase light levels					
		• provide a task light which is easy to adjust		✓	med	high	med
		• increase room lighting		✓	high	high	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	• Orientation of work piece or tool handle causes the wrist to be bent	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece to an upright position	✓		low	med	med
		77. Provide a tool with an appropriate handle angle			med	med	med
		• provide a tool with an in-line grip when a vertical tool axis is desired		✓			
		• provide a tool with a pistol grip when a horizontal tool axis is desired		✓	med	med	med
		• provide a tool which can be angled/bent for different work orientations		✓	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
	• Component container is too deep • Components are difficult to access	127. Reduce depth of storage container		✓	med	med	med
		125. Recess container into worksurface • critical components can be placed in recessed storage containers on the worksurface		✓	med	med	med
		136. Rotate the work piece • tilt component containers towards the person to increase access		✓	med	med	med
		132. Remove obstructions • the side of the component container should dip down to allow easier access to components		✓	med	med	med
	• Work location is too high	120. Raise the chair • adjust the chair upward	✓		low	med	med
		• provide a cushion to raise the person, if the chair will not raise high enough	✓		med	med	med
		• when the chair is raised, a foot rest may be necessary to support the feet		✓	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
		32. Lower the work piece/worksurface • modify existing table (best if only one person is using the table) • provide an adjustable height work table	✓	✓ ✓	med high	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of power tool with single finger trigger(see Figure 1.2) **Figure 1.2**	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger • extend trigger on existing tool (if feasible and safe)	✓	✓ ✓	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	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible, high friction surface		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer		✓	med	med	med
		113. Provide support for the cable or hose • provide a tool balancer to support cables		✓	med	med	med
		• provide a hook to support hose	✓	✓	med	med	med
		•					
	• Tool is too heavy	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		59. Provide a lighter weight 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
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• See specific case study for more detailed causes and solutions	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length • wrap the tool handle	 ✓	✓ ✓	med med low	med med med	med med med
	• Workstation has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	 ✓ ✓		 low low	 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
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from hands • provide tool which does not blow cold air on the hands		✓	med	med	med
		• attach an air diverter		✓	med	med	med
	• Tool handle conducts heat away from hand	104. Provide handles with insulating material • cover metal handles with insulating material	✓		low	med	med
	• Work area is too cold	23. Increase room temperature		✓	med	med	med
		105. Provide portable heaters		✓	med	med	med
		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

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	• Reaching for components on the back of the work bench • Components/work piece are located too far away • Components/work piece are located too high	41. Move work piece closer to body • place frequently used components closer to the person • infrequently used components should be removed from the workstation or placed at arm's length • store smaller quantities of components at the workstation	✓ ✓ ✓		med med low	med med med	med med med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work surface/work piece is too high	32. Lower the work piece/worksurface					
		• lower component storage containers which are frequently used		✓	med	med	high
	• Work is too low	124. Raise the work piece/worksurface					
		• raise the table on blocks		✓	low	med	med
		• provide an adjustable table		✓	high	med	high
		• provide a fixture (e.g., table-top riser) to raise the work piece into a comfortable viewing position		✓	med	med	med
		• lower the chairs.	✓		low	med	med
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		• provide adequate leg clearance to allow seated postures (e.g., remove obstructions)	✓	✓	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
	• Work is too far from the employee	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 • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Inadequate lower back support while sitting • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • adjust back rest to support lower back	✓		low	med	med
		• adjust the height of the chair to allow person to lean back in the chair while working	✓		low	med	med
		• provide a foot rest to support the feet	✓	✓	med	low	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back		✓	med	med	med
		• provide a chair with adequate lower back support		✓	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
16. Lifting forces	• Rarely occurs (If occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
		1. Alternate between sitting and standing tasks	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded compressible surface to sit on. • to reduce exposure to front edge of seat	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med
	• Workstation has hard edges	9. Eliminate exposure to hard edges • remove obstructions under bench	✓	✓	med	med	med
		• round off exposed 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	• Rarely occurs	N/A					
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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	✓	✓	med	med	med
		• remove obstructions					
		41. Move work piece closer to body	✓		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					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		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
	• Work location is blocked or is in an inappropriate orientation	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

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) **Figure 1.2** • Work location is blocked or is in an inappropriate orientation	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
		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) **Figure 1.3** • Work location is too far away	124. Raise the work piece/worksurface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide a chair/stool to sit on 38. Move closer to the work location • remove obstructions 41. Move work piece closer to body 136. Rotate the work piece (bench work) • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	 ✓ ✓ ✓ ✓ ✓	 ✓ ✓ ✓ ✓ ✓ ✓	 med high med med low low med	 med med med med med med med	 med high med med med med med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece (bench work) • turn the work piece manually • provide a fixture to allow the work piece to be rotated • remove obstructions prior to performing task	✓ ✓	 ✓ ✓	low med med	med 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
	• 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
		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		✓	med	med	med
		• provide a device to support the head and upper body while the person is working					
	• Chair or stool provides inadequate back support	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 • 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
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					

CASE STUDY -Chipping	
TASK TITLE: Chipping	
Task Description:	There are many different types of chipping tasks such as: chipping using a jack hammer (size may vary) or chipping using a chipping style bit mount onto a back hoe. The task is performed for varying amounts of time depending on complexity. Typical jobs in which chipping is performed include (not necessarily limited to): • road maintenance and repair. Chipping may be performed on a flat or curved surface such as the flat surface of a roadway vs. the edge of a side walk. Access to the area location may vary due to adjacent barriers such as walls.
Job Performance Measures Most Often Impacted by Chipping:	• Quality of the product (chipping). • Speed of completion of chipping task.
Typical Employee Comments about Chipping:	Employees typically complain about discomfort and/or stiffness in the shoulder/neck, hand/wrist/arm, back and legs/feet. Primary concern: shoulder/neck, hand/wrist/arm. Secondary concern: back, legs/feet.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Vibration Measurement, Biomechanical Lifting Analysis.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
	• Controls and levers within cab of backhoe too far away	38. Move closer to the work location • adjust seat forward	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Pulling hoses is difficult – Hoses caught on equipment – Poor floor surface or standing surface condition	17. Improve floor condition • repair cracks and gaps in floor • free hoses from interference	✓ ✓	✓	med low	low med	med low
	• Pulling controls levers is difficult – Poor control lever maintenance – Poor control lever design	101. Provide controls which do not require excessive forces • contact supplier to investigate adjustable levers and smoother traveling levers		✓	med to high	med	high
	• Carrying and lifting jack hammer	126. Reduce carry distance • transport jack hammer on back of truck from location to location • when unloading jack hammer ensure vehicle is next to work area	✓ ✓		low low	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
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location too low for prolonged periods causes strain on the neck (see Figure 1.1) **Figure 1.1**	20. Incorporate rest pauses 13. Encourage ergonomic work techniques • encourage employee to look up frequently	✓ ✓		low low	med med	med med
	• Work location positioned behind operator when in back hoe	20. Incorporate rest pauses	✓		low	med	med

Hand/Wrist/Arm

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	• Control lever location too high (back hoe)	123. Raise the person • adjust seat higher • provide seat cushion	 ✓ ✓		 low low	 med med	 med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Chipping tool must be manually supported or steadied. (see Figure 1.2) **Figure 1.2**	13. Encourage ergonomic work techniques					
		• let tool do the work	✓		low	med	med
		• hands are to act only to maintain alignment	✓		low	med	med
		• keep the tool in as close to a straight upright position as possible.	✓		low	med	med
	• Duration of holding concentrates stress in hands.	13. Encourage ergonomic work techniques					
		• release grip periodically	✓		low	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter					
		• provide jack hammer with an appropriate hand diameter between 1"-1.5" (2.5-3.8 cm).		✓	med	med	med
		• if tool handle diameter is less than 1", wrap the tool handle	✓		low	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Tool or control levers emit high levels of vibration – Poor tool maintenance	34. Maintain hand tools/power tools • inspect and repair tool on a regular basis to eliminate unnecessary vibration	✓		low	med	med
		74. Provide a tool that minimizes exposure to vibration/ impact/torque • provide a tool that creates less vibration		✓	med	med	med
		• modify existing tool; wrap handles with vibration dampening grips	✓		low	med	med
		93. Provide appropriate gloves • provide appropriate anti-vibrating gloves (caution should be used to prevent excessive hand forces)		✓	med	med	med
	– Poor technique	13. Encourage ergonomic work techniques • encourage employee to maintain a "loose" grip	✓		low	med	med

Hand/Wrist/Arm (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
	• Controls lever knobs have hard edges (back hoe)	88. Provide an appropriate handle diameter					
		• provide knobs of at least 1.5" (3.8 cm) and not greater than 3.0" (7.6 cm)		✓	med	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		low	med	med
		93. Provide appropriate gloves	✓	✓	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	• Prolonged use of chipping tool	141. Use heavy excavation equipment (e.g., back hoes) • use backhoe with chipping bit on arm for long duration tasks with good access.		✓	med to high	med	high
	• Poor technique causes bending	13. Encourage ergonomic work techniques • encourage employee to maintain tool in upright position	✓		low	med	med
13. Twisting of the lower back	• Work positioned behind worker when in cab (truck)	18. Improve visual access to work • alternative back hoe design.		✓	high	high	high
	• Work location is blocked or too far away	132. Remove obstructions	✓	✓	med	med	med
14. High speed, sudden movements	• Rarely occurs. If so, refer to 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
15. Static, awkward back postures	• Leaning forward in seat	115. Provide support for the lower back			low	med	med
		• modify or adjust existing seat	✓		low	med	med
		• ensure person sits back in seat to utilize back support	✓		low	med	med
		• adjust back support forward	✓				
		• insert additional back support such as a commercial back rest or cushion.		✓	med	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
16. Lifting forces	• Weight of the jack hammer requires high lifting forces when moving or lifting jack hammer	126. Reduce carry distance					
		• closer to work site to unload jack hammer.	✓		low	med	med
		4. Change lifting/carrying task into a rolling or sliding task	✓		low	low	med
		• slide jack hammer off edge of truck bed slide one end to the ground and then lift jack hammer upright.					
		32. Lower the work piece/work surface					
		• fabricate storage compartment on side of truck to house jack hammer so that it is low.		✓	med to high	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Lifting heavy pieces of concrete – low work height – poor hand holds	131. Reduce weight of work piece • break up concrete section into smaller pieces 141. Use heavy excavation equipment (e.g., back hoes) • remove concrete pieces with the aid of a bobcat loader.	✓	 ✓	low med to high	low med	med high
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Design and maintenance of seat and mounting increases vibration exposure (back hoe)	87. Provide an appropriate chair/stool • seating should incorporate vibration absorption qualities in base support of the seat either air or mechanical 35. Maintain tracks, rollers, and movement mechanisms • repair seat base		✓ ✓	high med	med med	med med

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 (see Figure 1.3) **Figure 1.3** • Design or poor condition of foot pedals (industrial equipment) may increase force requirements.	96. Provide appropriate shoe inserts. 50. Provide a foot pedal which requires the correct amount of force to use • repair foot pedals • contact vehicle supplier – 4-10 lb. minimum – 20 lb. maximum	✓ ✓	✓ ✓	low med med	med med med	med med med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges • use a cushion to eliminate exposure to pressure point • provide seating with rounded front edge of seat	✓	✓	low med	med med	med med
21. Awkward leg postures	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
22. Standing foot pedal	• Rarely occurs	N/A					
23. Difficult to see/light levels too low/too high	• Light levels are too low during task	22. Increase light levels • provide a flood light with adjustable intensity	✓	✓	high	high	high
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Cleaning by hand (detail work)	
TASK TITLE: Cleaning by hand (detail work)	
Task Description:	There are many different types of cleaning by hand (detail work). Cleaning by hand involves the use of precise hand tools (e.g., picks, small files) to remove bits and pieces of foreign objects. Task duration is dependent on the complexity. Typical jobs in which cleaning by hand (detail work) is performed include: • dental work • cleaning of technical equipment (building masks, microscopes). Cleaning by hand (detail work) may be performed on flat, angled, and upright surfaces, directly on equipment or in confined spaces.
Job Performance Measures Most Often Impacted by Cleaning by Hand (Detail Work):	• Quality of the cleaning (e.g., material removed completely) • Speed of completion of cleaning task
Typical Employee Comments about Cleaning by Hand (detail work):	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists.
Suggested Level II Analysis:	Grip Force Measurement, 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					
		• provide a height adjustable chair		✓	med	med	med
		• stand up to perform work task	✓		low	low	low
		• use a step stool, platform or ladder	✓	✓	med	med	med
		32. Lower the work piece/work surface		✓	high	med	med
		• provide adjustable table					
		117. Provide support for the upper body					
		• rest arms on nearby surfaces	✓		low	med	med
		• provide height adjustable armrests		✓	med	med	med
	• 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
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• tilt patient's head towards dental assistant	✓		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	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

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 low for prolonged periods causes stress on the neck	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table		✓	high	med	med
		• adjust dental chair head support to position patient's head higher	✓		low	med	med
		20. Incorporate rest pauses	✓		low	med	med
		13. Encourage ergonomic work techniques					
		• encourage employee to look up frequently.	✓		low	med	med
	• Work location is positioned flat on work surface (see Figure 1.1)	136. Rotate the work piece					
		• provide a fixture to angle work piece		✓	med	med	med
		• adjust dental chair head support to position patient's head higher	✓		low	med	med
		• ask patient to tilt his/her head towards dental assistant	✓		low	med	med

Figure 1.1

Hand/Wrist/Arm

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	• Using straight cleaning tool on flat horizontal surface	77. Provide a tool with an appropriate handle angle • angle handle of tool		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		42. Obtain patient's assistance	✓		low	med	med
	• Work location is too high	123. Raise the person	✓		low	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
		79. Provide a work surface which is adjustable in height • adjustable table		✓	high	med	med
		28. Lower the (patient's) chair	✓		low	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Task requires repeated motions	66. Provide a power tool		✓	med	med	med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Duration of holding the tool concentrates stress in the hands • Handle diameter is too small (see Figure 1.2) Figure 1.2	20. Incorporate rest pauses 66. Provide a power tool • to reduce duration 88. Provide an appropriate handle diameter • provide cleaning tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)	✓	 ✓ ✓	low med med	med med med	med med to high med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle grip is not compressible	54. Provide a high friction gripping surface • wrap tool with compressible grip • provide tool with a compressible handle (Caution: provide compressible grips which can be sterilized)	✓	✓	low med	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Design or poor condition of tool emits high levels of vibration	34. Maintain hand tool/power tool • inspect and repair tool on a regular basis to eliminate unnecessary vibration 74. Provide a tool that minimizes exposure to vibration/ impact/torque • provide a tool that emits less vibration	✓	✓	low to 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
10. Exposure to hard edges	• Work station has hard or square edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓ ✓		low low	med med	med med
11. Hands and fingers exposed to cold temperatures	• Frequent washing of hands in cold water may be an exposure source	13. Encourage ergonomic work techniques • wash hands in warm water 93. Provide appropriate gloves	✓ ✓		low low	med low	med low
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for the work piece • raise the dental chair higher	✓	✓ ✓	med high low	med 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
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med 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/work surface • provide a fixed table to support work piece • provide an adjustable table for the work piece • raise the dental chair higher	✓	✓ ✓	med high low	med med med	med med med
	• Work location is too far away	41. Move work piece closer to body	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually • provide a fixture to allow the work piece to be rotated • angle the patient's head towards the dental assistant	✓ ✓	✓	low med low	med med med	med med med
		117. Provide support for the upper body		✓	med to high	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	115. Provide support for the lower back					
		• adjust back rest to support the lower back	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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	96. Provide appropriate shoe inserts	✓		low	med	med
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		52. Provide a footrail or footrest	✓	✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square (see Figure 1.3) Figure 1.3	87. Provide an appropriate chair/stool • use a cushion to eliminate exposure to pressure point	✓		low	med	med
		• provide seating with rounded front edge of seat		✓	med	med	med
	• Under surface of work is square	9. Eliminate exposure to hard edges • use padding to cover square edge	✓		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
	• Leg room is limited under work surface (see Figure 1.4) Figure 1.4	138. Stand to perform task	✓		low	med	med
		79. Provide a work surface which is adjustable in height • provide work surface with adequate vertical and forward leg room	✓	✓	low to high	med	med
	• Feet are unsupported when seated. (see Figure 1.5) Figure 1.5	52. Provide a footrail or footrest	✓	✓	med	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	31. Lower the person • provide a chair/stool to sit on	✓	✓	med	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Cleaning - High Pressure	
TASK TITLE: Cleaning - High Pressure	
Task Description:	Washing an aircraft involves applying an aqueous, somewhat slippery, wash solution to the body of the aircraft, scrubbing the aircraft, washing the solution off, and repeating. Power wash equipment is available and is used for much of the operation. However, parts of the cleaning operation require manual labor such as setting up or adjusting the cleaning equipment; donning the personal protective equipment; and, hauling much of the equipment (high pressure nozzles, scrub brushes, squeegees, fluid containers, etc.). Typical jobs in which Cleaning with high pressure equipment is performed include: • air craft cleaning • cleaning large and small industrial equipment • cleaning the outside of facilities. This case study can be applied to washing done on horizontal, vertical, or overhead surfaces on aircraft, and heavy industrial equipment.
Job Performance Measures Most Often Impacted by Cleaning - High Pressure:	• Quality of the washing job • Speed of completion of the washing task
Typical Employee Comments about Cleaning - High Pressure:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck, hands /wrists/arms, and legs/feet. Primary: All body parts listed above are primary concerns.
Suggested Level II Analysis:	NIOSH lifting equation (for lifting demand of the job), Dynamic Task Analysis; Grip Force Measurement.

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 • provide an adjustable platform or scaffolding		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		136. Rotate the work piece • use rotating adjustable platform to house and position industrial parts for cleaning		✓	high	high	high
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Pull hoses – Poor housekeeping – Poor floor condition	17. Improve floor condition • repair cracks or gaps in floor • improve housekeeping	✓	✓	high low	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
	• High pressure sprayer must be manually supported, held or steadied (see Figure 1.1) **Figure 1.1**	20. Incorporate rest pauses 116. Provide fixture • attach/pivot spray gun on a tripod	✓	 ✓	low med	med med	med high
3. High speed movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low or too high	13. Encourage ergonomic work techniques • incorporate rest pauses	✓		low	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	• Work location is too high • Lack of support for tool means employee must bend wrist to direct spray • Handle shaped trigger requires wrist to bend to direct spray	123. Raise the person • use an adjustable platform or scaffolding 116. Provide fixture • support/pivot spray gun on tripod 77. Provide a tool with an appropriate handle angle • modify tool handle		✓ ✓ ✓	high med med	med med med	high high med
6. Repeated manipulations with fingers	• Tightening bolts or screws with a wrench or with the fingers can cause repetitive finger movements	66. Provide a power tool • use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and final check).		✓	med	med	med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of tool with single finger trigger concentrates stress (see Figure 1.2) Figure 1.2	62. Provide a multi-finger trigger • extend current trigger • provide a tool with a multi-finger trigger		✓ ✓	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	• High pressure sprayer handle must be manually supported, held or steadied	54. Provide a high friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		116. Provide support for the tool • support/pivot spray gun on tripod		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a sprayer of minimal weight		✓	high	high	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
	• Trigger required constant holding	62. Provide multi-Finger trigger • incorporate latch mechanism into trigger design (must comply with safety requirements)		✓	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
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Tool emits high levels of vibration	34. Maintain hand tools/power tools • inspect and repair tool on a regular basis to eliminate unnecessary vibration • wrap handles with vibration dampening grips	✓ ✓		low low	med med	med med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a smooth handle with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length • wrap handles with padding	✓	✓ ✓	med med low	med med med	med med med
11. Hand and fingers exposed to cold temperatures	• Work area is too cold	110. Provide shields or barriers from the wind 93. Provide appropriate gloves 12. Encourage appropriate seasonal clothing	✓ ✓	✓	med low low	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	31. Lower the person • provide a mobile chair or stool to sit on (e.g. under wing areas) • kneel or squat for short durations when working at low levels (provide adequate knee protection)	✓ ✓	✓	med low	med med	med med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions from the work area 136. Rotate the work piece • provide a rotating platform that locks into position to allow small pieces to be rotated.	✓	✓	low high	med high	med high
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back positions	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
16. Lifting forces	• Refer to Lifting case study						
17. Pushing or pulling	• Initial setup requires movement of heavy equipment	48. Provide a cart • provide a powered cart to carry and move the equipment		✓	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 (see Figure 1.3) Figure 1.3	96. Provide appropriate shoe inserts	✓		med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work location is too low	31. Lower the person • provide a chair or stool to sit on	✓	✓	med	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 adjustable intensity flood light • increase room lighting		✓ ✓	med high	high high	high high
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Coating/Immersing	
TASK TITLE: Coating/Immersing	
Task Description:	Coating/Immersing involves dipping parts into dip tanks to apply a coating. Part weight and size can vary considerably. The task is typically performed in a standing position. Since the liquid in the dip tanks may be caustic, hangar/fixtures are used to immerse the parts. Small parts may be secured to hangars using small clips. Large parts may simply be hung on a hook. Coating/immersing is performed in (not necessarily limited to): • general maintenance areas. In this case study, the assumed situation is that the operator is required to hold the hangar and move the parts in and out of the dip tanks. In Air Force applications, this job is expected to be low volume.
Job Performance Measures Most Often Impacted by Coating/Immersing:	• Quality of surface finish. • Quality of work.
Typical Employee Comments about Coating/Immersing:	The most common complaint from employees is discomfort and/or stiffness in the hands/wrists/arms and shoulders/neck.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Biomechanical Lifting Analysis

Shoulders/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Loading height is too high • Sides of dip tanks are too high	123. Raise the person • provide a fixed platform to elevate worker for all dip tanks		✓	high	med	high
		32. Lower the work surface • lower the height of the dip tanks (should be no higher than 30" (76cm) above the floor.		✓	high	med	high
	• Raising and lowering of hangers	61. Provide a mechanical lift device • provide an overhead manual pulley system above tanks to raise and lower hangars		✓	med	med	med
	• Absence of tow space	80. Provide adequate leg clearance • provide toe space of 6" X 6" (15 cm X 15 cm)		✓	high	med	high
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Repeated manual dipping of large parts	61. Provide a mechanical lift device for dipping large components • provide an overhead hoist with a basket attachment for dipping parts		✓	high	med	med
		• provide an overhead manual pulley system.		✓	med	med	med

Shoulders/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrist/Arm

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	• Design of the dipping tool causes wrist movements while dipping parts	77. Provide a tool with an appropriate handle angle • provide a dipping tool which allows the person to keep the wrist straight while dipping		✓	med	med	med
	• Design clamps on hanger may require wrist movements to tighten	140. Use alternative fasteners • use lockable clamps; avoid the use of pressure or screw-down clamps		✓	high	med	high
6. Repeated manipulations with fingers	• Tasks are hand-intensive	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety • alternate dipping big parts with small parts	✓		low	med	med
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Person is holding hanger or part	118. Provide support for the work piece • provide an overhead stationary hook to hanger part above tank as it drains	✓	✓	med	med	med
	• Inappropriate design of clamps for small parts	140. Use alternative fasteners		✓	high	med	high
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is cold	93. Provide appropriate gloves (must be safe for use in area with liquid/caustic materials)		✓	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	• Loading height is too high • Sides of dip tanks are too high	123. Raise the person • provide a fixed platform to elevate worker for all dip tanks 32. Lower the work surface • lower the height of the dip tanks (should be no higher than 30" (76 cm) above the floor).		✓ ✓	high high	med med	high high
13. Twisting of the lower back	• Raising and lowering of hangers • Absence of toe space	61. Provide a mechanical lift device • provide an overhead manual pulley system above tanks to raise and lower hangers 80. Provide adequate leg clearance • provide toe space of 6" x 6" (15 cm x 15 cm)		✓ ✓	med high	med med	med high
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Manual holding of parts/hanger above dip tank while fluid drains	118. Provide support for the work piece. • provide an overhead stationary hook to hang part above dip tank.	✓	✓	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
16. Lifting forces	• Repeated manual dipping of large parts	61. Provide a mechanical lift device • provide an overhead hoist with a basket attachment for dipping parts • provide an overhead manual-pulley-system to raise and lower hangars		✓ ✓	med med	med med	med med
17. Pushing or pulling	• Rarely occurs	N/A					
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	96. Provide appropriate shoe inserts 143. Wear appropriate shoes	✓ ✓		low low	low low	low low
20. Exposure to hard edges on legs, knees, and feet	• Knees press against front of dip tank (see Figure 1.1) **Figure 1.1**	9. Eliminate exposure to hard edges • cover surface with rubber	✓		low	low	low
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Computer Work	
TASK TITLE: Computer Work	
Task Description	Computer work involves the use of a computer to perform a variety of tasks related to maintenance and inspection activities. Computer work typically involves the use of a keyboard and, sometimes, an additional input device (e.g. a mouse or trackball). Typical jobs in which computer work is performed include (not necessarily limited to): • computerized record keeping • tracking of preventative maintenance inspections (PMIs) • ordering parts • writing reports and memos Computer work may be performed at a seated or standing work station or (via a laptop or a palmtop computer) in a variety of locations. In the maintenance inspection environment the issues or ergonomic concerns associated with computer work are generally less significant than for administrative areas since the duration of the task is lower. The key issues are discussed here for additional detail the user is directed to the computer work case study contained in the Level I Guide for Administrative Work Areas
Job Performance Measures Most Often Impacted by Using a Computer:	• Speed of completion of tasks. • Error free completion of tasks.
Typical Employee Comments about Using a Computer:	For computer work, employees typically complain about discomfort and/or stiffness in the hands/wrists, arms, shoulders/neck, and head/eyes. The primary body regions affected are: head/eyes, hands/wrists/arms, and shoulder/neck. The secondary body regions affected are: back/torso and legs/feet.
Suggested Level II Analysis:	Postural analysis, light level analysis.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Keyboard/mouse too high. (see Figure 1.1) **Figure 1.1**	32. Lower the work surface • set the height of the keyboard/mouse support surface so that the person's elbows are at the same height as the keyboard	✓		low	low	med
		• position the mouse at the same height as the keyboard	✓		low	med	med
		123. Raise the person	✓		low	low	med
		120. Raise the chair • set the height of the chair so that the person's elbows are at the same height as the keyboard or mouse Note: in some cases, a footrest will be required in order to support the person's feet	✓		low	low	med
	• Chair positioned too far away	38. Move closer to the work location • move chair closer to keyboard/ edge of work surface	✓		low	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Lack of leg clearance under desk.	80. Provide adequate leg clearance • remove clutter from under work surface. • remove cross beams if possible to increase clearance	✓	✓	low med	low low	low low
	• Arms of chair or other obstructions interfere with moving chair closer (see Figure 1.2) **Figure 1.2**	132. Remove obstructions • remove or adjust armrests, pencil drawers or other obstructions if they prevent the person from moving close enough to the work station	✓		low	med	med
	• Mouse/input device is too far away from the body • Mouse not positioned next to keyboard.	44. Place the mouse/input device next to the keyboard • position mouse next to keyboard • position mouse and keyboard so the forearm can be rested on the work surface while keying and mousing	✓ ✓		low low	low 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
	• Keyboard tray is too small	44. Place the mouse/input device next to the keyboard			med to high	med	med
		• Replace the current keyboard tray with a tray which accommodates a mouse/input device and a keyboard		✓			
		• add an attachment or extension to the side of the current tray	✓		low	med	med
	• Items used frequently not positioned close to the body.	41. Move work piece closer to body					
		• Items which are used every few minutes or more should be placed close to the body	✓		low	low	med
	• Employee is not conscious of poor work habits.	13. Encourage ergonomic work techniques	✓		low	low	med
		• encourage person to minimize reaching by arranging materials and documents according to frequency of use	✓		low	low	med
		• help person understand how to adjust the chair properly	✓		low	low	med
		• encourage person to take frequent rest pauses	✓		low	low	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	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Cradling of phone between the head and shoulder	73. Provide a telephone headset		✓	med to high	med	high
		• provide a selection of head set types to choose from (e.g., over-the-head, over-the-ear) for employees who must key and talk on the phone for prolonged periods	✓		low	med	med
		• encourage employee to hold the phone with their hand	✓		low	med	med
		• discourage employee from talking on the phone while keying					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Document positioned flat on work surface	111.Provide support for reference documents					
		• provide a document holder		✓	med	low	med
		• position document at the same height and angle as the monitor.	✓		low	low	med
		• if document is handled, flipped or written on, an inclined work surface is preferred.	✓		low	low	med
		• place document on side of dominant eye.	✓		low	low	med
	• Monitor positioned too low	122. Raise the monitor/screen - monitor should be positioned such that the top of the screen is between 0-4" (0-10 cm) below eye height:	✓		low	med	med
		• use a monitor riser, CPU/hard drive, or other stable surface to position monitor at the correct height					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Monitor positioned too high (head tipped backwards) (see Figure 1.3) **Figure 1.3** • Monitor and keyboard not aligned due to inadequate work station depth	30. Lower the monitor/screen • monitor should be positioned such that the top of the screen is between 0-4" (0-10 cm) below eye height:	✓		low	med	med
		• remove the hard drive from under the monitor	✓		low	med	med
		• use a monitor riser, or other stable surface to position monitor at the correct height	✓		low	med	med
		45. Position the monitor/screen in front of the body • position monitor so that it is directly behind the keyboard - this allows the body to be in alignment and prevents twisting of the neck	✓		low	med	med
		• provide a work surface that is deep enough to support the keyboard and the monitor screen. For large monitors, this indicates a work surface which is at least 30" (76.2 cm) deep.		✓	med	med	med
		• provide a work surface that is large enough for computer and paper tasks.		✓	med to high	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Monitor is too high for bifocal user.	100. Provide computer glasses • provide monofocal computer glasses		✓	med	med	med
		30. Lower the monitor/screen for bifocal users, place monitor directly on the work surface so that the head is upright not tilted back	✓		low	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	• Keyboard/mouse too high.	32. Lower the work piece/work surface • if the work surface/keyboard tray is adjustable in height, lower/set the height of the keyboard/mouse support surface so that the person's elbows are at the same height as the keyboard/mouse	✓		low	low	med
		120. Raise the chair • set the height of the chair so that the person's elbows are at the same height as the keyboard or mouse Note: in some cases, a footrest will be required in order to support the person's feet	✓		low	low	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Keyboard is sloped towards the person	49. Provide a flat/level keyboard (note: "flattening" the keyboard can help flatten the wrist)					
		• lower the feet on the back of the keyboard	✓		low	low	med
		• adjust the keyboard support surface so the keyboard is flat and level	✓		low	low	med
	• Resting wrists inappropriately on front edge of keyboard or on wrist rest	13. Encourage ergonomic work techniques					
		• maintain straight wrists while keying and while resting the hands	✓		low	low	med
		• rest hands on arm rests of work surface in between data entry tasks	✓		low	low	med
		65. Provide a palm rest	✓		low	low	low
		• palm rests provide a place to rest hands in between sets of key strokes. Encourage the person to avoid resting the hands on the palm rest while keying					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Using wrist movement to move mouse rather than arm movement	13. Encourage ergonomic work techniques • encourage person to use a forearm movement to move the mouse rather than a wrist movement	✓		low	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Keying or mousing habits (e.g., repetitive stretching of thumb to use space bar)	13. Encourage ergonomic work techniques • encourage person to practice keeping the hands and fingers in a relaxed position	✓		low	med	med
		• keep the wrists straight and flat	✓		low	med	med
		• keep the fingers together and slight curved	✓		low	med	med
		• use the forearms to move around on the keyboard instead of "reaching" with fingers	✓		low	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	• Keying/typing speed and length of task.	11. Eliminate unnecessary tasks • program macro keys to reduce keying.	✓		low	low	med
	• Length of task without a work break.	28. Incorporate rest pauses	✓		low	med	med
		33. Increase task variety	✓		low	med	high
	• Person has tendency to grasp mouse too hard	13. Encourage ergonomic work techniques • encourage person to practice keeping a light grip on the mouse	✓		low	med	med
	• Keys feel stiff; require excessive force to activate • Keys lack appropriate tactile and auditory feedback ("click").	56. Provide a keyboard which does not require excessive keying forces • maintain or replace keyboard		✓	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
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Individual rests wrists on edge of work surface.	9. Eliminate exposure to hard edges • move keyboard forward so forearms rest evenly on surface • for keyboard use, provide a palm rest • eliminate the hard edge by replacing the hard edge with a "bull-nose"/rounded edge	✓ ✓ ✓		low low low to med	med med med	med med med
	• Not enough room on work surface to support forearm for mousing.	24. Increase size of work surface • install keyboard tray that accommodates mouse, keyboard		✓	med	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 23. Increase room temperature		✓ ✓	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	• Reaching for items too far from body.	41. Move work piece closer to body • move documents and other reference materials into work zone.	✓		low	med	med
	• Chair arms interfere with moving chair closer.	132. Remove obstructions • remove or lower armrests.	✓		low to med	med	med
13. Twisting of the lower back	• Leg obstructions • Restricted leg clearance	80. Provide adequate leg clearance • eliminate leg obstructions	✓		low	med	med
	• Monitor and keyboard not aligned • Monitor in the corner of desk • Inadequate work station depth • Inadequate work space	45. Position the monitor/screen in front of body • position monitor so that it is directly behind the keyboard this allows the body to be in alignment and prevents twisting of the neck	✓		low	med	med
		• provide a work surface which is deep enough for a monitor and a keyboard. (at least 30" (76.2 cm) in depth is preferred, 36" (91.5 cm) for larger monitors)		✓	low to high	med	high
		If paper and computer tasks are performed at the same work station, provide a work surface which is large enough for both tasks		✓	low to high	med	high

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	• Rarely occurs	• N/A					
15. Static, awkward back postures	• Monitor greater than 30" (76 cm) from eye causes the person to lean forward to read monitor	41. Move work piece closer to body • position monitor between 18 and 30" (46-76 cm) from eyes 22"-24" (56-61 cm) is a good distance for many people 18. Improve visual access to work • increase font size of text - font size of at least 12 point is recommended for screen distances of 18"-30" (46-76 cm). - font sizes of greater than 12 point are recommended for screen distances of greater than 30" (76 cm)	✓ ✓		low low	med low	med low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • 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 a chair with adequate lower back support	✓ ✓ ✓	✓	low low low high	med med med med	med med med med
	• Keyboard is too low • Mouse/input device is too low • Documents are too low • Chair too high	124. Raise the work piece/work surface • raise the fixed table with risers • provide an adjustable table 31. Lower the person • provide a chair/stool to sit on 28. Lower the chair • adjust the chair height lower to reduce the need to lean forward	✓ ✓ ✓	✓	low high low to med low	med med med med	med high med med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Person tends to lean forward while working	13. Encourage ergonomic work techniques					
		• Encourage person to sit back and relax while working	✓		low	med	med
		• Encourage person to push his or her chair toward the work station in order to reduce the tendency to bend	✓		low	med	med
	• Keyboard or paperwork is too far away	38. Move closer to the work location					
		• pull the chair closer to the work station	✓		low	med	med
		• stand closer to the work station	✓		low	med	med
		41. Move the work piece closer to the body					
		• move the keyboard closer to the body	✓		low	med	med
	• Seat pan on chair is too deep	115. Provide support for the lower back					
		• attach a pillow to back rest to decrease the seat pan depth and support the lower back	✓		low	med	med
		• provide a chair with an adequate/adjustable seat pan depth and adequate lower back support		✓	high	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Inadequate foot support prevents person from obtaining proper back support • Chair too high causes person not lean against back rest	52. Provide a footrail/footrest • provide a footrest which allows both the heels and toes to be supported - a box or several ring binders taped securely together can also be used (for additional information on footrest design refer to Level I Guide for Administrative Work Areas	✓		low	low	low
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 on hard surfaces	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts • inserts should be made of a high performance material such as a gel filled or viscous-damping media that is durable (open-cell foam inserts tend to break-down quickly and lose ability to distribute forces)	✓		low	low	low
	• Inadequate foot support	52. Provide a footrail/footrest • provide a footrail which allows the person to rest one foot at a time		✓	low	low	low
	• Seat pan which is too deep causes pressure on back of legs	115. Provide support for the lower back • attach a pillow to back rest to decrease the seat pan depth and support the lower back	✓		low	med	med
		provide a chair with an adequate/adjustable seat pan depth and adequate lower back support		✓	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
20. Exposure to hard edges on legs, knees, and feet	• Hard edge on front of seat pan	64. Provide a compressible, padded surface to sit on • provide a cushion for the seat pan to prevent contact with hard edge	✓		low	med	med
		• provide a chair with a rounded front edge on the seat pan		✓	high	med	med
	• Seat pan which is too deep causes pressure on back of legs	115. Provide support for the lower back • attach a pillow to back rest to decrease the seat pan depth and support the lower back	✓		low	med	med
		• provide a chair with an adequate/adjustable seat pan depth and adequate lower back support		✓	high	med	med
21. Awkward leg postures	• Inadequate foot support causes legs to be tucked back or causes person to cross legs	52. Provide a footrail/footrest - provide a footrest which allows both the heels and toes to be supported - a box or several ring binders taped securely together can also be used	✓		low	low	low
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off monitor or other shiny surfaces.	109. Provide protection from glare from overhead lights/task lights • provide screen hood/visor.	✓		low	med	med
		• position monitor between rows of overhead lights.	✓		low	med	med
		• tilt monitor down so that it is parallel to the floor.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off monitor or other shiny surfaces.	109. Provide protection from glare from overhead lights/task lights • direct task light away from screen and eyes.	✓		low	med	med
		• turn off the task light	✓		low	med	med
		• move monitor screen out from underneath fixed task lights	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off monitor or other shiny surfaces.	108. Provide protection from glare from natural light • orient work station so that the monitor screen is perpendicular to the window. • adjust window coverings • provide window coverings	✓ ✓	✓	low low med to high	med med med	med med med
	Light levels too high: in particular, for computer tasks (for more detail on the impact of lighting, refer to Level I Guide for Administrative Work Areas)	27. Lower the light levels • 20-50 fc (200-500 lux) is an appropriate range of light levels for computer tasks. • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels are too low: in particular, for reading tasks	22. Increase light levels • provide task light (50-100 fc is an appropriate range of light levels for reading tasks) • increase overall light levels to meet the lighting needs of computer and paper tasks (50 fc is an appropriate light level where both computer and paper tasks are performed)		✓ ✓	med med	med med	med med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Uncorrected visual disorders cause the person to lean forward to read monitor or documents	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Font/character size too small to read on computer screen.	18. Improve visual access to work • increase font size of text font size of at least 12 point are recommended for screen distances of 18"-30" (46-76 cm). font sizes of greater than 12 point are recommended for screen distances of greater than 30" (76 cm)	✓		low	med	med
	• VDT screen dirty.	18. Improve visual access to work • clean screen regularly.	✓		low	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Crimping	
TASK TITLE: Crimping	
Task Description:	Crimping involves using a manual or power tool to compress two pieces of metal or wire together with a metal band/strap or compress an aluminum connector onto the end of a piece of wire. The manual crimper often resembles a pair of pliers and is commonly used in field applications or on aircraft (fixed work locations). The power crimper is often powered by hydraulic or electrical methods. Typical jobs in which crimping is performed include (not necessarily limited to): • aircraft maintenance • utilities maintenance/installation • electronics maintenance
Job Performance Measures Most Often Impacted by Crimping:	• Quality of crimp (strength) • Speed of task completion
Typical Employee Comments about Crimping:	Employees typically complain about discomfort or stiffness in the following areas: hands/wrists/arms and shoulders/neck. The primary body parts affected are typically: hands/wrists/arms The secondary body parts affected are typically: shoulders/neck
Suggested Level II Analysis:	Grip Force Measurement, 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					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is too far away (see Figure 1.1)	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
	Figure 1.1	41. Move work piece closer to body	✓		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	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work surface is too high or too low (see Figure 1.2) **Figure 1.2**	123. Raise the person • provide a step stool • provide an adjustable platform 32. Lower the work piece/work surface 136. Rotate the work piece • turn the work piece so the wrist can be straight while using crimper	 ✓ ✓ ✓	 ✓ ✓ ✓	 med med med low	 med med med med	 med med med med

Hands/Wrist/Arm

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	• Work location is too high (see Figure 1.3) **Figure 1.3** • Work orientation is awkward	66. Provide a power tool 123. Raise the person • provide a step stool • provide an adjustable platform 32. Lower the work piece/work surface 136. Rotate the work piece • manually turn the work piece so the wrist can be straight while using crimper	 ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓ 	med med med med low	med med med med med	med med med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of tool with single trigger concentrates stress • Handle span is too large on manual tool • The pliers type tool does not have a spring between the shafts of the handle	62. Provide a multi-finger trigger • extend current trigger 77. Provide a tool with an appropriate handle angle • achieve a smaller span 70. Provide a spring release mechanism on pliers-type tools		✓ ✓ ✓	low to med med low to med	med med med	med med med

Hands/Wrist/Arm-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture to support work piece		✓	med	med	med
		76. Provide a tool which requires minimal force to use • provide a manual tool that crimps with a ratchet mechanism		✓	med	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque		✓	med	med	med
	• Handle span is too large	88. Provide an appropriate handle diameter • provide a tool handle with a compressible grip surface		✓	med	med	med
		• provide a tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8cm).		✓	med	med	med
	• The type of tool is not appropriate for the amount of crimping (frequency or effort) that must be performed	66. Provide a power tool		✓	med	med	med

Hands/Wrist/Arm-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• The work piece must be moved and turned	118. Provide support for the work piece • provide a fixture to allow the work piece to be rotated • use clamps to hold surrounding wires away from the wire/area where crimping must occur	 ✓	✓	med low	med med	high high
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges (see Figure 1.4) **Figure 1.4**	94. Provide appropriate handles • provide a tool with a round, smooth handle with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length		✓ ✓	med med	med med	med med

Hands/Wrist/Arm-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	 ✓ ✓		 low low	 med med	 med med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓ 	med low	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 surface is too high/too low (see Figure 1.5) **Figure 1.5**	123. Raise the person • provide a step stool • provide an adjustable platform 32. Lower the work piece/work surface • extend wire length, if appropriate to lower the work (crimp) height; raise completed bundle when finished	✓	✓ ✓ ✓	med med med	med med med	med med med
	• Finish quality must be visually inspected	22. Increase light levels • provide task lighting that is easy to adjust • ensure that light levels are 200-250 lux (20-25 foot-candles)		✓ ✓	med med	med high	med high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Work space is cramped or access is limited (see Figure 1.6) **Figure 1.6**	117. Provide support for the upper body • provide a pad/mat • provide a device to support the upper part of the body 38. Move closer to the work location • remove panel or sheet metal to provide additional access	✓	✓ ✓	low med to high med	med med high	med high low
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Chair is inadequate	87. Provide an appropriate chair/stool	✓	✓	med	med	med
	• Work surface is too low (see Figure 1.7) **Figure 1.7**	124. Raise the work piece/work surface	✓	✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest	✓	✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard or sharp edges (see Figure 1.8) **Figure 1.8**	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges		✓	med	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges					
21. Awkward leg postures	• Work surface is to low	124. Raise the work piece/ work surface	✓	✓	med	med	med
		31. Lower the person • provide a stool to sit on	✓	✓	med	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Cutting/Shearing	
TASK TITLE: Cutting/Shearing	
Task Description:	Cutting/shearing involves using hand shears, powered hand shears, manual or powered table-top cutting boards to cut materials. Hand cutting/shearing typically occurs at a work bench or table. Using the cutting board sometimes involves carrying and holding the material. Typical jobs in which cutting/shearing is performed include (not necessarily limited to): • sheet metal fabrication
Job Performance Measures Most Often Impacted by Cutting/Shearing:	• Efficient completion of work • Minimal errors/dimensional accuracy
Typical Employee Comments about Cutting/Shearing:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms (from operating a manual hand shear) and legs/feet (from using manual foot control to operate table top cutting board. Primary: Hands/Wrists/Arms Secondary: Legs/Feet
Suggested Level II Analysis:	Grip Force, Dynamic Task Analysis

Shoulders/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 far away from worker	21. Increase handle length to improve leverage • lengthen handle to increase leverage		✓	med	med	med
	• Work location is too high	32. Lower the work piece/work surface	✓	✓	med	med	high
	• Operation of the table-top cutter involves shoulder movements	123. Raise the person	✓	✓	med	med	high
		66. Provide a power tool • provide a powered cutter • use a cutting board instead of manual hand shear		✓ ✓	med med	med med	med high
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Manual shears require high forces	34. Maintain hand tools/power tools • sharpen shears or replace cutting surfaces regularly	✓		low	high	med
		• lubricate and adjust moving parts to reduce forces	✓		med	med	med
		21. Increase handle length to improve leverage • lengthen handle to increase leverage		✓	med	med	med
		66. Provide a power tool • provide a power cutter		✓	med	med	med

Shoulders/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrist/Arm

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	• Angle of handles on scissors	77. Provide a tool with an appropriate handle angle • provide shears with a handle orientation which allows a more straight wrist while cutting		✓	med	med	med
	• Using hand shears on horizontal surface	136. Rotate the work piece • angle the work piece (e.g., incline upward, drafting table style) to improve wrist posture	✓		low	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of powered hand shear with single finger trigger concentrates stress	62. Provide a multi-finger trigger • extended current trigger • provide an appropriate tool with a multi-finger trigger • provide an automatic cut repeat to eliminate constant hold down of trigger	✓	✓ ✓ ✓	med med med	med med med	med med med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Inappropriate use of manual tool for repetitive or forceful task	66. Provide a power tool • provide a powered cutter • use cutting board instead of manual and sheet		 ✓ ✓	 med med	 med med	 med high
	• Handle diameter is too large	88. Provide an appropriate handle diameter • handle diameter between 1-1.5" (2.5-3.8 cm) on power tool		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for power tool		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

Hands/Wrist/Arm (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	• Hard/sharp edges present on work station or work piece	9. Eliminate exposure to hard edges	✓		low	med	med
		• round off edges	✓		low	med	med
		• covering hard edges					
		93. Provide appropriate gloves		✓	med	med	med
	• Tool handle has sharp edges	9. Eliminate exposure to hard edges		✓	med	med	med
		• provide shear handles with round, smooth, compressible grips		✓	med	med	med
		• provide shear handle sizes with adequate space for fingers for persons with large hands	✓		low	med	med
		• wrap handles with padding					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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	• Rarely occurs	N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work surface too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece	✓	✓ ✓	med med	med high	med high
	• Location of work too low	31. Lower the person • provide a chair/stool to sit on	✓	✓	med	high	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• If occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat 96. Provide appropriate shoe inserts	 ✓	✓	med low	med low	med low
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Excessive stroke or travel of manual foot lever	50. Provide a foot pedal which requires the correct amount of force to use • provide electric or power foot pedal		✓	med	med	high
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Drilling	
TASK TITLE: Drilling	
Task Description:	The task is performed for varying amounts of time depending on the complexity of the task. The task can be performed on wood, metal, plastic, rock or other material. The size of the drill bit will vary with the size of hole or bolt required. The effort associated with the task is often a function of; bit type and condition, speed and power of the drill, material type and technique.
Job Performance Measures Most Often Impacted by Drilling:	There are many different types of drilling processes such as electric drill and drill press. Typical jobs in which drilling is performed include: • metal fabrication • carpentry • assembly and repair Drilling may be performed on flat or upright surface directly on aircraft, equipment, bench tops, and on a variety of surface shapes.
Job Performance Measures Most Often impacted by Drilling	• Quality of drilling (e.g., straightness of hole) • Speed of completion of drilling task
Typical Employee Comments about Drilling:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulder/neck, hands/wrists/arms, back/torso, legs/feet or head/eyes. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Grip Force Measurement, 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 an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Drill must be manually supported, held or steadied (see Figure 1.1)	117. Provide support for the upper body					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med
	Figure 1.1						
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		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
		103. Provide extensions for tools		✓	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
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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
		103. Provide extensions for tools		✓	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
	• Drilling is performed on flat work surface	136. Rotate work piece (bench work) • turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • provide a drill tool with an in line grip or 90° off-set grip		✓	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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Improper bit/material combination • Inadequate drill or speed • Poor technique	76. Provide a tool that requires minimal force to use • provide an alternative drill bit design		✓	med	med	high
		13. Encourage ergonomic work techniques • let the tool do the work	✓		low	med	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface (bench work) • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table		✓	med	med	med
		• raise platform of drill press	✓	✓	med	med	med
		31. Lower the person • provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		13. Encourage ergonomic work techniques • educate worker to look up frequently	✓		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
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder • provide an adjustable platform or scaffolding	✓	✓ ✓	med med	med med	med med
		32. Lower the work piece/work surface	✓	✓	low to 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	136. Rotate work piece (bench work) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓	✓	low med	low med	low 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 • increase the size of access ports to increase access		✓	high	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	• Using pistol grip drill on horizontal surface	136. Rotate work piece (bench work) • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		103. Provide extensions for tools		✓	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
	• Work location is blocked or is in an inappropriate orientation	82. Provide adequate workspace • increase the size of access ports to increase access		✓	high	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder • provide an adjustable platform or scaffolding	✓	✓ ✓	med med	med med	med med
		32. Lower the work piece/work surface	✓	✓	low to 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
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of drill with single finger trigger concentrates stress	62. Provide a multi-finger trigger • extend current trigger • provide a multi-finger trigger tool (e.g., enough surface for two fingers)	✓	✓ ✓	med high	low med	med med
8. Hand/grip forces	• Drill tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece		✓	high	med	med
		54. Provide a high friction gripping surface • wrap the tool handle with a compressible grip surface	✓		low	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 drill of minimal weight		✓	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 tool with handle diameter between 1"-1.5" (2.5-3.5 cm)		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Design or poor condition of tool may expose employee to high levels of vibration	34. Maintain hand tools/power tools • inspect and repair tool on a regular basis to eliminate unnecessary vibration.	✓		low	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a tool that emits less vibration		✓	med	med	med
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

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		low	med	med
		• round off exposed edges					
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	high	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves	✓		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	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	med	med	med
		• raise platform of drill press	✓	✓	low	med	med
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• turn the work piece manually	✓		low	med	low
		• provide a fixture to allow the work piece to be rotated		✓	med	med	low
	• Work space or access is limited	117. Provide support for the upper body					
		• provide a pad/mat	✓		low	med	med
		• provide a device to support the upper body while welding (see illustration)		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		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 • 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

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location	✓		low	low	low
		32. Remove obstructions	✓		low	low	low
		41. Move work piece closer to body	✓		low	low	low
		136. Rotate the work piece					
		• rotate the work piece manually			low	med	low
		• provide a fixture to allow the work piece to be rotated	✓ ✓		med	med	low
		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
		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

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 (see Figure 1.2) **Figure 1.2**	115. Provide support for the lower back • pull chair forward and lean back while working • adjust back rest to support lower back • attach a small pillow to back rest to support lower back • provide chair with lower back support	✓ ✓ ✓	✓	low low low med	low low med med	low low med med
16. Lifting forces	• Initial setup may require the placement of the part on the workbench.	61. Provide a mechanical lift device • provide a hoist to place the unit on the workbench		✓	high	med	med
17. Pushing or pulling	• Initial setup requires movement of heavy equipment	48. Provide a cart • provide a powered cart to carry and move the equipment		✓	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 (see Figure 1.3) **Figure 1.3**	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	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges • use a cushion eliminate exposure to pressure point	✓		low	med	med
		• provide chair with rounded front edge of seat		✓	med	med	med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
		• round off exposed 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
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	high	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface (bench work)					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	med	med	med
		31. Lower the person					
		• provide a chair/stool to sit 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 for task	22. Increase light levels • provide a task light which is easy to adjust • increase room lighting		✓ ✓	med high	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Driving	
TASK TITLE: Driving	
Task Description:	Driving may be involved when operating commercial vehicles (automobiles, trucks, and vans), industrial equipment (paving equipment, backhoes, riding lawnmowers and graders) and recreational vehicles (snowmobiles and quads). Typical jobs in which driving is performed include (not necessarily limited to): • road maintenance and repair • lawn maintenance • trenching • base surveillance
Job Performance Measures Most Often Impacted by Driving:	No formal process has been established to measure quality driving performance.
Typical Employee Comments about Driving:	Employees typically complain about discomfort and/or stiffness in the back and legs/feet.
Suggested Level II Analysis:	Postural Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Controls levers within cab too far away	38. Move closer to the work location • move seat forward • add backrest pad if seat cannot be moved forward	 ✓ ✓		 low low	 low med	 low med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Pulling levers is difficult due to poor control lever maintenance • Pulling levers is difficult due to poor control lever design	101. Provide controls which do not require excessive forces • contact supplier to investigate adjustable levers and smoother traveling levers		✓	high	med	med
	• Turning steering wheel is difficult due to steering wheel design if not power steering wheel (see Figure 1.1) **Figure 1.1**	106. Provide powered assistance for a manual activity • steering wheel contact supplier to investigate power steering		✓	high	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location positioned behind operator when in backhoe, grader or forklift	20. Incorporate rest pauses 84. Provide an adjustable mirror	✓ ✓		low low	med med	med med

Hand/Wrist/Arm

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	• Control lever location too high (back hoe, grader or forklift)	123. Raise the person • adjust seat higher, if possible • provide seat cushion	✓ ✓		low low	low low	low low
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Control levers or steering wheel emit excessive vibration.	101. Provide controls which do not require excessive forces • Maintain equipment • provide levers or steering wheel that have vibration dampening materials	✓	✓	low high	low low	low low

Hand/Wrist/Arm (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	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	23. Increase room temperature • turn on heaters in vehicle 93. Provide appropriate gloves	 ✓ ✓		 low low	 low low	 med low

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change	Cost	Quality	Productivity
12. Repeated forward or sideways bending movements	• Lever positioned too far away	38. Move closer to the work location • move seat forward • insert additional back support such as a commercial back rest or cushion	 ✓ ✓		 low low	 low med	 low med
	• Leaning forward in seat (back hoe) (see Figure 1.2) **Figure 1.2**	115. Provide support for the lower back • ensure person sits back in seat to utilize back support • adjust back support forward • insert additional back support such as a commercial back rest or cushion.	 ✓ ✓ ✓		 low low low	 med med med	 med med med
13. Twisting of the lower back	• Work positioned behind worker when in cab	84. Provide an adjustable mirror • allow individual to see behind vehicle	✓		med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change	Cost	Quality	Productivity
15. Static, awkward back postures	• Leaning forward in chair	115. Provide support for the lower back					
		• ensure person sits back in seat to utilize back support	✓		low	low	med
		• adjust back support forward	✓	✓	low	low	med
		• insert additional back support such as a commercial back rest or cushion.			med	low	med
		• provide an appropriate chair		✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Poor design and maintenance of seat and mounting may increases vibration exposure	87. Provide an appropriate chair/stool					
		• seating should incorporate vibration absorption qualities in base support of the seat either air or mechanical	✓		med	med	med
		• maintain equipment	✓		med	low	low

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Hard edge of seat digs into under surface of thigh	64. Provide a padded, compressible surface to sit on • cut padding and recover seat pan to allow for a waterfall or downward curved edge • provide appropriate seating		✓ ✓	med med	low low	med med
21. Awkward leg postures	• Foot pedals are positioned too far away	38. Move closer to the work location • move seat forward • attach blocks/extensions securely to foot pedals	✓ ✓		low low	low low	low low
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Excavating/Shoveling	
TASK TITLE: Excavating/Shoveling	
Task Description:	Excavating involves the use of a shovel. The shovel may be stored on a vehicle or within the vehicle. The task performed for varying amounts of time depending on the complexity of the shoveling task. Typical jobs in which shoveling is performed include (not necessarily limited to): • road maintenance and repair • gardening • trenching
Job Performance Measures Most Often Impacted by Shoveling:	Speed of the shoveling task.
Typical Employee Comments about Shoveling:	Employees typically complain about discomfort and/or stiffness in the shoulder/neck, back and legs/feet.
Suggested Level II Analysis:	Dynamic Task Analysis, Biomechanical Lifting Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work is too far away - (manual shoveling) • One hand must hold shovel near the scoop	132. Remove obstructions to get closer to the work 103. Provide extensions for tools • provide handle attachment that can be attached to the shaft of the shovel	✓ ✓		low low	med med	med med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Shovel is too heavy • Ground is too hard for shoveling	59. Provide a lighter weight tool 144. Provide a machine/automate • use a backhoe	✓	✓	low high	med med	med high
3. High speed, sudden shoulder movements	• Poor shoveling technique	20. Incorporate rest pauses 13. Encourage ergonomic work techniques • pace the work task.	✓ ✓		low low	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
4. Head/neck bent or twisted	• Work location too low for prolonged periods causes strain on the neck	20. Incorporate rest pauses 13. Encourage ergonomic work techniques	✓		low	med	med
		• encourage employee to look up frequently	✓		low	med	med
	• Work location positioned behind operator when in back hoe	20. Incorporate rest pauses	✓		low	med	med

Hand/Wrist/Arm

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	• Control lever location too high (back hoe)	123. Raise the person • adjust seat higher • provide seat cushion	 ✓ ✓		 low low	 med med	 med med
	• Control lever distance traveled too far (back hoe)	101. Provide controls which do not require excessive forces • appropriate control levers • contact supplier to investigate adjustable levers and smoother traveling levers		 ✓ ✓	 med med	 med med	 med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide shovel with an appropriate hand diameter between 1”-1.5” (2.5-3.8 cm).		 ✓	 med	 med	 med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Non-compressible surface on handle	54. Provide a high friction gripping surface • provide a shovel with a compressible handle surface	✓		med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
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" in length.		✓	med	med	med
	• Controls lever knobs have hard edges (back hoe)	9. Eliminate exposure to hard edges • a knob with a round smooth handle, smooth knob with no ridges or edges	✓		med	med	med
		• provide knobs of at least 1.5" and not greater than 3.0"	✓		med	med	med

Hand/Wrist/Arm (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	Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		med	med	med
		93. Provide appropriate gloves	✓		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	• One hand must hold shovel near the scoop	103. Provide extensions for tools • provide shovel handle attachment		✓	med	med	med
	• Task duration is too long.	141. Use heavy excavation equipment (e.g., backhoes) • Use backhoe for long duration tasks with good access.		✓	high	med	high
		20. Incorporate rest pauses	✓		low	med	med
	• Leaning forward in seat (back hoe)	115. Provide support for the lower back • ensure person sits back in seat to utilize back support	✓		low	med	med
		• adjust backrest forward	✓		low	med	med
		• insert additional back support such as a commercial back rest or cushion.	✓		low	med	med
13. Twisting of the lower back	• Work positioned behind worker when in cab	18. Improve visual access to work • investigate alternative backhoe design.		✓	high	high	high
	• Work location is blocked or too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Twisting with the lower back instead of feet to transfer load of dirt/sand etc.	13. Encourage ergonomic work techniques	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Leaning forward in seat	115. Provide support for the lower back					
		• ensure person sits back in seat to utilize back support	✓		low	med	med
		• adjust back support forward	✓		low	med	med
		• insert additional back support such as a commercial back rest or cushion.	✓		med	med	med
		87. Provide an appropriate chair/stool	✓		med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
18. Whole body vibration	• Design and maintenance of seat and mounting increases vibration exposure (back hoe)	87. Provide an appropriate chair/stool • seating should incorporate vibration absorption qualities in base support of the seat either air or mechanical		✓	med	med	med
		• repair seat base	✓		low to med	med	med
	• Tight trousers increases the potential for low back pain	12. Encourage appropriate seasonal clothing • employees in industrial equipment to wear loose fitting trousers.	✓		med	med	med

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	96. Provide appropriate shoe inserts	✓		med	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
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Flame Cutting	
TASK TITLE: Cutting Metal Using Flame	
Task Description:	There are certain types of welding processes which lend themselves to rough metal cutting also. The focus of this case study is cutting with a torch. See welding case study for further information on welding. Typical jobs in which flame cutting is performed include: • metal fabrication • assembly/repair • structural maintenance • salvage operations Flame cutting may be performed on flat or upright surfaces directly on aircraft, pipes, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Flame Cutting:	• Quality of weld or cut • Speed of completion of flame cutting task
Typical Employee Comments about Flame Cutting:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulders/neck, hands/wrists/arms, back/torso, or legs/feet. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Grip Force Measurement, Postural, 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	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		low	med	med
	• Flame cutting tool or gas hose must be manually supported, held or steadied	112. Provide support for the arms					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med
		113. Provide support for hose or cord					
		• use wire hook to hang hose on nearby structure	✓		low	med	med
		• provide mobile tool balancer		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		132. Remove obstructions	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes ✓ Minor Modification	✓ Major Change	Cost	Impact On: Quality	Productivity
	• Flame cutting is performed on flat work surface	136. Rotate the work piece					
		• allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		77. Provide a tool with an appropriate handle angle					
		• provide a flame cutting tool with a pistol shaped grip (i.e. right angle)		✓	med	med	med
		• provide flame cutting tool with a nozzle which can be angled/bent for different flame cutting tasks		✓	med	high	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	Pulling hoses and carts is difficult • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition					
		• repair cracks or gaps in floor		✓	med to high	low	med
		• provide ramps to compensate for minor differences in floor height		✓	med to high	low	med
		• Improve housekeeping	✓		low	low	med
		19. Improve wheel condition					
		• provide wheels with appropriate bearings and tread composition		✓	med	low	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

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 low (see Figure 1.1)	124. Raise the work piece/work surface		✓	med	med	med
	Figure 1.1	31. Lower the person		✓	high	med	high
		87. Provide an appropriate chair/stool • to sit on for all or parts of the task	✓		low	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		low	med	med
	• Use of head movement to lower face shield is stressful	13. Encourage ergonomic work techniques • raise or lower the shield with hand	✓		low	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	• Using straight flame cutting tool on horizontal surface (see Figure 1.2) **Figure 1.2**	77. Provide a tool with an appropriate handle angle • attach a pistol-type handle to flame cutting tool • flame cutting tool with a pistol-type handle • flame cutting tool with a nozzle which can be angled/bent for different flame cutting tasks	✓	✓ ✓	low med med	med med high	med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Flame cutting tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece		✓	med	med	med
		54. Provide a high friction gripping surface					
		• provide a tool handle with a compressible grip surface		✓	med	med	med
		add a grip cover	✓		low	med	med
	• Tool is too heavy	116. Provide support for the tool					
		• provide a tool balancer		✓	med	med	med
		• flame cutting tool of minimal weight		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter					
		• flame cutting tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

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 • tool with a round, smooth handle with no ridges or edges • a handle of at least 5" in length		✓ ✓	med med	med med	med med
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 110. Provide shields or barriers from the wind 93. Provide appropriate gloves	 ✓	✓ ✓ 	med med low	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	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓		low	med	med
		83. Provide an adjustable height lift table		✓	high	med	high
		87. Provide an appropriate chair/stool to lower the person	✓		low	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Lack of support for body in awkward postures.	117. Provide support for the upper body • provide a pad/mat	✓		low	med	med
		• provide a device to support the upper body while flame cutting		✓	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
	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		83. Provide an adjustable height lift table • to support work piece		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
16. Lifting forces	• Initial setup may require the placement of the part on the workbench.	61. Provide a mechanical lift device • provide a hoist to place the unit on the workbench		✓	high	med	med
17. Pushing or pulling	Pulling hoses and carts is difficult • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • repair cracks or gaps in floor • provide ramps to compensate for minor differences in floor height		✓ ✓	med to high med to high	med med	med med
		19. Improve wheel condition • repair wheels on carts • provide wheels with appropriate bearings and tread composition	✓	✓	low 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 (see Figure 1.3) **Figure 1.3**	86. Provide an appropriate anti-fatigue mat 96. Provide appropriate shoe inserts	 ✓	✓	med low	med med	med med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges • provide padding for edges • lay a blanket or cushion over hard edges	✓ ✓		low low	med med	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	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓		low	med	med
		83. Provide an adjustable-height lift table		✓	high	med	high
		87. Provide an appropriate chair/stool	✓		low	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Folding/Fitting	
TASK TITLE: Folding/Fitting	
Task Description:	Folding involves the manual turning of light or heavy fabric in a specified pattern. The fold pattern must be followed for each type of product (patterns outlined in product manual). Most folding patterns are performed by two individuals due to the size of the product. Typical jobs in which folding is performed include (not necessarily limited to): • Parachute packing • Raft packing Folding may be performed on the floor or on a table surface. This case study includes only the folding part of parachute and raft packing which requires minimal force. The actions associated with packing the folded material into the case is reflected in the "Packing" case study.
Job Performance Measures Most Often Impacted by Folding:	• Adherence to the folding pattern. • Speed of completion of folding task.
Typical Employee Comments about Folding:	Employees typically complain about discomfort in the shoulders, backs, legs/feet. Primary concerns: back, legs/feet. Secondary concerns: shoulders.
Suggested Level II Analysis:	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	• Work location is too high	123. Raise the person • use a step stool, platform or ladder		✓	med	med	med
		32. Lower the work piece/work surface		✓	low	med	med
	• Size of material requires reaching	142. Use two or more persons to perform the transfer	✓		low	low	low
2. Arm Forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Pulling fabric is difficult (see Figure 1.1) **Figure 1.1**	13. Encourage ergonomic work techniques • minimize high speed movements while pulling fabric	✓		low	med	med
		• avoid rushing	✓		low	med	med
	• Carrying folded rafts more than three steps	48. Provide a cart • use a floor dolly to move folded raft	✓		low	med	med
		61. Provide a mechanical lift device		✓	high	low	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

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	• Rarely occurs	N/A					

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	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					

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	• Rarely occurs	N/A					

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 1.2) **Figure 1.2**	124. Raise the work piece/work surface • provide a fixed table to support workpiece • provide an adjustable table for workpiece		 ✓ ✓	 med high	 med med	 med high
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	13. Encourage ergonomic work techniques 132. Remove obstructions • remove unnecessary items from the work area	✓ ✓		low low	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting Forces	Lifting heavy folded objects • low height • no hand holds	61. Provide a mechanical lift device • lifting hoist to move raft or work piece • use straps to lift item 142. Use two or more persons to perform the transfer	 ✓ ✓	✓ 	high low low	med med med	high med med
17. Pushing or pulling	• Rarely occurs	N/A					
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 on hard surface (see Figure 1.3) **Figure 1.3**	96. Provide appropriate shoe inserts 86. Provide an appropriate anti-fatigue mat	✓	 ✓	low med	low med	low med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					

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 height too low (see Figure 1.4) **Figure 1.4** • Hard Surface	13. Encourage ergonomic work techniques • periodically stand up to change position.	✓		low	med	med
		95. Provide appropriate knee protection		✓	med	med	med
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		124. Raise the work piece/work surface • prevent kneeling	✓		low	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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Forming	
TASK TITLE: Forming	
Task Description:	Forming is a manual task which is typically performed to create a small volume (e.g., one) of special purpose metal parts. The process involves forcing, deforming, or pressing a piece of sheet metal around a wood mold or pattern. The pattern defines the shape of the final part. Depending on the part shape, tools such as hammers, or other heavy weight metal bars may be used. Typical jobs in which forming may occur include (not necessarily limited to): • metal fabrication • model shop • zone or facilities maintenance. The task is usually performed on a work table and may require the use of a vise to stabilize the pattern.
Job Performance Measures Most Often Impacted by Forming:	Dimensional accuracy, time taken to completion.
Typical Employee Comments about Forming:	Employees report that manual forming is one of the hardest or most physically demanding jobs in the department. The primary body regions affected by manual forming include the hands/wrists/arms, shoulder/neck and (upper)back/torso. The secondary body region affected is the (lower) back/torso.
Suggested Level II Analysis:	Grip Force Measurement, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	position Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• The work piece is too high	32. Lower the work piece/work surface • lower the work table or bench	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Use of manual tool is inappropriate for the task • Material is difficult to form/mold	66. Provide a power tool • provide a vibration-controlled impact tool 15. Heat metal/material to make more pliable • provide gloves to protect hands from heat		✓ ✓	high med	med med	high med
3. High speed, sudden shoulder movements	• Use of manual tool is inappropriate for the task • Material is difficult to form/mold	66. Provide a power tool • provide a vibration-controlled impact tool 15. Heat metal/material to make more pliable • provide gloves to protect hands from heat		✓ ✓	high med	med med	high med
4. Head/neck bent or twisted	• Work piece orientation is awkward	136. Rotate the work piece • rotate the work piece manually by changing its in the vice • provide a special purpose fixture	✓	✓	low 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	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide a vibration-controlled impact tool		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Use of manual tool is inappropriate for the task • Maintaining grip on manual tool is difficult	66. Provide a power tool • provide an vibration-controlled impact tool 54. Provide a high friction gripping surface • provide padding/wrapping to provide a compressible gripping surface on hammer or other tools	✓	✓	high low	med med	high med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide a vibration-controlled impact tool		✓	high	med	high
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 • provide a handle of at least 5" in length		✓ ✓	med med	med med	med med
	• Workstation has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓	✓	low med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 high • Work location is too low	32. Lower the work • piece/work surface lower the work table or bench 123. Raise the person • provide a stable platform 124. Raise the work piece/work surface • raise the work station on blocks • raise the fixture or vise • provide an adjustable work table	✓ ✓ ✓ ✓	 ✓	low low low low med	med med med med med	med med med med med
13. Twisting of the lower back	• Work piece orientation is awkward	136. Rotate the work piece • rotate the work piece manually by changing its position in the vice • provide a special purpose fixture	✓	 ✓	low med	med med	med med
14. High speed, sudden movements	• Excessive dirt and/or dust, and presence of water or lubricant on floor	17. Improve floor condition • improve housekeeping • clean/dry floor prior to performing the task • wear the appropriate shoes/sole for floor surface and work environment	 ✓ ✓ ✓		 low low low	 low low low	 low low low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
	• Standing in a fixed position for prolonged periods	13. encourage ergonomic work techniques • encourage employee to walk periodically	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Gluing/Laminating (Dopping)	
TASK TITLE: Gluing/Laminating (Dopping)	
Task Description:	Gluing/Laminating involves the use of primarily three tools: a paint brush to apply the glue and thinner, a heat gun to warm the surface and make it pliable, and finally a sealing iron to seal the applied dacron and base material. Many times the gluing/laminating process is performed on the aircraft while it is on the ground, thus requiring the individual to perform work overhead or very low to the ground. Typical jobs in which sanding is performed include (not necessarily limited to): • aircraft maintenance/restoration • model shop
Job Performance Measures Most Often Impacted by Gluing/Laminating:	Integrity of surface and joints.
Typical Employee Comments about Gluing/Laminating:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists/arms, and sometimes the lower back. Primary concerns: Shoulders/Neck Secondary concerns: Hands/Wrists/Arms, and Body/Torso
Suggested Level II Analysis:	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	• Work location is too high (see Figure 1.1) **Figure 1.1**	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding	✓ ✓	✓ ✓	med med high	med med med	med med high
		112. Provide support for the arms • provide adjustable arm support for long duration tasks in one position		✓	med	high	med
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated • rotate the work piece manually	 ✓	✓ 	med low	med med	med med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Supporting tools for long periods	116. Provide support for the tool • provide a tool balancer for bench work • provide a mobile tool balancer that can be hung overhead for field work		 ✓ ✓	 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
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
	• Work location is too high (see Figure 1.2)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform			med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
	Figure 1.2						
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece	✓		low	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	• Handle angle on tool causes awkward wrist postures	77. Provide a tool with an appropriate handle angle • provide a tool with a pistol-type handle • provide a tool which can be angled/bent for different tasks • attach a pistol-type handle to tool		✓ ✓ ✓	med med med	med med med	med med med
	• Using the paint brush results in wrist movements	11. Eliminate unnecessary tasks • provide a roller or a special purpose spray gun for applying glue and thinner		✓	med	med	med
	• Work location is too high	123. Raise the person • use a step stool or a ladder • provide a fixed platform • provide an adjustable platform or scaffolding	✓	✓ ✓ ✓	med med high	med med med	med med high
6. Repeated manipulations with fingers	• Rarely occurs.	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of heat gun with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)	✓	✓	med	med	med
		10. Eliminate need to constantly hold trigger • provide a tool with "cruise control". Toggle switches that allow continuous operation without holding the trigger down		✓	med	med	med
8. Hand/grip forces	• Tool must be manually supported, held or steadied	116. Provide support for the tool • provide a mobile tool balancer that can be hung overhead for field work (e.g., like an "I.V. rack)		✓	med	med	med
		113. Provide support for the cable or hose • provide a hook to hang cable in work area	✓	✓	med	low	low
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter of between 1"-1.5" (2.5-3.8 cm) is appropriate for this task		✓	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
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length • wrap tool handle	 ✓	✓ ✓ 	med med low	med med med	med med med
11. Hands and fingers exposed to cold temperatures	• Work area is tool cold	93. Provide appropriate gloves	✓		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	• Rarely occurs-most binding is of a stable nature	N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	low med	low med
		117. Provide support for the upper body • Provide a device to support the upper body while working		✓	med	med	med
	• Work space or access is limited (such as internal to a structure	63. Provide a padded, compressible surface to lay on	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • raise the work with a hoist		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	low
		41. Move work piece closer to body	✓		low	med	low
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Inadequate lower back support while seated • Inappropriate chair adjustment. • Inappropriate chair design	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	med	med
		• provide a chair with adequate lower back support		✓	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
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 (see Figure 1.3) **Figure 1.3**	85. Provide an appropriate anti-fatigue mat 96. Provide appropriate shoe inserts	✓ ✓		med med	low low	low low
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide knee pads • provide a cushion to kneel on	 ✓ ✓		 med low	 med med	 med med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • raise the work using a hoist 31. Lower the person • provide a chair/stool to sit on • provide knee pads • provide a pad or cushion to kneel on	 ✓ ✓	 ✓ ✓	 med low low low	 med med med med	 high med 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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Grinding	
TASK TITLE: Grinding	
Task Description:	Grinding involves the use of a manual (file) or powered (pneumatic or hydraulic hand grinders) tools to remove or shape material. The work piece is often metal or wood. Additionally, the work piece can be fixed (in a vise) or supported (mounted on a structure). Typical jobs in which grinding is performed include: • aircraft maintenance • sheet metal repair • facility maintenance • model shop Grinding may be performed on flat or upright surfaces directly on aircraft, equipment, bench tops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Grinding:	• Quality of finished surface (consistency, free of defects, no overgrind) • Speed of completion of grinding task.
Typical Employee Comments about Grinding:	Employees typically report discomfort and/or stiffness in the shoulders/neck and hands/wrists/arms. Primary: The primary body parts affected are the shoulder/neck and hand/wrists/arms Secondary: In some cases the back/torso and legs/feet are affected as well (although don't typically comment).
Suggested Level II Analysis:	Grip Force Measurement, 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 or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
		112. Provide support for the arms					
		• rest arms on nearby surfaces	✓		low	med	med
	• 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 work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow 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

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Tool requires high forces to remove material	92. Provide appropriate abrasive material • substitute higher grit media removal of large amounts of material	✓		low	med	med
		• Grind in stages with different grit to achieve appropriate finish	✓		low	med	med
		34. Maintain hand tools/power tools	✓		low	med	med
	• Large quantity of material must be removed	66. Provide a power tool • obtain a heavier duty tool which reduces forces and time required to remove material		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide power tools of minimal weight (particularly for lighter grinding tasks)		✓	med	med	med
3. High speed, sudden shoulder movements	• Manual grinding or filing requires high speed arm movements	66. Provide a power tool, whenever possible		✓	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 low (see Figure 1.1) **Figure 1.1**	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece		✓	med	med	med
		• tilt the work piece toward the worker	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	med
		31. Lower the person	✓		med	med	med
		• provide a stool to sit on					
		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

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 too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Light levels are too low	22. Increase light levels					
		• (provide light levels at the task of 50-100 foot-candles (500-1000 lux)) for grinding tasks (precision grinding tasks require more light: 100 fc (1000 lux)or more)		✓	med	med	med
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high

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	• Tool handle orientation causes awkward postures	77. Provide a tool with an appropriate handle angle • provide multiple tool designs for complex parts		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓ ✓		low med	med med	low 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

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of power tool with single finger trigger concentrates stress on finger	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Hand grinding may cause excessive fingertip forces	118. Provide support for the work piece • provide and mount small parts (that must be held against a grinding wheel) to a grinding block with an attached handle so that pressure is applied with a full hand grip rather than a finger press		✓	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
	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a clamp	✓		low	med	med
		54. Provide a high friction gripping surface • wrap the tool handle	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a tool of minimal weight when appropriate		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide tool with an appropriate handle diameter between 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
	• Vibration often causes person to apply more force to control the tool	74. Provide a tool that minimizes exposure to vibration/impact/torque • attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5" (3.8 cm))		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Power tools produce hand/arm vibrations	74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping • attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5" (3.8 cm))		✓ ✓	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	• 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" in length		✓	med	med	med
	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	low	low
		• round off exposed edges		✓	med	low	low
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from the hands • provide tool which does not blow cold air on the hands		✓	med	med	med
		93. Provide appropriate gloves • caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task	✓		med	low	low

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work area is too cold	23. Increase room temperature	✓		low	low	med
		105. Provide portable heaters		✓	med	low	med
		110. Provide shields or barriers from the wind		✓	med	low	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 1.2) **Figure 1.2**	124. Raise the work piece/work surface • provide a fixed table to support work piece 79. Provide a work surface which is adjustable in height 31. Lower the person • provide a stool for working on low areas	✓ ✓	✓ ✓ 	med high low	med med med	med high med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation • Work space or access is limited	136. Rotate work piece (bench work) • turn the work piece manually • provide a fixture to allow work piece to be rotated 63. Provide a padded, compressible surface to lay on 117. Provide support for the upper body	✓ ✓ ✓	 ✓ ✓	low med low med	med med med med	med med med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		83. Provide an adjustable height lift table		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work) • rotate the work piece manually • provide a fixture to allow work piece to be rotated	✓	✓	low med	med 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

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		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
	• Chair or stool provides inadequate back support	115. Provide support for the lower back • pull chair forward and lean back while working	✓		low	low	low
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support	✓		med	low	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (If it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 appropriate anti-fatigue mat	✓		med	low	low
		96. Provide appropriate shoe inserts	✓		med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges					
		• Use a cushion eliminate exposure to pressure point	✓		low	low	low
		• provide chair with rounded front edge of seat	✓		med	low	low
	• Work station has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	low	low
		• round off exposed edges		✓	low	low	low
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Hammering	
TASK TITLE: Hammering	
Task Description:	Hammering involves the use of a hammer to pound nails or shape a variety of materials. The hammering task can be done at a variety of heights and locations. Task duration is dependent on the complexity or nature of the product. Tools used in hammering can include rubber mallets, sledge hammers, and framing (e.g., carpenter's) hammers. Typical jobs in which nailing is performed include: • basic shaping of metal forms • aligning and straightening structures • general maintenance Hammering may take place on bench tops or fixtures, directly on structures or equipment, or on the floor.
Job Performance Measures Most Often Impacted by Hammering:	• Quality of the final product (free of defects, appearance) • Speed of completion of task
Typical Employee Comments about Hammering:	Personnel typically report fatigue or discomfort in the hands/wrists/arms and shoulders/neck. Primary: The primary body regions affected the hands/wrists/arms and shoulders/neck. Secondary: In some cases, back/torso and legs/feet are also affected.
Suggested Level II Analysis:	Grip Force Measurement, 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 or ladder	✓	✓	med	med	med
		• provide a fixed platform			med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table (cut legs)	✓		low	med	med
		• provide an adjustable height work table		✓	high	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Manual hammering causes high forces	11. Eliminate unnecessary tasks/repeated pounding	✓		med	med	med
		• determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required (e.g., number of nails)					
		• use a hammer which is large enough/heavy enough	✓		low	med	med
		66. Provide a power tool		✓	med	high	high
	• Inappropriate technique may increase force	13. Encourage ergonomic work techniques • encourage person to use minimal force in order to perform task	✓		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
3. High speed, sudden shoulder movements	• Manual nailing requires high speed movements	11. Eliminate unnecessary tasks • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		low	med	med
		66. Provide a power tool • provide a pneumatic nail gun		✓	med	high	high

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	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/ work surface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Hand/Wrist/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 hammering requires wrist movements	11. Eliminate unnecessary tasks • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		low	med	med
		77. Provide a tool with an appropriate handle angle • provide tools with an appropriate handle angle for the position of the work		✓	med	med	med
		66. Provide a power tool • provide a pneumatic nail gun		✓	med	high	high

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hand/Wrist/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	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture to the support the work piece		✓	med	med	med
		54. Provide a high friction gripping surface • provide a hammer handle with a compressible grip surface		✓	med	med	med
		• wrap the handle with friction tape	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide appropriate sized hammer for the particular task		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Manual hammering causes impact to the hand and wrist	11. Eliminate unnecessary tasks • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		low	med	med
		66. Provide a power tool • provide a pneumatic nail gun		✓	med	high	high

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		13. Encourage ergonomic work techniques • encourage person to use minimal force in order to perform task • encourage employee to release grip (slightly) at the point of impact	 ✓ ✓		 low low	 med med	 med med
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 110. Provide shields or barriers from the wind 12. Encourage appropriate seasonal clothing 93. Provide appropriate gloves • (Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task)	 ✓ ✓	✓ ✓ ✓	med med low 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	124. Raise the work piece/ work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions	✓	✓	med	med	med
		139. Rotate the work piece					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Manual hammering can cause high speed movements in the lower back	11. Eliminate unnecessary tasks					
		• determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		med	med	med
		13. Encourage ergonomic work techniques					
		• encourage person to use minimal force in order to perform task	✓		low	med	med
		• encourage the person to maximize the benefit of momentum and tool weight (e.g., chopping wood)	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		2. Avoid high force tasks while seated • perform high force hammering tasks while standing	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 on hard surface	96. Provide appropriate shoe inserts	✓		low	low	low
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		52. Provide a footrail or footrest	✓	✓	med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Hard edges in work area contact legs/knees • Kneeling required	95. Provide appropriate knee protection	✓	✓	med	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/ work surface					
		• place the work piece on a fixed table	✓		med	med	med
		• provide an adjustable height table		✓	high	med	high
		• provide a support fixture		✓	med	med	med
		87. Provide an appropriate chair/stool - stool should be stable, low to the ground and able to roll - stool provides an alternative to kneeling or squatting		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
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 hammering tasks • increase room lighting • if necessary, provide a task light which is easy to adjust	 ✓	✓ ✓ ✓	high high med	high high med	high high med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Hose Handling	
TASK TITLE: Hose Handling - Aircraft Refueling	
Task Description:	Hose handling activities in this example describe the process used to refuel a fighter aircraft. The fuel is delivered to the aircraft by a fuel truck. The individual pulls the fuel hose from the truck, carries/drags the hose to the aircraft, and raises and secures the hose fitting to the aircraft. After re-fueling, the hose is removed from the aircraft. The spool on which the hose is carried on the truck is used to re-wind the hose. Typical jobs in which hose handling is involved include: • aircraft refueling • fire fighting • liquid fuels maintenance/attaching and detaching hoses. This case study addresses potential ergonomics issues associated with a moving and handling low pressure hoses.
Job Performance Measures Most Often Impacted by Hose Handling:	• Avoidance of spills. • Speed of task completion.
Typical Employee Comments about Hose Handling:	Employees typically identify discomfort in the shoulder and back from dragging the hose and lifting it to the refueling locations. In some cases, there may be a concern for the hands and fingers due to the difficulty in and detaching hoses and clamps. Primary concerns: back/torso, shoulder/neck Secondary concerns: hands/wrists/arms.
Suggested Level II Analysis:	Dynamic Task Analysis, Grip Force Measurement, Push/Pull Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Refueling point is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
	• Inappropriate technique used to drag hose	13. Encourage ergonomic work techniques • face the direction of travel when moving hoses • hold hose close to the body at waist level or over the shoulder	✓ ✓		low low	med med	med med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Weight of hose, distance traveled, and friction between the hose and the ground	126. Reduce carry distance • locate the fuel / truck as close to the air craft as possible. 13. Encourage ergonomic work techniques • unwind the fuel hose (at least partially) prior to dragging the hose to the aircraft; avoid simultaneous pulling and unwinding of the hose from the truck.	✓ ✓		low low	low 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
	• Wear or damage to hose clamp or material build-up can make clamp difficult to seal and remove. (see Figure 1.1) **Figure 1.1**	35. Maintain tracks, rollers, or movement mechanisms • regularly clean and repair hose connectors/clamps • replace damaged clamps • replace worn hoses with hoses that are enclosed in a low friction casing - facilitates sliding	✓	✓ ✓	low med high	med med med	med med high

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Weight of hose, distance traveled, and friction between the hose and the ground	126. Reduce carry distance • locate the truck as close to the air craft as possible.	✓		low	low	med
		13. Encourage ergonomic work techniques • unwind the fuel hose (at least partially) prior to dragging the hose to the aircraft; avoid simultaneous pulling and unwinding of the hose from the truck.	✓		low	low	med
		75. Provide a tool which can be used by both hands • use a hook (handle sized for both hands) to drag the hose instead of gripping the hose itself.	✓		med	low	med
	• Wear or damage to hose clamp or material build-up can make clamp difficult to seal or remove	35. Maintain tracks, rollers, or movement mechanisms • regularly clean and repair hose connectors/clamps	✓		low	med	med
		• replace damaged clamps		✓	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
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs.	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	93. Provide appropriate gloves	✓	✓	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	• Rarely occurs	N/A					
13. Twisting of the lower back	• Inappropriate work technique while moving hose	13. Encourage ergonomic work techniques • face the direction of travel when moving hoses • hold hose close to the body at waist level or over the shoulder	✓ ✓		low low	low low	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Hose is heavy • Lifting hose from ground level increases force in the low back	13. Encourage ergonomic work techniques • place hose over the shoulder immediately upon removal from truck - never let hose reach the end of the hose reach the ground.	✓		low	low	med
17. Pushing or pulling	• Weight of hose, distance traveled, and friction between the hose and the ground	126. Reduce carrying distance • locate the fuel truck as close to the aircraft as possible. 35. Mountain tracks, rollers, or movement mechanism. • replace worn hoses with hoses that are enclosed in a low friction casing - facilitating sliding.	✓	 ✓	low high	low med	med high
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	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Lifting	
TASK TITLE: Lifting	
Task Description:	Lifting involves the manual handling of items of varying weights and sizes. It involves the transfer of items at between varying heights and locations (floor/shelves or a work surface). Pushing and pulling typically occur while moving carts or pieces of equipment. Pushing and pulling can also occur while removing and installing components. • Lifting/pushing/pulling are components of many jobs.
Job Performance Measures Most Often Impacted by Lifting:	• Speed of completion of the larger task. • Component damage during handling.
Typical Employee Comments about Lifting:	Employees typically complain about discomfort in the back/torso, legs/feet, hands/wrists, arms, and shoulders/neck. Primary: The primary body part affected is typically the **back/torso** Secondary: The following body parts are also affected: shoulders/neck, hands/wrists/arms, and legs/feet may also be affected.
Suggested Level II Analysis:	NIOSH Lifting Equation, Biomechanical Lifting Analysis, Push/Pull Force Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Object is too high	32. Lower the work piece/work surface • place heaviest items below shoulder height (50" (127 cm) or less)	✓		low	med	med
		• place heaviest items on middle shelves of storage racks	✓		low	med	med
	• Object is too far away	38. Move closer to the work location	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Item is too heavy	61. Provide a mechanical lift device		✓	high	low	med
		131. Reduce weight of work piece		✓	med	med	med
		142. Use two or more persons to perform the transfer	✓		low	low	low
		26. Increase weight of work piece • ensures that the item will be handled mechanically		✓	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
	• High forces required to install or remove component	128. Reduce force required to install or remove the component					
		• use lubricant where feasible	✓		low	med	med
		• modify design of component or subsystem to reduce forces during installation or removal		✓	high	med	med
	• Rolling/sliding resistance of cart or piece of equipment causes high forces	19. Improve wheel condition					
		• repair wheels on carts or equipment	✓		med	med	med
		• install appropriate wheels		✓	low to med	med	med
	• Cart or piece of equipment is too heavy to be pushed manually	131. Reduce weight of work piece					
		• reduce number of items or weight of items on cart	✓		low	low	med
		67. Provide a powered cart		✓	med to high	low	med
	• Floor/surface condition causes high forces during a rolling or sliding task	17. Improve floor condition					
		• improve housekeeping	✓		low	low	med
		• repair cracks or gaps in floor		✓	med	low	med
		• provide ramps to compensate for minor differences in floor height		✓	med to high	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Carry distance is more than three steps	126. Reduce carry distance • arrange storage and work areas to reduce travel distances	✓		low	low	med
		48. Provide a cart • to transport materials		✓	med	low	med
		11. Eliminate unnecessary tasks • eliminate or combine handling tasks	✓		low	low	med
		• transport items in larger quantities instead of handling them individually	✓		low	low	med
		37. Modify facilities to decrease handling • widen doors to allow materials to be handled on carts		✓	high	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Speed of lift	13. Encourage ergonomic work techniques • encourage person to avoid rushing while handling items	✓		low	low	med
	• Item is stuck in location • Item is difficult to install	128. Reduce force required to install or remove the component • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal	✓	✓	low high	med med	med med
4. Head/neck bent or twisted	• Inadequate head room causes awkward postures	82. Provide adequate workspace • store item in area where there is adequate headroom	✓		low	low	med
		• use flow-racks to cue items to the front of a storage rack		✓	high	low	high
		55. Provide a hook-type tool to pull items		✓	low	low	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	• Shape of grasping location (handle) on work piece causes awkward wrist positions	94. Provide appropriate handles • provide handles which pivot slightly to permit a straight wrist during handling • provide cut-outs on boxes or containers		✓ ✓	med med	low low	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Item is difficult to grasp • Item has no handles • Item is slippery (see Figure 1.1) **Figure 1.1**	76. Provide a tool which requires minimum force to use • provide handles with compressible grips 61. Provide a mechanical lift device	✓		med med to high	low low	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓ ✓	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	• Object is too low (see Figure 1.2) **Figure 1.2**	124. Raise the work piece/work surface					
		• place heaviest items between knuckle and shoulder height (25”-50”) (64-127 cm)	✓		low	low	low
		• provide a fixed table to support work piece		✓	low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		• place heaviest items on middle shelves of storage racks	✓		low	low	med
	• Object is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to the body	✓		low	med	med
	• Lifting item out of a deep container causes awkward bending	69. Provide a smaller container	✓	✓	med	low	med
	• Item is handled in a restricted space	82. Provide adequate work space		✓	low to med to	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Person tends to use the back to lift instead of using the legs to assist in the lift (check to make sure that there is no contributing factor in the workplace)	13. Encourage ergonomic work techniques • provide training on ergonomics principles and lifting techniques • encourage person to use leg muscles to lift	✓ ✓		low low	low low	med med
13. Twisting of the lower back	• Access is restricted to a component that needs to be removed	82. Provide adequate workspace • improve access during installation and removal	✓		low	low	high
	• Item is handled in a restricted space	61. Provide mechanical lift device • provide mechanical assistance for handling the load		✓	med to high	low	med
	• Work area layout	130. Reduce the angle a person turn to transfer an item • for example, if the transfer involves a 180 degree twist, move the source or destination to reduce the twist to 90 degrees or less	✓		low	low	med
	• Person tends to twist with the back instead of using the legs and feet to pivot	13. Encourage ergonomic work techniques • provide training on ergonomics principles and lifting techniques • encourage person to use legs pivot when handling a load	✓ ✓		low low	low low	med med

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	• Item is stuck in location • Item is difficult to install or remove	128. Reduce force required to install or remove the component • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal	✓	✓	low high	low med	med high
	• Person tends to lift with a jerky motion instead of a smooth motion	13. Encourage ergonomic work techniques • encourage person to avoid rushing while handling items	✓		low	low	med
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Item is too heavy	61. Provide a mechanical lift device		✓	high	low	med
		131. Reduce weight of work piece (object)	✓		low	low	med
		142. Use two or more persons to perform the transfer	✓		low	low	med
		26. Increase weight of work piece • ensures that the item will be handled mechanically		✓	high	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• High forces are required to install or remove the component	128. Reduce force required to install or remove the component • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal	✓	✓	low high	low low	med med
17. Pushing or pulling	• Rolling/sliding resistance of cart or piece of equipment causes high forces	19. Improve wheel condition • repair wheels on carts or equipment • provide wheels with appropriate bearings and tread composition	✓	✓	low med	low low	med med
	• Cart or piece of equipment is too heavy to be pushed manually	131. Reduce weight of work piece • reduce number of items or weight of items on cart	✓		low	low	med
		67. Provide a powered cart • provide motorized assistance to transport cart or piece of equipment		✓	high	low	high
	• Floor/surface condition causes high forces during a rolling or sliding task	17. Improve floor condition • improve housekeeping • repair cracks or gaps in floor • provide ramps to compensate for minor differences in floor height	✓	✓ ✓	low med high	low low low	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	Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work object is too low	124. Raise the work piece/ work surface 118. Provide support for the work piece • provide an adjustable table for work piece	✓	✓ ✓	med high	med med	med high
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Machining	
TASK TITLE: Machining	
Task Description:	Machining involves the use of a hydraulic cutting tool (e.g., Computer Numerically Controlled-CNC) to cut/form a shape out of a piece of metal. The employee must load the piece of metal, cycle the machine, and then remove the finished product. Additionally, the employee typically performs a series of test measurements. In some cases, the employee may need to grind the piece after machining is completed. Typical jobs or work areas in which machining is performed include (not necessarily limited to): • aircraft maintenance • facility maintenance • model shop
Job Performance Measures Most Often Impacted By Machining:	• Dimensional accuracy of finished product • Speed of task completion
Typical Employee Comments about Machining:	Due to the wide variety of work situations, employees may complain about discomfort or stiffness in any of the following areas: shoulders/neck, hands/wrists/arms, back/torso or legs/feet The primary body parts affected are typically: shoulders/neck, hands/wrists/arms and back/torso The secondary body parts affected are typically: legs/feet
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis, Light Measurement, Lighting 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 far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body • modify fixture		✓	low	med	med
	• Work location or bin is too low	83. Provide an adjustable-height lift table • provide a spring loaded pallet jack to elevate the parts bin		✓	med	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• The work piece is too heavy	61. Provide a mechanical lift device • provide a mechanized method for installing and removing the work piece.		✓	med	med	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

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	• Finish quality must be visually inspected and measured	22. Increase light levels • provide task lighting which is easy to adjust	✓		med	med	med
		136. Rotate the work piece • turn the work piece to an upright or tilted position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Hands/Wrist/Arm

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	• Inappropriate fixture design	136. Rotate the work piece • manually turn the work piece to an upright position • provide a fixture to allow the work piece to be rotated 66. Provide a power tool • replace manual clamps with a hydraulic fixture	✓	 ✓ ✓	low med high	med med high	med med high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of tool with single trigger concentrates stress	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger • provide electronic caliper to eliminate thumb action		✓ ✓	med high	med med	med med
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied during grading or inspection	118. Provide support for the work piece • provide a fixture to support work piece 118. Provide support for the work piece • provide a tool balancer for bench work		✓ ✓	med med	med med	med med

Hands/Wrist/Arm (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 tool with an appropriate handle diameter between 1"-1.5".		✓	med	med	med
	• The work piece must be moved and turned	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• The tool has not received proper maintenance	34. Maintain hand tools/power tools • perform periodic maintenance on all tools	✓		low	med	med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• The hand is inadequately protected	74. Provide a tool that minimizes exposure to vibration/ impact/torque • Provide and attach a compressible anti-vibration surface to the tool handle		✓	med	med	med
	• Lack of clamping device increases employee contact with vibrating surface	118. Provide support for the work piece • provide a fixture or jig to hold the work piece		✓	med	med	med
	• 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" in length		✓	med	med	med
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 surface is too low (see Figure 1.1) **Figure 1.1**	124. Raise the work piece/work surface • provide a spring loaded pallet jack to elevate the parts bin		✓	med	med	med
		136. Rotate the work piece • turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated or raised		✓	med	med	med
		83. Provide an adjustable-height lift table • use for part storage		✓	med	med	med
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work surface is too low	124. Raise the work piece/work surface • provide a spring loaded pallet jack to elevate the parts bin		✓	med	med	med
	• Load point too far away	38. Move closer to the work location • remove guards during load/unload	✓		low	low	med
		• redesign fixture to locate part closer to employer		✓	high	low	med
16. Lifting forces	• The work piece is too heavy	61. Provide a mechanical lift device • provide a mechanized method for installing and removing the work piece.		✓	high	med	med
		124. Raise the work piece/work surface • provide a spring loaded pallet jack to elevate the parts bin		✓	med	med	med
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts		✓	low	low	low
		52. Provide a footrail or footrest	✓	✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• provide gloves to protect hands		✓	low	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Finish quality must be visually inspected (see Figure 1.2) **Figure 1.2**	22. Increase light levels • provide task lighting which is easy to adjust • ensure that light levels are 200-250 lux (20-25 foot-candles)	✓	✓	med high	med high	med high

CASE STUDY - Masking	
TASK TITLE: Masking	
Task Description:	Masking involves the use masking tape paper (or other material) to cover an area that is not to be painted during the paint spraying or hand painting process. This task includes covering the area prior to painting and then the removal of the masking after the painting task is completed. Objects may be fixed in a vice or mounted, supported on a table surface or free standing. Task duration is dependent on the part complexity. Typical jobs in which masking is performed include: • vehicle painting • aircraft painting • painting of technical equipment Masking may be performed on flat, angled, and upright surfaces directly on equipment or in tight or restricted space work areas.
Job Performance Measures Most Often Impacted by Masking:	Quality of the masking (e.g., prevent over-spray and related re-work) Speed of completion of masking task
Typical Employee Comments about Masking:	Since the body position varies depending on the part employees may complain about discomfort and/or stiffness in the shoulders/neck, hands/wrists/arms. back/torso and legs/feet. Primary concerns: depends on the task Secondary concerns: depends on the task
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Elemental Task Analysis, Light Measurement, Lighting 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 an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
		136. Rotate work piece (bench work)					
		• turn the work piece	✓		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 activity 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 too far away	41. Move work piece closer to body					
		• provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, an eliminate reaches		✓	med	med	med
		38. Move closer to the work location					
		• move person closer to the work	✓		low	med	med
		• provide sit-stand capability		✓	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					
		• provide tools to smooth down tape while minimizing reaching		✓	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
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking • design component for access • design component to allow the use of a mechanical mask		✓ ✓ ✓	med med med	med med med	med med med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	• N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface • provide an adjustable height table or fixture to support the work piece		✓	high	med	med
		31. Lower the person • provide a chair/stool to sit on for all or parts of the task	✓		med	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	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	136. Rotate work piece (benchwork) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		114. Provide support for the head • provide a cushion to support the head	✓		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
		82. Provide adequate workspace • add access panels to increase access • increase the size of access ports to increase access		✓ ✓	high high	med med	high med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot-candles (500 - 1000 lux) for masking tasks (precision masking tasks require more light: 100 fc (1000 lux) or more) • provide a task light which is easy to adjust • increase room lighting		✓ ✓ ✓	high med high	high med high	high med high

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	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece • provide a fixture to orient the work piece to allow straight wrist postures		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • the handle angle should allow the wrists to remain straight while working		✓	med	med	med
		79. Provide a work surface which is adjustable in height		✓	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

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking • design component for access • design component to allow the use of a mechanical mask		✓ ✓ ✓	med med med	med med med	med med med
6. Repeated manipulations with fingers	• Handling masking tape requires repeated finger movements, particularly while placing and smoothing the tape down	3. Change a pinch grip to a power grip • provide specialized tools for smoothing tape		✓ ✓	med med	med med	med med
7. Hyper extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Tearing or cutting tape • High forces associated with pressing and smoothing down tape	76. Provide a tool which requires minimal force to use • provide a tape dispenser which cuts tape to length 3. Change a pinch grip to a power grip • provide specialized tools for smoothing tape		✓ ✓	med med	high med	high med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Holding heavy rolls or bundles of masking tape	116. Provide support for the tool • provide a dispenser which is mounted so that the tape is maintained at an appropriate height		✓	med	high	high
	• Work piece must be manually supported	118. Provide support for the work piece • use jig or fixture to reduce/ eliminate the need to manually support the work piece		✓	med	med	med
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

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	• Work piece has hard or sharp edges	9. Eliminate exposure to hard edges • lay a material or padding over the hard edges • redesign work piece or component to eliminate hard edges • round off exposed edges	 ✓ ✓	 ✓ 	 low med low	 low med med	 low med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 surface too low • Work surface too far away	124. Raise the work piece/work surface • provide an adjustable work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, an eliminate reaches		✓	med	med	med
		31. Lower the person • provide chair or stool	✓		med	med	med
		136. Rotate work piece (bench work) • manually reorient the work piece	✓		low	med	med
		• provide a jig or fixture to allow the work piece to be rotated		✓	med	med	med
		103. Provide extensions for tools • provide extensions on application tools to reduce bending		✓	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
		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
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	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
13. Twisting of the lower back	• Location of work	41. Move work piece closer to body • provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, an eliminate reaches		✓	med	med	med
		38. Move closer to the work location	✓		low	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/work surface • provide a fixed table to support work piece		✓	low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	low
		• provide a fixture to allow the piece to be rotated	✓		med	med	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		117. Provide support for the upper body • provide a padded surface to support upper body where work requires a bent or awkward posture		✓	med	med	med
		103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform activity 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
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	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	115. Provide support for the lower back • pull chair forward and lean back while working • adjust backrest to support lower back • attach a small pillow to back rest to support lower back • provide chair with lower back support	 ✓ ✓ ✓	 ✓	 low low low med	 low low low med	 low low low med
16. Lifting forces	• If occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• If occurring, see Lifting Case Study	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest		✓	low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • provide an adjustable work surface		✓	high	med	high
		• provide fixture or jig which can hold work piece (bench work)		✓	med	med	med
		31. Lower the person • provide chair		✓	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

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		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
	• Design of component	11. Eliminate unnecessary tasks					
		• redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	med	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Masoning	
TASK TITLE: Masoning	
Task Description:	Masonry work involves the use of a number of hand tools of various sizes and shapes. The task may include pouring concrete, smoothing and finishing concrete with treadle. The masonry task can be done at a variety heights and angles. Task duration is dependent on the complexity or nature of the job. Typical jobs in which masoning is performed include (not necessarily limited to): • road maintenance and repair • construction Some aspects of brick work are also included in this case study.
Job Performance Measures Most Often Impacted by Masoning:	Integrity of the concrete, level surface. Speed of the masonry task.
Typical Employee Comments about Masoning:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, back and legs/feet.
Suggested Level II Analysis:	Postural Analysis, Elemental Task Analysis, Dynamic Task Analysis, NIOSH Lifting Analysis (if applicable).

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 • Work location is too far away (see Fig 1.1) **Figure 1.1**	123. Raise the person • use a step stool, platform or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		117. Provide support for the upper body • move with the work side to side-move feet rather than the arms		✓	med	med	high
		20. Incorporate rest pauses	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Carrying and lifting bricks – holding/lifting unstable loads – no hand holds	48. Provide a cart • transport bricks on transport trolley		✓	med	med	med
	• Throwing bricks or other supplies up to higher elevations or to scaffold	61. Provide a mechanical lift device • use a bucket and pulley system to raise and lower supplies		✓	med	med	high
3. High Speed sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck	• Looking down to monitor	20. Incorporate rest pauses	✓		low	med	med

Shoulder/Neck

bent or twisted	quality of work						

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	• Using hand treadle tool on a horizontal surface (see Figure 1.2) **Figure 1.2**	77. Provide a tool with an appropriate handle angle • provide angled/bent tool handle for different tasks • Add a multi-position hinge to current tool handles to maximize flexibility	✓	✓	med low	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Tool or materials are too heavy • Handle is too heavy or large for easy gripping	59. Provide a lighter weight tool 13. Encourage ergonomic work techniques • avoid picking up more than one brick at a time • pick up items at a point where the weight is balanced	✓ ✓	✓	med low low	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
		76. Provide a tool which requires minimal force to use • all tools which must be pulled or used as spreaders should be equipped with full handles		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Design or poor condition of tamping tool can expose worker to high levels of impact or vibration	74. Provide a tool that minimizes exposure to vibration/impact/torque • inspect and repair tool on a regular basis to eliminate unnecessary vibration	✓		med	med	med
		• provide a tool that emits less vibration		✓	med	med	med
		13. Encourage ergonomic work techniques • keep the tamping tool upright and level	✓		low	med	med
		• let the weight of the tamping tool do the work-the worker should only guide the tool	✓		low	med	med
10. Exposure to hard edges	• Rarely occurs	N/A					

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	• Work area is too cold	110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		low	med	med
		93. Provide appropriate gloves	✓		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	• Work location is too low (see Figure 1.3) **Figure 1.3**	20. Incorporate rest pauses 31. Lower the person • provide a chair or stool to sit on (for certain bricking applications) 117 Provide support for the upper body	✓ ✓	 ✓ ✓	low med med	med med med	med med high
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions 38. Move closer to the work location	✓ ✓		low low	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static awkward back postures	• Work location is too low	20. Incorporate rest pauses 31. Lower the person • provide a chair or stool to sit on (for certain bricking applications) 117 Provide support for the upper body	✓ ✓	 ✓ ✓	low med med	med med med	med med high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Lifting weights such as stacks of bricks or tamper or stacks of reinforcement bars – holding/lifting unstable loads – no hand holds	61. Provide mechanical lift device • transport bricks on transport trolley	✓		med	med	med
		• use straps at each end to load and use two employees to carry the load	✓		med	med	med
		• use a bucket and pulley system to raise and lower bricks or other materials		✓	med	med	med
		78. Provide a wheel barrow		✓	med	med	med
		126. Reduce carry distance • drive vehicle closer to work area to unload bricks	✓		low	low	high
		13. Encourage ergonomic work techniques	✓		low	med	med
		4. Change lifting/carrying task to a rolling or sliding task • add wheels to tamping tool or other heavy or bulky equipment to facilitate transport to the work area		✓	med	med	high

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	• Pushing or pulling wheel barrel – Poor wheel design – Poor wheel maintenance	19. Improve wheel condition • repair wheels • provide wheels with appropriate bearings and tread composition 13. Encourage ergonomic work techniques • avoid overloading carts or wheel barrels	✓ ✓	 ✓	med med low	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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees and feet	• Kneeling causes external pressure to the knees	95. Provide appropriate knee protection • provide knee pads • provide a cushion to kneel on	✓	✓	med low	med med	med med
21. Awkward leg positions	• Work location is too low	31. Lower the person • provide a stool or chair to sit on, if appropriate	✓		med	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/high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Mediablasting - Blast Cabinet	
TASK TITLE: Mediablasting - Blast Cabinet	
Task Description:	Media blasting involves using an air system in which grit is entrained making a very abrasive stream. This combination is effective for removing paint, rust, and other coatings. It is particularly effective for removing coverings and coatings from irregularly shaped surfaces (generally metals) where sanding or liquid dunking is not possible or practical. This task is performed while standing or sitting on a tall stool. Hands are placed into gloves which are extended into the media blasting enclosure or cabinet. The part to be cleaned/stripped is inside of the enclosure as is the high pressure nozzle. The abrasive stream is then aimed, via the nozzle, to the surfaces of the part to be cleaned/stripped. The part is then moved, rotated, or otherwise manipulated such that all necessary surfaces are accessible to the operator. Parts are loaded and unloaded through a door in the side of the enclosure. Typical jobs in which media blasting is performed include (not necessarily limited to): • coating and plating operations • finishing/painting operations • rework operations.
Job Performance Measures Most Often Impacted by Mediablasting:	Complete removal of desired material Completion of task in desired period of time
Typical Employee Comments about Mediablasting:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, the shoulders/neck, the lower back, and the legs/feet. The primary body regions of concern are: shoulders/neck, hands/wrists/arms The secondary body regions of concern are: back/torso, legs/feet
Suggested Level II Analysis:	Grip Force Measurement, Posture Analysis

Shoulders/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Arm portals are too high • Work piece is too high	123. Raise the person • provide several fixed-height platforms which can be easily moved into place for different sized people	✓		low	med	med
		• provide a height-adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface • provide an ability to adjust the height of the work piece inside the cabinet	✓		low	med	med
		112. Provide support for the arms • provide a padded, compressible surface to rest arms	✓		low	med	med
		• provide adjustable arm supports that are mounted at the base of the arm portals		✓	med	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Force required to control blasting nozzle	116. Provide support for the tool • provide an articulating arm to support and resist the reaction force of the blasting nozzle		✓	med	med	med

Shoulders/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Holding work piece while blasting	118. Provide support for the work piece • provide a fixture or clamp to stabilize the work piece • the fixture should allow the component to be rotated (as necessary to present all surfaces which need to be blasted)		✓ ✓	med high	med med	med high
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low • Worker cannot view part detail necessary without bending neck	124. Raise the work piece/work surface • add risers inside cabinet 136. Rotate the work piece • provide a fixture to allow the component to be rotated to the desired position	✓	✓	low 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	• Orient manual positions of the component • The need to position the blast nozzle	136. Rotate the work piece • provide a fixture to allow the component to be rotated to the desired position 75. Modify the tool • add an auxiliary handle to the nozzle • redesign the nozzle/hose to incorporate hinge/pivot feature		✓ ✓ ✓	med med med	med med med	med med high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Positioning nozzle creates resistance • Inadequate grip surface	116. Provide support for the tool • provide an articulating arm support to resist the reaction force of the blasting nozzle. This tool support should have a pivot capability to allow the operator to guide the tool without applying a large amount of force		✓	med	med	med
		145. Modify the tool • add an auxiliary handle		✓	low	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• High speed movements required for some blasting tasks	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med
	• Blasting causes exposure to vibration	116. Provide support for the tool • provide a tool balancer that absorbs the shock and vibration		✓	med	med	med
		74. Provide a tool that minimizes exposure to vibration/ impact/ torque • provide a nozzle with vibration dampening material built into the handle		✓	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	• Hard edges on blasting nozzle	9. Eliminate exposure to hard edges • provide a nozzle with a handle which is round and smooth with no ridges or edges		✓	med	med	med
		• cover or wrap hard edges (Caution: be sure not to increase the handle diameter significantly greater than 1.5". This can increase grip forces required)	✓		low	med	med
	• Hard edges on arm portals	9. Eliminate exposure to hard edges • pad the edges of the arm portal with a compressible material	✓		med	med	med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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	• Rarely occurs	N/A					
13. Twisting of the lower back	• Picking up the blast nozzle from the bottom of the cabinet • Reaching to access remote areas of the work piece	116. Provide support for the tool • provide a tool balancer • provide a hook 118. Provide support for the work piece • provide a fixture to support the work piece the fixture should allow the component to be rotated (as necessary to present all surfaces which need to be blasted)	 ✓	✓ ✓	med low med	med med med	med med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Arm portals are too low • Work piece is too low	124. Raise the work piece/ work surface					
		• raise the height of the arm portals so everyone can operate the blast cabinet without having to bend over	✓	✓	med	med	med
		• provide an ability to adjust the height of the work piece using risers inside cabinet		✓	med	med	med
		31. Lower the person					
		• provide a chair (assumes that leg clearance is available for sitting) or sit stand stool		✓	med	med	med
		• provide several fixed-height platforms which can be easily moved into place for different sized people	✓		low	med	med
		• provide an height-adjustable platform		✓	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
	• Work location is too far away	41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Inadequate leg clearance for sitting	80. Provide adequate leg clearance • provide a blast cabinet that provides adequate leg clearance for sitting while blasting		✓	med	med	med
	• Inadequate lower back support • Inappropriate chair adjustment • Inappropriate chair design	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	med	med
		• provide a chair with adequate lower back support		✓	med	med	med
16. Lifting forces	• if occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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	87. Provide an appropriate chair/stool		✓	med	med	med
		5. Change posture frequently	✓		low	med	med
		52. Provide a footrail or footrest	✓	✓	med	low	low
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Knees press against hard side of cabinet	9. Eliminate exposure to hard edges • attach a pad to the blast cabinet to protect the knees	✓		low	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Standing foot pedal causes awkward leg and back postures	134. Replace standing foot pedals with alternative controls • provide a remote, hand operated control		✓	med	med	med
		145. Modify footpedal • provide a heel block • recess footpedal off the front end of a platform	✓ ✓		low low	med med	med med

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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text x	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Mediablasting - High Pressure Gun	
TASK TITLE: Mediablasting -High Pressure Gun	
Task Description:	Media blasting involves using a high pressure fluid or air system in which grit is entrained making a very abrasive stream. This combination is effective for removing paint, rust, and other coatings. It is particularly effective for removing coverings and coatings from irregularly-shaped surfaces (generally metals) where sanding or liquid dunking is not possible or practical. This task is performed while standing inside of a large enclosure with the part(s) to be cleaned/stripped. The worker is in full body protective clothing including helmet and face shield. The abrasive stream is aimed, via the nozzle, to the surfaces of the part to be cleaned/stripped. The part is then moved, rotated, or otherwise manipulated such that all necessary surfaces are accessible to the operator. Parts are loaded and unloaded through a door in the side of the enclosure. Typical jobs in which media blasting is performed include (not necessarily limited to): • coating and plating operations • finishing/painting operations • rework operations
Job Performance Measures Most Often Impacted by Media Blasting-High Pressure Gun:	• Complete removal of desired material • Completion of task in desired period of time
Typical Employee Comments about Media Blasting-High Pressure Gun:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, the shoulders, the neck, and the legs/feet. The primary body regions of concern are: shoulders/neck, hands/wrists/arms The secondary body regions of concern are: In cases where heavy components must be repositioned or lifted, the back may also be impacted, legs/feet.

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					
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface					
		• modify/lower existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Work location is fixed	136. Rotate the work piece					
		• provide a turntable to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
	• Surfaces that must be sprayed are flat/horizontal orientation	136. Rotate the work piece					
		• provide a turntable to allow the work piece to be rotated from flat to upright		✓	med	med	med
		• turn the work piece to an upright position, manual	✓		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/carry-ing materials	• Force required to control blasting nozzle • Inadequate gripping surface	116. Provide support for the tool • provide a tool balancer to support and resist the reaction force of the blasting nozzle		✓	med	med	med
		94. Provide appropriate handles • attach an auxiliary handle with a hose clamp	✓		low	med	med
	• Hose must be manually supported, held or steadied	113. Provide support for the tool • provide a tool balancer to support the hoses		✓	med	med	med
		• use a hanger or hook to keep the hose off the floor	✓	✓	med	low	low
		• put hose over shoulder/use shoulder as hose support	✓		low	med	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

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	• Inappropriate tool handle for the task	77. Provide a tool with an appropriate handle angle					
		• provide a tool with a pistol-type handle		✓	med	med	med
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of tool with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger • extend trigger on existing tool (if feasible and safe)	 ✓	✓ ✓	med med	med med	med med
8. Hand/grip forces	• Tool must be manually supported, held or steadied; force from nozzle increases force	113. Provide support for the cable or hose • provide a hook to hang cable in work area		✓	med	med	med
	• Nozzle provides high force to hands	116. Provide support for the tool • provide a tool balancer to support and resist the reaction force of the blasting nozzle (this tool support should have a pivot capability to allow the operator to guide the tool without applying a large amount of force and articulating arm is preferred for this application)		✓	high	med	high
	• Tool is too heavy	59. Provide a lighter weight 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
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter of between 1"-1.5" (2.5-3.8cm) is appropriate for this task		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Blasting causes exposure to vibration	116. Provide support for the tool • provide a tool balancer; an articulating arm absorbs shock and vibration		✓	high	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a tool with vibration dampening material built into the handle		✓	high	med	med
		• wrap the handle with vibration damping material		✓	med	med	med
		20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	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	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold • Metal tool body is not insulated	23. Increase room temperature		✓	med	med	med
		105. Provide portable heaters		✓	med	med	med
		104. Provide handles with temperature insulating material		✓	med	med	med
		93. Provide appropriate gloves	✓	✓	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	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece		✓ ✓	med high	med med	med high
	• Work location is too far away	136. Rotate the work piece • rotate the work piece manually • provide a turntable fixture (that locks) to allow the work piece to be rotated	✓	✓	low med	med med	med med
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• 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
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		20. Incorporate rest pauses	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (if it occurs, see the Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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	96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
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 • increase enclosure lighting		✓	med	high	high
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Melting (Small Parts)	
TASK TITLE: Melting (Small Parts)	
Task Description:	Melting of small parts involves heating a substance (such as wax) and applying it to a part requiring many fine movements. This task may be performed from the seated or standing position. Hand tools with pencil size grips may be employed to perform the task. Task duration is dependent on the complexity or nature of the product. Typical jobs in which melting small parts is performed include (not necessarily limited to): • dental lab
Job Performance Measures Most Often Impacted by Melting (Small Parts):	Final quality of product (characteristics identified by lab).
Typical Employee Comments about Melting (Small Parts):	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms and shoulders/neck.
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 is performed in a restricted space	41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
	• Jig or fixture is not available	136. Rotate the work piece • provide fixture or jig with rotational capability		✓	med	med	med
	• Work location is too high or too far away	83. Provide an adjustable height lift table		✓	high	med	med
		123. Raise the person • use a step stool • provide an adjustable platform	✓	✓ ✓	low high	med med	med high
		41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
2. Arm forces: Repeated contraction of arm muscles or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder	• Rarely occurs	N/A					

movements							

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	• Lighting is not appropriate for the detail required	22. Increase light levels • provide a task light which is easy to adjust • increase room lighting • provide a task light with a magnifying glass		✓ ✓ ✓	med high med	med high high	med high high
	• Object is located flat on the work surface	136. Rotate the work piece • provide a fixture or jig with rotational capability		✓	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	• Work objects are located too far away	41. Move work piece closer to body • move supplies and tools within easy reach 136. Rotate the work piece • provide fixture with rotational capability	✓	 ✓	low med	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Work piece must be hand held	136. Rotate the work piece • provide a fixture or jig with rotational capability		✓	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
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station has sharp or hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		112. Provide support for the arms		✓	med	med	med
		• add padded arm rest extensions to table top					
	• 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" (12.7cm) in length		✓	med	med	med
		• wrap handle with fabric tape	✓		low	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	• Rarely occurs	N/A					

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 surface too low	124. Raise the work piece/work surface • raise the table onto blocks	✓		low	med	med
	• Lighting is not appropriate for the detail required	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
		• provide a task light with a magnifying glass		✓	med	high	high
	• Movement around work area is restricted	79. Provide a work surface which is adjustable in height		✓	med	med	med
		81. Provide adequate toe clearance • provide toe spaces at standing work stations		✓	med	med	med
13. Twisting of the lower back	• Work objects are located too far away	41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
		136. Rotate the work piece • provide fixture		✓	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
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Chair is inappropriate for task	115. Provide support for the lower back • adjust the chair's backrest forward • provide a chair which has an adjustable floating backrest	✓	✓	low med	med med	med med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest	✓	✓	med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓ ✓		low low	med med	med med
	• Work surface does not have toe spaces	81. Provide adequate toe clearance • provide toe spaces at standing work stations.		✓	med	med	med
21. Awkward leg postures	• Chair is too high/dangling feet	52. Provide a footrail or footrest	✓	✓	med	low	low
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Monitoring	
TASK TITLE: Monitoring	
Task Description:	For maintenance and inspection tasks, monitoring is generally performed within the context of another task such as machining or pressure checking. Monitoring refers to the process of continually or repeatedly viewing gauges or computer screens. The monitoring task is similar to using a computer and to machine aided visual inspection. Monitoring differs from using a computer in that using a computer involves keying or other data entry while monitoring is primarily limited to viewing of the information. The distinction between monitoring and inspection is that monitoring involves processed information (a gauge, dial or readout) while inspection is looking at the item itself.
Job Performance Measures Most Often Impacted by Monitoring:	• Ensuring that the system performs appropriately • Detection and correction of parameters which impact safety, system performance, and product quality.
Typical Employee Comments about Monitoring:	Employees most often report fatigue or discomfort in the following body regions: shoulders/neck, or head/eyes.
Suggested Level II Analysis:	Postural Analysis, Light measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Rarely occurs	N/A					
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Display is improperly positioned -too high -too low -off-center	18. Improve visual access to work • position frequently accessed displays 0-4" below eye level	✓	✓	med	med	low
		• position frequently accessed displays directly in front of person	✓	✓	med	med	low
		• angle off-center displays towards the person	✓	✓	med	med	low
	• Display is too far away	39. Move monitor/screen closer to body • position displays between 18"-30"(46-76 cm) 22-24"(56-61 cm) is a good distance for general tasks		✓	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
	• Readouts are too small	18. Improve visual access to work					
		• use digital displays only when exact values are needed		✓	low to high	med	med
		• use analog displays when trends, ranges or status values are needed		✓	low to high	med	med
		• ensure that all numbers and messages are easily readable (character height at least .25") for normal (18-30"(46-76 cm)) viewing distances		✓	low to high	med	med
	• Light levels are too low	22. Increase light levels					
		• provide a task light which is easy to adjust	✓		med	med	med
		• increase room lighting		✓	high	high	high

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	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/ thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

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	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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	• Display is too low	30. Lower the monitor screen • position frequently accessed displays 0-4” (0-10cm) below eye level	✓		low	med	low
	• Display is too far away	39. Move monitor/screen closer to body • position displays between 18”-30” (45.7-76.2 cm) • 22”-24” (55.9-61 cm) is a good distance for general tasks		✓	low to high	med	med
	• Display readout is too small	18. Improve visual access to work • use digital displays only when exact values are needed		✓	low to high	med	med
		• use analog displays when trends, ranges or status values are needed		✓	low to high	med	med
		• ensure that all numbers and messages are easily readable (character height at least .25”(.64 cm)) for normal (18-30”(46-76cm)) viewing distances		✓	low to high	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		14. encourage person to have visual disorders corrected • regular eye exams • use of trifocals or other prescription glasses suited to viewing monitor distances without backwards neck bending	✓	✓	med med	med med	med med
13. Twisting of the lower back	• Display is off center	18. Improve visual access to work • position frequently accessed displays directly in front of person • angle off-center displays towards the person	✓ ✓		med med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Display readout is too small	124. Raise the work piece/work surface • raise the monitor	✓		low	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • 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 a chair with adequate lower back support	✓ ✓ ✓	✓	low low low med	low low low med	med med med med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded, compressible surface to sit on • use a cushion eliminate exposure to pressure point	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med to high	med	med
	• Work station has hard edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
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 a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
	• Light levels too high	27. Lower the light levels		✓	high	low	med
	• Gauges/Displays are poorly positioned	18. Improve visual access to work					
		• position frequently accessed displays 0-4” (0-10 cm) below eye level	✓	✓	med	med	med
		• position frequently accessed displays directly in front of person	✓	✓	med	med	med
		• angle off-center displays towards the person	✓	✓	med	med	med
	• Glare reflected on monitor or off work surface	109. Provide protection from glare from overhead lights/task lights					
		• provide screen hood/visor.	✓		med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
		• position monitor between overhead lights.	✓	✓	med	low	low
		• tilt monitor down to change the angle of reflection	✓		low	low	low

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Task light causes glare	109. Provide protection from glare from overhead lights/task lights • direct task light away from screen and eyes	✓		low	low	low
	• Position of window in relation to monitor (in front or behind person) causes glare	108. Provide protection from glare (from natural light) • place monitor perpendicular to the window.	✓	✓	med	low	low
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med	med	med
	• Monitor positioned too close to eyes.	40. Move monitor/screen further away from body • position monitor 18 -30" (46-76 cm) from the eyes	✓	✓	med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Monitor positioned too far from eyes.	39. Move monitor/screen closer to body • position monitor 18 -30" (46-76 cm) from the eyes		✓	med	med	med
	• Uncorrected visual disorders.	14. Encourage person to have visual disorders corrected • encourage person to have eyes checked and corrected for visual disorders.	✓		low	med	med
		• use of trifocals or other prescription glasses suited to viewing monitor distances without backwards neck bending		✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Task lacks variety	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

CASE STUDY - Nailing	
TASK TITLE: Nailing	
Task Description:	Nailing involves the use of a hammer or nail gun to drive nails into a variety of materials. The hammering task can be done at a variety of heights and locations. Task duration is dependent on the complexity or nature of the product. Hammers and nail guns vary in size and weight depending on the size nail to be used and the type of material to be nailed. Typical jobs in which nailing is performed include: • carpentry • crating or other wood assembly processes • general maintenance Nailing may take place on bench tops, directly on wood structures, or on the floor.
Job Performance Measures Most Often Impacted by Nailing:	• Quality of the final product (structural integrity, free of defects, appearance) • Speed of completion of task
Typical Employee Comments about Nailing:	Personnel typically report fatigue or discomfort in the hands/wrists/arms, shoulders/neck and lower back. Primary: The primary body regions affected are typically the hands/wrists/arms and shoulders/neck. Secondary: In some cases, the following body regions are also affected: back/torso.
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Grip Force Measurement

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 or ladder	✓	✓	low	med	med
		• provide a fixed platform or scaffolding	✓	✓	med	med	med
		32. Lower the work piece/work surface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Number of fasteners determines the amount of nailing required	129. Reduce number of fasteners used	✓	✓	low to med	med	med
		140. Use alternative fasteners					
		• Use fasteners (such as screws) that reduce number of fasteners needed		✓	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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Manual nailing causes high forces	66. Provide a power tool • use a power tool which does not require high force or high speed movements to activate (see Design Criteria section for power tool design criteria)		✓	med	med	med
	• Nail gun is heavy	59. Provide a lighter weight tool • provide lighter weight tool • provide appropriate sized hammer for each task		✓ ✓	med med	med med	med med
	• Carrying pieces of wood over long distances is fatiguing for arms	48. Provide a cart • use an available cart to transport wood	✓		low	med	high

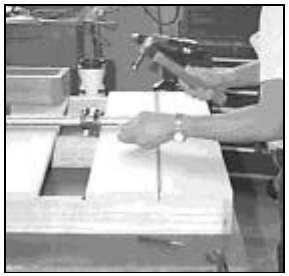
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Manual nailing causes high speed movements	66. Provide a power tool • use a power tool which does not require high force or high speed movements to activate (see Design Criteria section for power tool design criteria) 140. Use alternative fasteners • Use fasteners (such as screws) that reduce number of fasteners needed		✓ ✓	med med	med med	med med
4. Head/neck bent or twisted	• Rarely occurs to any significant exposure level	N/A					

Hand/Wrist/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 nailing causes wrist movements (see Figure 1.1) **Figure 1.1** • Nailing is performed on flat work piece with a pistol-shaped nail gun.	77. Provide a tool with an appropriate handle angle • use a power tool which does not require awkward wrist movements or postures (see Design Criteria section for power tool design criteria) 136. Rotate the work piece • turn the work piece to an upright position/angle forward	 ✓	✓	med low	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Using nail gun causes repeated single finger trigger activation	62. Provide a multi-finger trigger • provide a tool with a two-finger trigger		✓	med	med	med

Hand/Wrist/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	• Tool or work piece must be manually supported, held or steadied (see Figure 1.2)  **Figure 1.2**	118. Provide support for the work piece • use clamp to stabilize part		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		• wrap the hammer handle with friction tape	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide appropriate sized nail gun for the particular task		✓	med	med	med
	• Force required to activate the nail gun is excessive	34. Maintain hand tools/power tools • repair and lubricate tool to minimize forces required to activate	✓		low to med	med	med
		76. Provide a tool which requires minimal force to use • provide a nail gun with minimal force required to activate		✓	med	med	med

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Force required to pound nails is excessive	140. Use alternative fasteners • Use fasteners (such as screws) that reduce number of fasteners needed and reduce forces required		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Manual nailing causes high speed movements and impact	66. Provide a power tool • provide a pneumatic nail gun		✓	med	med	med
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	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
		105. Provide portable heaters		✓	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	• Rarely occurs (See question 15, static awkward postures)	N/A					
13. Twisting of the lower back		132. Remove obstructions	✓		low	med	med
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • provide a pad/mat	✓		med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 66. Provide a power tool • increase the speed of the task to decrease the time bent forward.		✓ ✓ ✓	med med high	med med med	med med high
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 on hard surface	96. Provide appropriate shoe inserts	✓		med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Hard edges in work area contact legs/knees • Kneeling required	95. Provide appropriate knee protection	✓		med	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • place the work piece on a fixed table • provide a support fixture	✓	✓	low med	med med	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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Opening/Closing Heavy Doors	
TASK TITLE: Opening/Closing Heavy Doors	
Task Description:	Opening and closing of heavy doors is a task which often must be performed prior to initiating or completing the primary work tasks**.** The types of doors may include large hangar doors that move sideways on tracks, doors that move up and down on rollers or tracks, and large hinged doors on buildings or pieces of equipment. The defining characteristics of doors in this case study is that they are moved, not removed (i.e., it is never necessary to manually support the full weight of the door).
Job -- Performance Measures Most Often Impacted by Opening/Closing Heavy Doors:	There are typically no performance measures associated with the Open/Close Heavy Doors task. However, a door which is difficult to move may be left open making temperature control inside a shop difficult to maintain.
Typical Employee Comments about Opening/Closing Heavy Doors:	Employees do not typically complain about fatigue and discomfort associated with opening/closing heavy doors. They are, however, typically concerned about hurting their backs when they must deal with a door that is in disrepair or that is otherwise difficult to move. Primary body regions affected (or injured) include the shoulders, and lower back. Secondary body parts affected may include legs/feet, and sometimes the hands.
Suggested Level II Analysis:	Biomechanical Lifting Analysis, Push/Pull Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
1. Reaching	• Rarely occurs	N/A					
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Weight of door is excessive	107. Provide powered or mechanical assistance for door					
		• modify existing door		✓	med	med	med
		• add counter balance to decrease effort		✓	med	med	med
		• add a motor to eliminate manual opening/closing		✓	med	med	med
		58. Provide a lighter weight door					
		• replace heavy door with light-weight door		✓	high	med	med
		61. Provide a mechanical lift device					
		• use a hoist/lifting device to assist in opening /closing vertical doors		✓	high	med	high
	• Tracks, rollers or movement mechanism are worn or out of alignment	35. Maintain tracks, rollers, and movement mechanisms	✓		med	med	med
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		low	med	med
		• Clean and lubricate tracks, rollers or movement mechanisms.					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
3. High speed, sudden shoulder movements	• Procedure used by employee places unnecessary stress on shoulder	13. Encourage ergonomic work techniques					
		• use entire body and momentum (lean) to move door	✓		low	low	low
		• move door slowly and increase speed as the door begins to move	✓		low	low	low
	• Tracks, rollers or movement mechanism are worn or out of alignment	35. Maintain tracks, rollers, and movement mechanisms					
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		med	med	med
		• clean and lubricate tracks, rollers or movement mechanisms.	✓		low	med	med
4. Head/ neck bent or twisted	• Rarely occurs	N/A					

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 10. Exposure to hard edges	• Handle or gripping surface is too small or does not exist	94. Provide appropriate handles • modify existing door • provide auxiliary handle: – avoid use of "cut-out" for handle – if "cut-out" is necessary, provide a vertical bar inside cut-out to enable the person to use a full hand grip • attach external vertical handle		✓ ✓ ✓	med med med	med med med	med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Handle or gripping surface is too small, is inappropriate, or does not exist	3. Change a pinch grip to a power grip • replace fingertip latches with larger latches that can be activated using the whole hand		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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	• Handle is too low (see Figure 1.1) **Figure 1.1** • Door location/access is too far away	121. Raise the handle • raise the door handle 55. Provide a hook-type tool to pull items • use a hook to initiate a pull from floor level 132. Remove obstructions • remove obstructions along the path of travel	 ✓ ✓	✓ ✓ ✓	med low to med low to med	med med med	med med med
13. Twisting of the lower back	• Handle or gripping surface is too small or does not exist	94. Provide appropriate handles • modify existing door • provide auxiliary handle: – avoid use of "cut-out" for handle – if "cut-out" is necessary, provide a vertical bar inside cut-out to enable the person to use a full hand grip • attach an external vertical handle	 ✓	 ✓ ✓	 med med med	 med 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
	• Procedure used by employee places unnecessary stress on shoulder	13. Encourage ergonomic work techniques					
		• provide training to illustrate proper method	✓		low	low	low
		• use entire body and momentum (lean) to move door	✓		low	low	low
		• push rather than pull, whenever possible	✓		low	low	low
		• face the direction of movement when pushing	✓		low	low	low
		• use 2 hands or keep the body balanced when pulling	✓		low	low	low
14. High speed, sudden movements	• Procedure used by employee places unnecessary stress on shoulder	13. Encourage ergonomic work techniques					
		• provide training to illustrate proper method	✓		low	low	low
		• use entire body and momentum (lean) to move door	✓		low	low	low
		• move door slowly and increase speed as the door begins to move	✓		low	low	low
	• Tracks, rollers or movement mechanism are worn or out of alignment	35. Maintain tracks, rollers, and movement mechanisms.					
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		med	low	med
		• clean and lubricate tracks, rollers or movement mechanisms.	✓		low	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
15. Static, awkward back postures	• Rarely occurs						
16. Lifting forces	• Weight of door is excessive	107. Provide powered or mechanical assistance for door.					
		• modify door		✓	med	med	med
		• add counter balance to decrease effort	✓	✓	med	med	med
		• add a motor to eliminate manual opening/closing		✓	med	med	med
		58. Provide a lighter weight door					
		• replace heavy door with light-weight door		✓	high	med	med
	• Tracks, rollers or movement mechanism are worn or out of alignment	61. Provide a mechanical lift device					
		• a hoist/lifting device to assist in opening /closing vertical doors		✓	high	med	high
		35. Maintain tracks, rollers, and movement mechanisms					
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		med	med	med
		• clean and lubricate tracks, rollers or movement mechanisms.	✓		low	high	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Ordnance Disposal	
TASK TITLE: Ordnance Disposal	
Task Description:	Ordnance disposal involves responding to the discovery of an unidentified device or possible explosive device. A team of individuals responds to identify the device and determine whether or not the device is an active explosive. Completing these procedures often requires members of the team to repeatedly walk large distances (e.g., 300 - 1000 meters) to and from the device. Heavy pieces of equipment are also carried by the employee over these distances. After the team has determined the status of the device, the device is exploded/deactivated, or otherwise removed from the area. The task involves loading/unloading equipment (e.g., x-ray) onto trucks, traveling to the site, donning specially designed protective gear, and completing the tasks described above.
Job Performance Measures Most Often Impacted by Ordnance Disposal:	Response time is a primary measure of performance. Factors that appear to impact that response time include: • time to unpack and don the protective suit; • time to load equipment onto truck; and • time to unpack/prepare equipment for use in the field. The measure of success is safety, avoidance of injury to individuals or damage to the surrounding area.
Typical Employee Comments about Ordnance Disposal:	Employees first comment about the weight and bulk of the protective suit and the increased fatigue that the suit causes while walking great distances. Primary body parts affected, based on employee complaints of discomfort, are the arms, shoulders, and low back. Secondary concerns are for the legs and feet.
Suggested Level II Analysis:	Dynamic Task Analysis, Biomechanical Lifting Analysis, Metabolic Energy Expenditure Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• The employee is too low for "dressing" the other employee with protective suit (see Figure 1.1) **Figure 1.1**	123. Raise the person • provide a stable work platform to assist with dressing torso, shoulders and head • employee being dressed can step up or down to different heights	✓ ✓	✓	med low	med med	med med
2. Arm forces: Repeated contractions of the muscles of the arm or holding/carry-ing materials	• The need to carry heavy equipment over great distances increases stress	48. Provide a cart • place all equipment cases on permanent rollers or wheel carts • fabricate a carrier equipped with a wheel to transport individual pieces of equipment to and from the device 131. Reduce weight of work piece • light-weight equipment and /or storage containers		✓ ✓ ✓	med med high	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
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

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	• Complexity of suit design increases demands and hands and wrists	11. Eliminate unnecessary tasks • simplified suit design		✓	high	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					

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	• Working in a cold environment exposes the hands to cold.	104. Provide handles with insulating material • add insulating material to equipment handles to prevent heat transfer		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		med	med	med
		93. Provide appropriate gloves	✓		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	• Ground level storage of equipment and containers (see Figure 1.2) **Figure 1.2**	83. Provide an adjustable-height lift table • large collapsible work platform/table on which equipment and containers can be placed as they are unloaded from the truck.		✓	high	med	high
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• The need to manually carry portable equipment increases force.	48. Provide a cart • fabricate a carrier equipped with a wheel to roll individual pieces of equipment to and from the device location		✓	med	med	med
	• Inappropriate storage container design increases handling requirements	11. Eliminate unnecessary tasks • equip storage cases with hinges so that they may be opened without the employee having to lift and support the weight of the cover.		✓	med	med	med
	• Equipment and suit is stored away from the truck	11. Eliminate unnecessary tasks • dedicated storage area • storage on secured trucks to enable team to store suits and all equipment on trucks; eliminate the need for transferring equipment		✓ ✓	med med to high	med med	med med
17. Pushing or pulling	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Knees are exposed to hard edges during kneeling	95. Provide appropriate knee protection • reinforce knee area of protective suit to provide cushioned surface for kneeling		✓	med	med	med
21. Awkward leg postures	• Storage of equipment and cases at floor or ground level requires the employee to kneel or squat (see Figure 1.3) **Figure 1.3**	124. Raise the work piece/work surface • provide large collapsible work platform/table on which equipment and containers can be placed as they are unloaded from the truck.		✓	high	med	high
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 • equip truck or team with area flood light		✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Packing	
TASK TITLE: Packing	
Task Description:	Packing involves lifting the product and placing it into a container. Once it is placed into the container the individual manually pulls the edges of the fabric together to produce a complete package. Cords are manually pulled through the holds of the outer fabric to tighten and size piece. The packing pattern must be followed for each type of product (patterns outlined in product manual). Most packing patterns are performed by two individuals due to the size of the product and the force required to pack the work piece. Typical jobs in which folding is performed include (not necessarily limited to): • Parachute packing • Raft packing The packing process can be performed on a table or on the floor surface.
Job Performance Measures Most Often Impacted by Packing:	Quality of the product (packing). Speed of packing
Typical Employee Comments about Packing:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, back and legs/feet. Primary concern: back/torso and legs/feet Secondary concern: hands/wrists/arms
Suggested Level II Analysis:	Dynamic task analysis, Postural Analysis, Grip Force Measurement

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 (see Figure 1.1) **Figure 1.1**	123. Raise the person • use a step stool, platform or ladder	✓	✓	low to med	med	med
		32. Lower work piece		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location • remove obstruction	✓		low	med	med
		41. Move work piece closer to body	✓		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/carry-ing materials	Pulling cords or container is difficult (see Figure 1.2) **Figure 1.2** • Poor hand holds • Poor housekeeping • Poor floor condition • Carrying folded packed work piece more than three steps	55. Provide a hook-type tool to pull items • provide curved hook to assist pulling cord. 26. Improve floor condition • repair cracks or gaps in floor and • provide ramps to compensate for minor differences in floor height • Improve housekeeping 48. Provide a cart • provide trolley to move work piece 61. Provide a mechanical lift device	✓ ✓	✓ ✓ ✓ ✓	low to med med to high med to high low med med	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
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.3) **Figure 1.3** • Work location is too high	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		13. Encourage ergonomic work techniques • educate person to work in a kneeling position when item is located on floor surface (provide knee protection). .	✓		low	med	med
		123. Raise the person • provide fixed height platform		✓	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	• Work location is blocked or is in an inappropriate orientation • Work location is too high	136. Rotate the work piece • rotate the work piece manually 123. Raise the person • use a fixed platform	✓		low	med	med
				✓	med	med	med
6. Repeated manipulations with fingers	• Task is repetitive in nature requiring similar movement patterns.	20. Incorporate rest pauses	✓		low	med	med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Excessive force required to tighten cord and pack	13. Encourage ergonomic work techniques • twist cord around T-hook to assist with pulling cords. • use knee rather than hand to push down on pack when item is located on floor surface.	✓		low	med	med
			✓		low	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
	• Small diameter of the cord	3. Change a pinch grip to a power grip • twist cord around a small rod to change the grip from a pinch to a power grip.	✓		low	med	med
9. High speed hand/wrist/arm movement or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station has hard or sharp material edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓	✓	low med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 1.4) **Figure 1.4**	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide and adjustable table for work piece		✓ ✓	med high	med med	med high
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually 132. Remove obstructions	✓ ✓		low low	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	Lifting heavy packed objects • low height • no hand holds	61. Provide a mechanical lift device • provide lifting hoist to move raft or work piece		✓	high	med	high
		13. Encourage ergonomic work techniques • educate person on two man lift procedure	✓		low	med	med
17. Pushing or pulling	Pulling/pushing storage containers is difficult • Poor housekeeping • Poor floor condition • Lack of wheels on container	17. Improve floor condition • repair cracks or gaps in floor		✓	high	med	med
		• provide ramps to compensate for minor differences in floor height		✓	high	med	med
		• improve housekeeping	✓		low	med	med
		13. Encourage ergonomic work techniques • position packing container so that it does not have to be moved after loading	✓		low	med	med
		119. Provide wheels • mount wheels onto bottom of container		✓	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 on hard surface (see Figure 1.5) **Figure 1.5**	96. Provide appropriate shoe inserts 86. Provide an appropriate anti-fatigue mat	✓ 	 ✓	low med	med med	med med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work height too low (see Figure 1.6) **Figure 1.6**	1. Alternate between sitting and standing tasks • periodically stand up to change position. 95. Provide appropriate knee protection	 ✓ ✓		 low med	 med med	 med med

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
22. Standing foot pedal	• Rarely occurs	N/A					
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Painting/ Spraying	
TASK TITLE: Painting/Spraying	
Task Description:	Painting involves the use of a paint applicator such as a roller, or paint spray gun. Painting can be performed on a variety of surfaces and/or objects. Typical jobs in which painting is performed include: • construction • aircraft maintenance • vehicle maintenance Painting may be performed on vertical, horizontal, overhead, or floor surface, and on or under a variety of different surfaces/shapes.
Job Performance Measures Most Often Impacted by Painting:	Coverage and surface finish. Task completion on schedule.
Typical Employee Comments about Painting:	The most common reports of discomfort have been of the hand/wrist, shoulder and neck. The concentration can vary with the method used for paint application. Primary concerns are: shoulder/neck, hand/wrist/arm Secondary concerns are: back/torso, legs/feet
Suggested Level II Analysis:	Grip Force Measurement, Dynamic Task Analysis, Light Measurement

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	103. Provide extensions for tools • provide extensions on roller to improve arm posture while painting overhead or on high walls		✓	med	high	high
		123. Raise the person • use a step stool or ladder • provide a platform or scaffolding • provide painter's stilts	✓	✓ ✓ ✓	med high med	med med med	med high high
	• Painting is performed on flat work surface (see Figure 1.1) **Figure 1.1**	103. Provide extensions for tools • provide extensions on roller to improve arm posture while painting overhead		✓	med	med	med
	• Orientation of parts or spray technique requires a top to bottom (spraying from high to low) pattern	136. Rotate work piece • change from vertical to horizontal orientation to allow side-to-side spray pattern (arms move, wrists stay straight).	✓	✓	low to med	high	med
		13. Encourage ergonomic work techniques • spray in a side-to-side pattern	✓		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/carry-ing materials	Pulling hoses and carts used for spray paint systems • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • keep floor free of debris • repair cracks or gaps in floor 19. Improve wheel condition • repair wheels • provide wheels that are roll more easily 67. Provide a powered cart	 ✓ ✓ 	 ✓ ✓ ✓	 low low to med low med high	 med med med med med	 med med med med high
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too high (see Figure 1.2) **Figure 1.2**	114. Provide support for the head • provide a head and neck support which rests on the shoulders for continuous overhead work 123. Raise the person • provide a fixed platform • provide scaffolding 32. Lower the work piece/work surface • reduce height of existing table • provide an adjustable height work table 103. Provide extensions for rollers	 ✓ 	 ✓ ✓ ✓ ✓ ✓	 low med high med high med	 med med med med med med	 med med high med high 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	• Using wrist movements to paint with a brush or spray gun.	13. Encourage ergonomic work techniques					
		• encourage person to use arm movements rather than wrist movements while painting	✓		low	med	med
		• spray in a side-to-side pattern rather than an up-and down-pattern	✓		low	med	med
		106. Provide powered assistance for a manual activity			low to med	med	med
		• use a roller or a paint gun instead of a paint brush whenever large surfaces are being painted		✓			
	• Part is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		103. Provide extensions for tools		✓	med	med	med
		• to access tight locations					
	• Work location is too high causing awkward wrist positions	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform or scaffolding		✓	high	med	high
		• provide painter's stilts		✓	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
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of painting gun with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two finger or a four finger trigger • extend trigger on existing tool (if feasible and safe) 10. Eliminate need to constantly hold trigger • provide a tool with a toggle switch that allows continuous operation without holding the trigger down		✓ ✓ ✓	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
8. Hand/grip forces	• Part must be manually supported, held or steadied	118. Provide support for work piece • provide a fixture which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		113. Provide support for the cable or hose • provide a hook to hang spray in gun hose		✓	med	med	med
		• support air hose with a belt clip		✓	med	med	med
		76. Provide a tool which requires minimal force to use		✓	med	med	med
		• provide a swivel attachment for air hose on paint gun		✓	med	med	med
		• support air hose with a tool balancer or belt clip					
	• Tool is too heavy	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		59. Provide a lighter weight tool • Provide lighter weight housing for spray gun		✓	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
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length (provide adequate clearance for gloves)		✓ ✓	med med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs to any significant degree	N/A					

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) **Figure 1.3**	124. Raise the work piece/ surface • provide a fixed table to support part • provide an adjustable table for part • angle part using a wooden frame fixture 31. Lower the person • provide a chair/stool to sit on	✓ ✓	✓ ✓ ✓ ✓	low to med high med low to med	med med high med	med high med med
13. Twisting of the lower back	• Work location is in an inappropriate orientation • Work space or access is limited (such as under a structure)	136. Rotate work piece (bench work) • turn the work piece manually • provide a fixture to allow the work piece to be rotated 63. Provide a padded, compressible surface to lay on 124. Raise the work surface • use a hoist/lift device to raise the structure to create improved access	✓ ✓ ✓	 ✓ ✓	low med low high	med med med med	med med med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support part • provide an adjustable table for work piece 8. Distribute intensive activities throughout the process • perform the most awkward painting tasks intermittently if possible	✓	✓ ✓ ✓	low to med high med	med med med	med med med
16. Lifting forces	• Rarely occurs	• N/A					
17. Pushing or pulling	Pulling hoses and carts • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • keep floor free of debris • repair cracks or gaps in floor 19. Improve wheel condition • repair wheels • provide wheels that are roll more easily 67. Provide a powered cart	✓ ✓	✓ ✓ ✓	low med low med med to high	med 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 (see Figure 1.4) **Figure 1.4**	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 knee pads • provide a cushion to kneel on	 ✓ ✓		 low low	 med med	 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	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide knee pads • provide a chair/stool to sit on • provide a pad or cushion to kneel on	 ✓ ✓ ✓ ✓	 ✓ ✓ ✓	 low to med high low low low to med	 med med med med med	 med med med 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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Paving	
TASK TITLE: Paving	
Task Description:	Paving involves the operation of heavy equipment. The paver spends the majority of time in a seated position operating equipment levers (levers operate in a horizontal throw pattern). The duration of the task depends on the paving job assigned that day. Typical jobs in which paving is performed include (not necessarily limited to): • road repair and maintenance
Job Performance Measures Most Often Impacted by Paving:	• Integrity of the surface.
Typical Employee Comments about Paving:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms and back. The primary areas of concern are the hands/wrists/arms, back/torso and legs/feet. The secondary areas of concern are the shoulders/neck.
Suggested Level II Analysis:	Postural Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Task is repetitive and lacks variety	20. Incorporate rest pauses	✓		low	med	med
	• Controls are located too far away from employee (see Figure 1.1) **Figure 1.1**	87. Provide an appropriate chair/stool • provide chair with a vibration dampening seat pan, proper lumbar support and the ability move forward		✓	high	med	med
	• Lack of arm supports	112. Provide support for the arms • provide flexible arm supports or pad contact surface with compressible material.		✓	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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Windshield is dirty or broken	18. Improve visual access to work • replace windshield if broken • clean windshield if dirty.	✓	✓	med low	med med	med med
	• Absence of sun visor	108. Provide protection from glare of natural light • provide sun visor for cab's interior		✓	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	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Vibration from the steering wheel is not damped. (see Figure 1.2) **Figure 1.2**	91. Provide anti-vibration materials • provide anti-vibration padding for the steering wheel 93. Provide appropriate gloves • provide anti-vibration gloves		✓ ✓	med med	med med	med med
10. Exposure to hard edges	• The window edges and other cab interior surfaces create edges of concentrated stress	9. Eliminate exposure to hard edges • pad contact surface with compressible material	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold or cab interior is cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓ 	med low	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	• Seat faces away from work area	82. Provide adequate work space • purchase future trucks with swivel seat capability		✓	high	med	high
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Task lacks variety (see Figure 1.3) **Figure 1.3** • Inadequate seating	25. Increase task variety 20. Incorporate rest pauses 87. Provide an appropriate chair/stool • provide chair with a vibration dampening seat pan and proper lumbar support	✓ ✓	✓	low low high	med 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
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• The vibration damping materials are in need of maintenance or seating mounts are inadequate. (see Figure 1.4) **Figure 1.4**	87. Provide an appropriate chair/stool • provide chair with a vibration dampening seat pan and proper lumbar support.		✓	high	med	med
		12. Encourage appropriate clothing • encourage operator to wear loose fitting clothing	✓		low	low	low
		20. Incorporate rest pauses	✓		low	med	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Cab has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
21. Awkward leg postures	• Seat is improperly positioned in a small cab	87. Provide an appropriate chair/stool • provide height adjustable chair with a vibration dampening seat pan and proper lumbar support		✓	med	med	med
		• adjust seat backward/extended foot controls is necessary		✓	med	med	med
		80. Provide adequate leg clearance • move personal items	✓		low	med	med

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.	• Windshield is dirty or broken	18. Improve visual access to work • replace windshield if broken • clean windshield if dirty.	 ✓	✓	 med low	 med med	 med med
	• Absence of sun visor	108. Provide protection from glare of natural light • provide sun visor for cab's interior	 ✓		 low	 med	 med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Prying	
TASK TITLE: Prying	
Task Description:	This task involves using a pry-bar or crow-bar to loosen or remove a door, lid, or component. In some cases, a screw driver or other tool is enlisted for the task. The working end of the tool is positioned on or near the part that is to be pried apart. Sometimes the pry bar needs to be hammered or forced into place. Once positioned force is applied to the handle to pry apart the two pieces. Typical jobs in which prying is performed include (not necessarily limited to): • shipping • warehousing • wood shop • fabrication • maintenance (e.g., tire repair) The primary ergonomics concern with prying is force.
Job Performance Measures Most Often Impacted by Prying:	Task performed in desired amount of time.
Typical Employee Comments about Prying	Employees typically complain about discomfort and/or stiffness in the shoulders/neck, hands/wrists and sometimes in the back. Primary: hand/wrist/arm and shoulders/neck Secondary: back/torso
Suggested Level II Analysis:	Grip Force Measurement, 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	• Rarely occurs	N/A					
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• High forces required to pry object	21. Increase handle length to improve leverage • provide longer pry bars to minimize reaching		✓	med	med	med
3. High speed sudden shoulder movements	• High forces required to pry object	76. Provide a tool which requires minimal force to use • provide a pry bar with a hammering location		✓	med	med	med
		• use a hammer/mallet to work the component loose gradually	✓		low	med	med
		32. Lower the work piece/work surface • this would allow the person to use more of his/her body weight to perform the task while the arms are in a strong position		✓	med	med	med
		144. Provide a machine/automate • purchase a machine for tire maintenance		✓	high	med	high
4. Head/neck bent or twisted	• Rarely occurs to any significant exposure	N/A					

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	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Inadequate or slippery grip surfaces on the pry bar	54. Provide a high friction gripping surface					
		• provide a tool handle with a compressible grip surface		✓	med	med	med
		• increase "handle" on pry bar; provide space for two-hand grip		✓	med	med	med
		66. Provide a power tool					
		• provide hydraulic tool separate parts (e.g., jaws of life)		✓	high	med	high
	• Handle is not long enough	21. Increase handle length to improve leverage		✓	med	med	med
	• Resistance between surfaces is high	76. Provide a tool which requires minimal force to use					
		• Provide a pry bar with a hammering location		✓	med	med	med
		• Use a hammer/mallet to work the component loose gradually	✓		low	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
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Manual prying may require repeated, jerky movements.	66. Provide a power tool • provide a hydraulic tool to separate parts		✓	high	med	high
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs to any significant exposure level	N/A					

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	• Rarely occurs to any significant level	N/A					
13. Twisting of the lower back	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • Provide a mat to cover sharp or blunt surfaces so that the worker can get closer to the work location	✓		low	med	med

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	• Forces required to pry object loose	76. Provide a tool which requires minimal force to use • Provide a pry bar with a hammering location • Use a hammer/mallet to work the component loose gradually	✓	✓	med low	med med	med med
15. Static, awkward back postures	• Rarely occurs	N/A		✓	high	med	high
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs						
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	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Pumping	
TASK TITLE: Pumping	
Task Description:	The pumping task is general performed within the context of a larger job or task. The pumping task can vary in scope from a small hand pump requiring very little force, to a large pump such as a floor jack involving significant forces.
Job Performance Measures Most Often Impacted by Pumping:	• Completion of task in a reasonable amount of time.
Typical Employee Comments about Pumping:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulders/neck, hands/wrists/arms, or back/torso. The primary body regions of concern are: shoulders/neck, back/torso The secondary body regions of concern are: hands/wrists/arms
Suggested Level II Analysis:	Grip Force Measurement, 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	• Pump handle position is too high	123. Raise the person • provide a stable platform		✓	med	med	med
		32. Lower the work piece/worksurface • position the pump handle near elbow level		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • change the pump handle angle or bend the handle		✓	med	med	med
	• Pump handle covers too much travel	51. Provide a foot pump • for low frequency high force tasks		✓	med	med	med
		66. Provide a power tool • use electric or air power to activate the pump		✓	med	med	med
2. Arm forces: Repeated contractions of the muscles of the arm or holding/carrying materials	• Pumping forces are high	76. Provide a tool which requires minimal force to use • install a longer handle to increase leverage		✓	med	med	med
		• use a multiplying gear		✓	med	med	med
		• use a foot pump		✓	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
3. High speed, sudden shoulder movements	• Inappropriate use of manual pump.	106. Provide powered assistance for a manual activity • use electric or air power to activate the pump		✓	med	med	med
4. Head/neck bent or twisted	• Visual Access is limited due to awkward pump position or obstructions	18. Improve visual access to work • position the display towards the operator's line of vision while the person is activating the pump • remove obstructions	 ✓	✓	med to high low	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	• Pump handle is too small	103. Provide extensions for tools • provide a longer handle so that the activity is more focused on the arm than the hands/wrists		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand		91. Provide appropriate tool • use electric or air power to activate the pump		✓	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	• Tool handle has hard edges	9. Eliminate exposure to hard edges • wrap the handle • provide a handle of at least 5" (12.7 cm) in length; add an extension		✓ ✓	med med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 12. Provide appropriate gloves	 ✓	✓	med low	low 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	• Pump handle position inappropriate	124. Raise the work piece/worksurface • position the pump handle near elbow level		✓	med	low	low
		77. Provide a tool with an appropriate handle angle • change the pump handle angle or bend the handle		✓	med	med	med
		103. Provide extensions for tools • Install a longer handle		✓	med	med	med
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Pumping forces are high	76. Provide a tool which requires minimal force to use • use a multiplying gear		✓	med	med	med
		66. Provide a power tool • use electric or air power to activate the pump		✓	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
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Pumping forces are high (see Figure 1.1) **Figure 1.1**	76. Provide a tool which requires minimal force to use • install a longer handle • use a multiplying gear 66. Provide a power tool • use electric or air power to activate the pump		✓ ✓ ✓	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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Foot pump is used regularly	58. Modify foot pedal • recess foot pedal to keep both heels on floor		✓	med	low	med
		• add a heel block	✓	✓	low to med	low	med

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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Riveting/Bucking	
TASK TITLE: Riveting/Bucking	
Task Description:	Riveting and bucking involves placement and fastening of rivets to hold sheet metal to a metal frame or to other sheet metal. The task requires a hard, heavy surface to pound against (i.e., the buck, a fist-sized, or smaller, piece of metal and a tool to pound with, being either a hammer or powered riveter. The flat head of the rivet is held by the buck on one side while the rivet is flattened out on the other by the hammer or riveter. Other tools used may be a metal stick to position the holes of the two pieces being mated, cleats which also act as guides, grinders, drills, screwdrivers, and pliers. Typical work locations in which sheet metal riveting and bucking are performed might include: • the shop floor • in jigs • on the aircraft itself. Riveting and bucking may be performed on vertical, horizontal, overhead, or on a variety of different surface shapes.
Job Performance Measures Most Often Impacted by Riveting/Bucking:	• The quality of the rivet • The speed of task completion.
Typical Employee Comments about Riveting/Bucking:	Employees commonly report of upper extremity, back, foot discomfort. Employees repeatedly identify stabilizing the bucking bar as a primary source for upper extremity discomfort. Primary: varies depending on the task Secondary: varies depending on the task
Suggested Level II Analysis:	Grip Force Measurement, 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	✓	✓	low to med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		med	med	med
	• Gun must be manually supported, held or steadied	117. Provide support for the upper body					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	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 too far away from worker • Work location is blocked or is in an inappropriate orientation	41. Move work piece closer to body					
		• provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches		✓	med	med	med
		38. Move closer to the work location					
		• move person closer to the work	✓		low	med	med
		• provide sit-stand capability		✓	med	med	med
		112. Provide support for the arms					
		• rest arms on nearby surfaces	✓		low	med	med
		• provide flexible arm rests		✓	med	med	med
		8. Distribute intensive activities throughout the process					
		• perform activity 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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Force required to perform operation is high (see Figure 1.1) **Figure 1.1**	76. Provide a tool which requires minimal force to use • provide alternative riveter 116. Provide support for the tool • provide a jig such that the riveter and buck are not held simultaneously		✓ ✓	high med	med med	high med
3. High speed, sudden shoulder movements	• Rarely occurs	• N/A					

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 low	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece	✓	✓	low to med	med	med
		• provide an adjustable table		✓	high	med	med
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med to high	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece (bench work)					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		114. Provide support for the head					
		• Provide a cushion to support the head	✓		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
		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
	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot-candles (500 - 1000 lux)		✓	high	high	med
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	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	• Using riveter or buck on surface which requires poor orientation of riveter (see Figure 1.2) **Figure 1.2** • Difficult to reach riveting or bucking operation	136. Rotate the work piece (bench work) • provide a fixture to orient the work piece to allow straight wrist postures		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • the handle angle should allow the wrists to remain straight while working		✓	med	med	med
		79. Provide a work surface which is adjustable in height		✓	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

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Setup and cleaning require many finger movements • Handling and placing rivets requires many manipulations	16. Improve cleat design 98. Provide automatic or semi-automatic feed for fasteners • riveter with automatic or semi-automatic feed		✓ ✓	med med	med med	med med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Single-finger trigger	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Work piece must be manually supported, held, or steadied • Tool is too heavy • Handle diameter is too large	118. Provide support for the work piece • jig or fixture that supports the work piece such that the orientation and position allow easier access to part • develop support for the tool for riveter • develop a clampable buck for some tasks 59. Provide a lighter weight tool • reduce the weight of the riveter 88. Provide an appropriate handle diameter		✓ ✓ ✓ ✓ ✓	med med med med med	med 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
	• Air hose must be manually supported, held, or steadied	112. Provide support for the arms • rest arms on nearby surfaces	✓		low	low	low
		• provide flexible armrests		✓	med	med	med
		113. Provide support for the cable or hose • use hook to hang hose on nearby structure	✓		low	med	med
		116. Provide support for the tool		✓	med	med	med
	• Work piece must be manually repositioned	118. Provide support for the work piece • use jig or fixture to reduce/ eliminate the need for gripping		✓	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
9. High speed hand/wrist/arm movements (impact)	• Excessive vibration (see Figure 1.3) **Figure 1.3**	74. Provide a tool that minimizes exposure to vibration/impact/ torque • riveter with better vibration characteristics • improved maintenance scheduling • provide vibration dampening material on handle		✓ ✓ ✓	med med med	med med med	med med med
10. Exposure to hard edges	• Hard/sharp edges present in worksite • Work piece has hard or sharp edges • Tool handle has sharp edges	9. Eliminate exposure to hard edges • use gloves that are: - cut resistant - high friction - padded palms • modify or purchase a new handle for tools with: - padding to reduce/eliminate contact - handle with increased surface area	✓	✓	low to 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
		9. Eliminate exposure to hard edges • by covering sharp edges or exposed corners: - with padding - by rounding off	✓	✓	low to med	med	med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 surface too low (see Figure 1.4) **Figure 1.4**	124. Raise the work piece/work surface					
		• provide an adjustable work surface	✓		high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches	✓		med	med	med
		31. Lower the person • provide chair or stool		✓	med	med	med
		136. Rotate the work piece					
		• manually reorient the work piece	✓		low	med	med
		• provide a jig or fixture to allow the work piece to be rotated		✓	med	med	med
		77. Provide a tool with an appropriate handle angle					
		• reorient riveter handle		✓	med	med	med
		• reorient buck handle		✓	med	med	med
		103. Provide extensions for tools					
		• riveter with lengthened handle		✓	low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Location of work	41. Move work piece closer to body					
		• provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches		✓	med	med	med
		38. Move closer to the work location	✓		low	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/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location	✓		low	low	low
		32. Remove obstructions	✓		low	low	low
		41. Move work piece closer to body	✓		low	low	low
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	low
		• provide a fixture to allow the work piece to be rotated		✓	med	med	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		117. Provide support for the upper body • provide a padded surface to support upper body where work requires a bent or awkward posture		✓	med	med	med
		103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform activity 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

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	115. Provide support for the lower back					
		• pull chair forward and lean back while working	✓		low	low	low
		• adjust back rest to support lower back	✓		low	low	low
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support		✓	med	low	low
16. Lifting forces	• if occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• if occurring, see Lifting Case Study	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or footrest	✓	✓	low to med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work location is too low(see Figure 1.5) **Figure 1.5**	124. Raise the work piece/work surface • provide an adjustable work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches		✓	med	med	med
		31. Lower the person • provide chair		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Light levels are too low	22. Increase light levels • provide a task light which is easy to adjust	✓	✓	med	med	med
		• increase room lighting		✓	med	high	med
	• Task lacks variety	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

CASE STUDY - Sanding	
TASK TITLE: Sanding	
Task Description:	Sanding involves the use of manual (sandpaper, file, etc.) or powered (pneumatic/electric/hydraulic hand sanders) tools to remove or shape material. The work piece is often metal or wood. Additionally, the work piece can be fixed (in a vise) or supported (mounted on a structure). Typical jobs in which sanding is performed include: • aircraft maintenance • sheet metal repair • facility maintenance • model shop. Sanding 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 Sanding:	• Quality of finished surface (consistency, free of defects) • Speed of completion of sanding task.
Typical Employee Comments about Sanding:	Employees typically report discomfort and/or stiffness in the shoulders/neck and hands/wrists/arms. Primary: The primary body parts affected are the shoulder/neck and hand/wrists/arms Secondary: In some cases the back/torso and legs/feet are affected as well.
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	• Work location is too high (see Figure 1.1) **Figure 1.1** • Work location is too far away	123. Raise the person • use a step stool or ladder • provide an adjustable platform or scaffolding	✓	✓ ✓	med high	med med	med high
		32. Lower the work piece/work surface	✓	✓	med	med	med
		112. Provide support for the arms • rest arms on near-by surfaces • provide flexible armrests	✓	✓	low med	med med	med med
		38. Move closer to the work location • remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (benchwork) • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	✓ ✓	✓	low med	med med	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
		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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Tool requires high forces to remove material • Large quantity of material must be removed	66. Provide a power tool • substitute a high grit sand paper for remove large amounts of material	✓	✓	low to med	med	med
		133. Replace abrasive or cutting material frequently	✓		low	med	med
		76. Provide a tool which requires minimal force to use • use power tool whenever possible		✓	med	med	high
		• obtain a heavier duty tool which reduces forces and time required to remove material		✓	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
	• Tool is too heavy	59. Provide a lighter weight tool • provide power tools of minimal weight (particularly for lighter sanding tasks)		✓	med	med	med
3. High speed, sudden shoulder movements	• Manual sanding requires high speed arm movements	66. Provide a power tool use power tool whenever possible		✓	med	med	high

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 low	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece	✓	✓	low to med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface		✓	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	136. Rotate work piece(benchwork) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		114. Provide support for the head • Provide a cushion to support the head	✓		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
		82. Provide adequate workspace • add access panels to increase access • increase the size of access ports to increase access		✓ ✓	high high	med med	high med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 fc (500 - 1000 lux) for sanding tasks -precision sanding tasks require more light: 100 fc (1000 lux or more)		✓	high	high	high
		• provide a task light which is easy to adjust	✓	✓	med	med	med
		• increase room lighting		✓	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	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is too low (see Figure 1.2)	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece	✓	✓	med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med

Figure 1.2

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Tool handle orientation causes awkward postures (see Figure 1.3) **Figure 1.3**	77. Provide a tool with an appropriate handle angle orientation for specific tasks		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		82. Provide adequate workspace • perform activity as bench work rather than on the aircraft/structure		✓	med	med	med
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					

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	• Use of power tool with single finger trigger concentrates stress on finger (see Figure 1.4) **Figure 1.4**	62. Provide a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Hand sanding causes excessive fingertip forces	3. Change a pinch grip to a power grip • provide a sanding block with an attached handle so that pressure is applied with a full hand grip rather than a finger press	✓	✓	low to 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
	• Welding tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a vice fixture to support work piece		✓	med	med	med
		54. Provide a friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		• wrap the handle	✓		low	med	med
		116. Provide support for the tool provide a method to support the tool for bench work		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a sander of minimal weight		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Handle diameter is too large	75. Provide a tool that can be used with both hands		✓	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
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Hand sanding causes high speed movements • Power tools produce hand/arm vibrations	66. Provide a power tool • use power tool whenever possible 74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping • attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5"(3.8 cm))		✓ ✓ ✓	med med med	med med med	med med med
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 • provide a handle of at least 5" (14.7 cm) in length		✓ ✓	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
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		low	med	med
		• round off exposed edges					
	• Work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• lay a blanket or cushion over hard edges to eliminate hard edges					
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from the hands					
		• provide tool which does not blow cold air on the hands		✓	high	med	med
		• Add an alternative air hose connection		✓	med	med	med
		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
	• Work area is too cold	23. Increase room temperature	✓		low	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves		✓	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	• Work location is too low	124. Raise the work piece/work surface • 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
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work space or access is limited	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
14. High speed, sudden movements	• Hand sanding causes high speed movements	66. Provide a power tool • use power sander whenever possible		✓	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
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		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
		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

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work) • 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
		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

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	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	med	med
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• Rarely occurs (If it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 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	• Front edge of seat is hard or square	64. Provide a padded, compressible surface to sit on • Use a cushion to eliminate exposure to pressure point	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med
	• Work station or work piece 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	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	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
		31. Lower the person					
		• provide a chair/stool to sit on		✓	med	med	med
		• provide a pad or cushion to kneel on	✓		med	med	med
		• provide knee pads	✓		med	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Sawing	
TASK TITLE: Sawing	
Task Description:	Sawing involves using a manual or powered (pneumatic or electrical) tool to cut or shape material. Often the material is wood, but occasionally can be fiberglass. Additionally, the material can be affixed to a work surface (with a clamp) held by hand, or pushed through the machine. Typical jobs in which sawing is performed include (not necessarily limited to): • model shop • facility/structural maintenance • shipping/receiving/transport
Job Performance Measures Most Often Impacted by Sawing:	• Speed of task completion • Quality of cut
Typical Employee Comments about Sawing:	Employees typically have complaints about discomfort or stiffness in the following areas: shoulders/neck, hands/wrists/arms, back/torso and legs/feet. The primary body parts affected are typically: hands/wrists/arms, shoulders/neck and back/torso. The secondary body parts affected are typically: legs/feet.
Suggested Level II Analysis:	Grip Force Measurement, Postural Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Repeated activation of on/off switch	32. Lower the work piece/work surface • provide alternative means for activation of on/off switch (e.g., foot control)		✓	med	med	med
		• lower the switch		✓	med	med	med
	• Material retrieved is too high	123. Raise the person • provide a step stool	✓		low	med	med
		32. Lower the work piece/work surface • lower part storage		✓	med	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Material supported is too heavy	90. Provide an auxiliary table • provide auxiliary table to support load	✓	✓	med	med	med
3. High speed, sudden shoulder movements	• Type of tool used is not appropriate for the amount of material to be cut	66. Provide a power tool		✓	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	• Rarely occurs	N/A					

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	• Rarely occurs	• N/A					
6. Repeated manipulations with fingers	• Rarely occurs	• N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of power saw with single finger trigger concentrates stress	62. Provide a multi-finger trigger • extend current trigger • provide a tool with a multi-finger trigger		✓ ✓	med med	med med	med med
8. Hand/grip forces	• Material supported is too heavy or awkward	90. Provide an auxiliary table • provide auxiliary table to support load	✓	✓	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
9. High speed hand/wrist/arm movements	• The tool has not received proper maintenance	34. Maintain hand tools/power tools • perform periodic maintenance on all tools	✓		low to med	med	med
	• The hand is inadequately protected	74. Provide a tool that minimizes exposure to vibration/impact/torque • provide and attach a compressible anti-vibration surface to the tool handle		✓	med	med	med
	• Lack of clamping device increases employee contact with vibrating surface	118. Provide support for the work piece • provide a fixture or jig to hold the work piece		✓	med	med	med
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" in length		✓	med	med	med
		• provide appropriate gloves	✓		low	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
	• Work station or work piece 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
		• provide appropriate gloves	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters	✓		med	med	med
	• Tool exhaust blows on wrist	7. Direct cold air away from the hands		✓	med	med	med
		93. Provide appropriate gloves	✓		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	• Work table is too low	124. Raise the work piece /work surface • raise the saw or leg extensions.	✓	✓	low to med	med	med
13. Twisting of the lower back	• Material supported is too heavy or awkward	124. Raise the work piece/work surface • provide auxiliary table to support load	✓	✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
16. Lifting forces	• Material supported is too heavy or awkward	90. Provide an auxiliary table • provide auxiliary table to support load 61. Provide mechanical lifting device • use a hoist to handle large items	✓ ✓	✓ ✓	med high	med med	med med
17. Pushing or pulling	• Material supported is too heavy or awkward	90. Provide auxiliary table • provide auxiliary table to support load 48. Provide a cart	✓ ✓	✓ ✓	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 (see Figure 1.1) **Figure 1.1**	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	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Finish quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust • provide task lighting that allows for 200-250 lux (20-25 foot-candles) 136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓ ✓	 ✓ ✓	low high low med	med high med med	med high med med

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CASE STUDY - Sewing	
TASK TITLE: Sewing	
Task Description:	Sewing involves the use of a sewing machine to join two or more pieces of fabric. Typically the tasks are performed on a single needle machine by a seated employee. Typical jobs in which sewing is performed include (not necessarily limited to): • survival equipment • life support • museum/exhibit production.
Job Performance Measures Most Often Impacted by Sewing:	Quality of product, time taken to completion.
Typical Employee Comments about Sewing:	There appears to be a significant difference in symptoms or complaints of fatigue and soreness between high and low volume sewing jobs. Fatigue and discomfort complaints also increase as the fabric or material thickness increases and/or the workability decreases. For employees who do report symptoms, the primary body parts affected are the shoulder/neck (one shoulder usually worse than the other), hands/wrist/arm, and lower back. The secondary body parts affected are the legs/feet due to constant use of foot pedals.
Suggested Level II Analysis:	Postural Analysis, Elemental Task Analysis, Light Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work surface is too high	32. Lower the work piece/work surface • adjust current work surface	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	med
		120. Raise the chair	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carry-ing materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• The practice of manually ripping a seam during disassembly or rework	13. Encourage ergonomic work techniques • work procedure training	✓		low	med	med
		• pre-cut thread at regular intervals across seam	✓		low	med	med
		• rip the seam in small sections; avoid ripping in one motion	✓		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
4. Head/neck bent or twisted	• Work surface is too low	124. Raise the work piece/work surface • adjust current work surface	✓		low	med	med
		28. Lower the chair	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
	• Light levels are too low	22. Increase light levels • repair/replace bulb on existing task light	✓		low	med	med
		• reposition task light to prevent glare or bright spot on the needle plate	✓		low	med	med
		• provide a task light with variable intensity		✓	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	• The work surface is flat	136. Rotate the work piece • adjust the work surface • angle work surface toward operator	 ✓ ✓		 low low	 med med	 med med
	• The chair is too low	120. Raise the chair	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
	• The work surface is too high	32. Lower the work piece/work surface • adjust current work surface	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of manual scissors for cutting and trimming thread increase stress to the wrists	66. Provide a power tool • automatic cutter that should be activated by “healing” the foot pedal. Caution must be used in the design to prevent errors from accidental activation		✓	high	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
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work surface edge is sharp or unpadded	9. Eliminate exposure to hard edges • round off exposed edges • provide padding for edges • provide a work surface with rounded edges	 ✓ ✓ 	 ✓	 low low med	 med med med	 med med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 surface too low	124. Raise the work piece/work surface • adjust current work surface	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	high
		28. Lower the chair	✓		low	med	med
13. Twisting of the lower back	• Location of material and supplies is too low	48. Provide a cart • establish height at same level as machine table (e.g., 29-30 " (74-76 cm) above the floor)	✓	✓	med	med	med
		90. Provide an auxiliary table • fixed, stationary or mobile • adjustable in height	✓	✓ ✓	med med	med med	med med
14. High speed, sudden movements	• Large pieces of material get caught on sharp corners of small work table	57. Provide a larger work surface • increase the size of the existing worktable	✓		med	med	med
		• fabricate table extensions to increase the size to the largest piece of material	✓		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
15. Static, awkward back postures	• Inappropriate seating (see Figure 1.1) **Figure 1.1**	86. Provide an appropriate chair		✓	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
16. Lifting forces	• Large bolts of fabric/ticking are too heavy for manual handling (see Figure 1.2) **Figure 1.2** • Fabric is stored in an orientation which is different than that which is required for use	131. Reduce weight of work piece • decrease weight of bolt by ordering shorter lengths of fabric 61. Provide a mechanical lift device • a special purpose hoist/manipulator to handle bolts of fabric 139. Store materials in the same orientation in which they are used • store the bolts in a horizontal orientation	 ✓	 ✓ ✓	 med high low	 med med med	 med high med
17. Pushing or pulling	• Rarely occurs	N/A					
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	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Hard or sharp edges and restricted space under machine table interferes with legs	80. Provide adequate leg clearance • reposition the waste tray • modify the machine support 9. Eliminate exposure to hard edges • provide padding for sharp edges	✓ ✓	 ✓ 	low med low	med med med	med med med
21. Awkward leg postures	• Foot pedal is too close or too far away from the employee • Foot pedal is too far away • Foot pedal in not aligned with chair/employee	135. Reposition foot pedal • move the foot pedal away from employee • move the foot pedal closer to the employee • align the foot pedal with the chair • locate the foot pedal to achieve a 100-105 degree angle at the knee and ankle	✓ ✓ ✓	 ✓	low low low med	med med med med	med med med med
22. Standing foot pedal	• Use of mechanical foot pedal	76. Provide a tool which requires minimal force to use • electronic foot pedal		✓	med	med	med

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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Soldering	
TASK TITLE: Soldering	
Task Description:	Soldering involves the melting of metal to complete electrical connections. Soldering is typically employed in tasks involving electrical wiring and circuitry. Equipment used includes metal solder wire and a solder gun. Typical jobs in which welding is performed include: • electrical assembly/repair • dental lab • circuit board manufacturing/repair • model shop Soldering may be performed on flat or upright surfaces inside electrical cabinets, on equipment, or on benchtops.
Job Performance Measures Most Often Impacted by Welding:	• Quality of electrical connection (consistency, free of defects) • Speed of completion of task
Typical Employee Comments about Welding:	Employees most often report fatigue or discomfort in the shoulders/neck, hands/wrists/arms, and head/eyes. Primary: The primary body region affected are shoulders/neck, hands/wrists/arms, and head/eyes Secondary: In some situations, the back/torso and legs/feet can also be affected
Suggested Level II Analysis:	Postural Analysis, Dynamic Task 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 or ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table		✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		112. Provide support for the arms					
		• Rest arms on near-by surfaces	✓		low	med	low
		• Provide flexible armrests		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		112. Provide support for the arms					
		• Rest arms on near-by surfaces	✓		low	med	low
		• Provide flexible armrests		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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
2. Arm forces: Repeated contraction of the muscles of the arm or holding/carrying materials	• Rarely occurs. If it occurs, refer to Lifting case study	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		• lower the chair	✓		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
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		31. Lower the work piece					
		• modify existing table		✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		114. Provide support for the head					
		• provide a cushion or neck roll if back of head is on the ground	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• turn the work piece	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		132. Remove obstructions	✓		low	med	med
	• Small details are difficult to see	60. Provide a magnifying glass					
		• provide a magnifying glass when the level of detail is high and the task is performed continuously for substantial periods of time		✓	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
	• Light levels are too low	22. Increase light levels • provide a task light which is easy to adjust • increase room lighting	✓	✓ ✓	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	• Shape of soldering gun handle requires employee to bend wrist	77. Provide a tool with an appropriate handle angle					
		• attach a pistol-type handle to soldering gun		✓	med	med	med
		• provide a soldering gun with a pistol-type handle		✓	med	med	med
		• provide soldering gun with a tip which can be angled/bent for different tasks		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	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
6. Repeated manipulations with fingers	• Positioning wires and small components requires finger movements	20. Incorporate rest pauses 25. Increase task variety 8. Distribute intensive activities throughout the process	✓ ✓		low low to med	med med	med med
7. Hyperexten-sion of finger thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Holding wires, components, or circuit boards in place during soldering	118. Provide support for the work piece • provide devices to hold wires or components in place temporarily during soldering • provide flexible fixtures for holding circuit boards (fixtures which allow the component to be tilted at various angles and rotated are recommended; pivoting or ball and socket based fixtures work well) 54. Provide a high friction gripping surface/cover		✓ ✓ ✓	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
	• Handle diameter is too large	88. Provide an appropriate handle diameter • if tool is held like a pencil a diameter of approximately 0.5" (1.5 cm) is recommended • if tool is held like a hammer a diameter of approximately 1"-1.5" (2.5-3.8 cm) is recommended		✓ ✓	med med	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges • lay a blanket or cushion over hard edges • Redesign work piece or component to eliminate hard edges	✓ ✓ ✓	✓	low low low med to high	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
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		96. Provide appropriate gloves • Remove fingers to maximize dexterity	✓		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	• Work location is too low	124. Raise the work piece/work surface					
		• 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
		• lower existing chair	✓		low	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		• pull the chair forward towards the work	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Chair or stool provides inadequate back support	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	med	med
		• provide chair with lower back support		✓	med	med	med
		13. Encourage ergonomic work techniques					
		• alternate between sitting and standing tasks	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Feet cannot reach the floor	52. Provide a footrail or footrest • provide a foot rest to support the feet	✓		low	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or foot rest	✓		low	low	med
		13. Encourage ergonomic work techniques • alternate between sitting and standing tasks	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded, compressible surface to sit on • use a cushion eliminate exposure to pressure point	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med
	• Feet are dangling while sitting in chair	52. Provide a footrail or footrest • provide a footrest to support feet	✓		low	med	med
	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide knee pads	✓		med	med	med
		• provide a pad or cushion to kneel on	✓		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
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges		✓	med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• Redesign work piece or component to eliminate hard edges		✓	high	med	med
	• Work station has leg obstructions or no leg clearance	9. Eliminate exposure to hard edges					
		• eliminate obstructions	✓		low	med	med
		• provide adequate leg clearance		✓	med	med	med
	• Work station is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	med to high	med	high

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	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide a chair/stool to sit on	 ✓ ✓	 ✓ ✓ 	 med high med	 med med med	 med high 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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text x	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Stripping/de-painting by hand	
TASK TITLE: Stripping/de-painting by hand	
Task Description:	Stripping/de-painting by hand is a process where a solvent is applied to a surface order to remove the finish on that surface. The individual doing this task may use either brushes or rags to apply the solvent. Many times the process appears to involve wiping down a surface (e.g., wood or metal) with a liquid. The process may be done by placing the piece on a work bench or the individual may stand/sit/kneel on or near the structure (e.g., aircraft).
Job Performance Measures Most Often Impacted by Stripping/de-painting by Hand:	Amount of material removed in a time period. Quality of surface (consistency, free of mars)
Typical Employee Comments about Stripping/de-painting by Hand:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck, hands/wrists, back and legs. The primary body parts affected are typically: hands/wrists/arms and shoulders/neck. The secondary body parts affected are typically: back/torso and legs/feet.
Suggested Level II Analysis:	Postural Task 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 too high	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/ work surface	✓	✓	med	med	med
		117. Provide support for the upper body					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible arm rests		✓	med	med	med
		90. Provide an auxiliary table					
		• provide a fixture or jig to allow the work to be repositioned		✓	med	med	med
	• The concentration of solvent is not strong enough for the amount of material to be removed	97. Provide appropriate solvent solution		✓	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 too far away	38. Move closer to the work location • modify work platform to position employee closer to work		✓	med	med	high
		132. Remove obstructions	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• The concentration of solvent being used is not strong enough for the amount material to be removed	97. Provide appropriate solvent solution		✓	med	med	med
	• The method used is not appropriate for the amount of material to be removed.	66. Provide a power tool • evaluate the possibility of mechanical stripping		✓	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
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location too high (see Figure 1.1) **Figure 1.1**	123. Raise the person • provide a step stool • provide an adjustable platform	✓	✓ ✓	med high	med med	med high
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Finish quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust • provide task lighting that allows for at least 75fc foot-candles (750 lux)	✓ ✓		med med	med med	med med
	• Work location is too low	31. Lower the person • provide a stool	✓	✓	med	med	med
		124. Raise the work piece		✓	med	med	med

Hand/Wrist/Arm

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	• The type of tool used is not appropriate for the amount of material to be removed.	66. Provide a power tool		✓	med	med	med
	• Work surface is too high or too far away	123. Raise the person • provide a step stool • provide an adjustable platform	✓	✓ ✓	med high	med med	med high
		32. Lower the work piece/work surface	✓	✓	med	med	med
		136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hypertension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• The type of tool used is not appropriate for the amount of material to be removed.	66. Provide a power tool		✓	med	med	med
	• The concentration of solvent being used is not strong enough for the amount of material to be removed	97. Provide appropriate solvent solution	✓	✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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 surface is too high or too far away	123. Raise the person • Provide a step stool • provide an adjustable platform (see Figure 1.2) **Figure 1.2** 32. Lower the work piece/work surface	✓	✓ ✓ ✓	med high med	med med med	med high med
13. Twisting of the lower back	• The type of tool used is not appropriate for the amount of material to be removed. (see Figure 1.3) **Figure 1.3**	66. Provide a power tool • evaluate the feasibility of mechanical stripping.		✓	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
	• Work surface is in an awkward orientation	136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
	• Work space is cramped or access is limited	63. Provide a padded, compressible surface to lay on to get closer to the work	✓		low	med	med
		117. Provide support for the upper body • provide a mobile stool with a back rest to support the upper body		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward postures	• Work space is cramped or access is limited	63. Provide a padded, compressible surface to lay on	✓		low	med	med
		117. Provide support for the upper body • provide a mobile stool with a back rest to support the upper body		✓	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
	• Work surface is too far away	132. Remove obstructions	✓		low	med	med
		124. Raise the work piece/work surface • use risers	✓		low	med	med
		31. Lower the worker • provide a stool to sit on	✓		low	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or footrest	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges		✓	med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
21. Awkward leg postures	• Work surface is too low	124. Raise the work piece/ work surface	✓	✓	med	med	med
		31. Lower the worker • provide a stool to sit on	✓	✓	med	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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Stripping/depainting by Mechanical Methods	
TASK TITLE: Stripping/depainting by Mechanical Methods	
Task Description:	Stripping/depainting by mechanical methods is a process where rust, paint, and other coatings are removed from metal or wood surfaces via mechanized methods. The methods usually involve attaching a grinding wheel or other abrasive material to a drill, or the heating of a surface with a heat gun and then removal by hand. Depending on the object's size and complexity, this task can be performed standing or sitting. Often when the material is worked on, it is clamped onto a work surface to prevent shifting. Then, the part is then moved, rotated, or otherwise manipulated such that all necessary surfaces are accessible to the operator. Typical jobs in which stripping/depainting - mechanically is performed include (but not necessarily limited to): • sheet metal fabrication • HVAC maintenance • facility maintenance
Job Performance Measures Most Often Impacted by Stripping/de-Painting By Mechanical Methods:	Time to completion vs. amount of material removed, avoidance of surface damage Quality of surface (consistency, free of mars)
Typical Employee Comments about Stripping/depainting by Mechanical Methods:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists, although back and leg stress can be common in some applications. The primary body parts affected are typically: hands/wrists/arms and shoulders/neck. The secondary body parts affected are typically: back/torso and legs/feet.
Suggested Level II Analysis:	Postural Task 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	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	low	low
		• provide a fixed platform		✓	med	low	low
		• provide an adjustable manlift or scaffolding (for aircraft)		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table	✓		med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
2. Arm forces: Repeated contraction of the muscles of the arm or holding/ carrying materials	• Tool requires high forces to remove material	76. Provide a tool which requires minimal force to use					
	• Large quantity of material must be removed	• replace grinding media regularly	✓		low	med	med
		• repair the tool for maximum performance	✓		low	med	med
		13. Encourage ergonomic work techniques					
		• let the tool do the work	✓		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
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.1) **Figure 1.1**	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table to raise and/or angle part towards the worker	✓	✓ ✓	med high	med med	med high
		31. Lower the person • provide a chair/stool to sit on for some of the task	✓	✓	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 med high	med med med	med med high

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	• Handle angle on tool causes awkward wrist postures	77. Provide a tool with an appropriate handle angle					
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool, when appropriate		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable manlift or scaffolding		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of tool with single finger trigger	62. Provide a multi-finger trigger					
		• provide a tool with a two finger or a four finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)		✓	med	med	med
		10. Eliminate need to constantly hold trigger		✓	med	med	med
		• provide a tool with toggle switches that allow continuous operation without holding the trigger down					

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	• Tool requires high forces to remove material • Large quantity of material must be removed	76. Provide a tool which requires minimal force to use • substitute a higher grit for removal of large amounts of material • replace grinding media regularly • repair the tool for maximum performance	✓ ✓ ✓		low low low	med med med	med med med
		66. Provide a power tool • obtain a heavier duty tool which reduces forces and time required to remove material		✓	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
	• Tool must be manually supported, held or steadied	54. Provide a high friction gripping surface					
		• provide a tool handle with a compressible, high friction surface		✓	med	med	med
		• wrap the handle with friction tape	✓		low	med	med
		116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work, if appropriate		✓	med	med	med
		113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		low	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	7. Direct cold air away from hands • provide tool which does not blow cold air on the hands		✓	med	med	med
		• provide an air diverter on existing tools		✓	med	med	med
		93. Provide appropriate gloves • (Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task)	✓		low	med	med
	• Work area is too cold	23. Increase room temperature		✓	med	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves	✓		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	• Rarely occurs (see question #15)	• N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low (see Figure 1.2) **Figure 1.2**	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• 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	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Inadequate lower back support	115. Provide support for the lower back					
	• Inappropriate chair adjustment.	• adjust back rest to support lower back	✓		low	med	med
	• Inappropriate chair design	• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		provide a chair with adequate lower back support		✓	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
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 (see Figure 1.3) **Figure 1.3**	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	• Front edge of seat is hard or square	64. Provide a cushion • to reduce exposure to front edge of seat	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide knee pads • provide a cushion to kneel on	 ✓ ✓		 low low	 med med	 med med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges • lay a blanket or cushion over hard edges	✓		low	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide a chair/stool to sit on	 ✓ ✓	 ✓ ✓	 low high med	 med med med	 med high 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	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Turning Valves	
TASK TITLE: Turning Valves	
Task Description:	Valves are turned for a variety of reasons. Some valves are turned to achieve a desired level of acceptance of a piece of equipment being tested on a machine. Other valves are turned (usually with a much greater force or resistance) to control the flow of liquid (e.g., fuel or water) through a piping system. Valves may be small (e.g., fist-sized) or large (e.g., steering wheel-sized) and may be circular or disguised as a lever. Typical tasks that involve turning valves include: • Fuel Access Tester • Oxygen Mask Tester • Facility Maintenance Boiler Rooms • Liquid Fuels Maintenance. The task of turning valves can be performed on the floor, on bench tops, and overhead.
Job Performance Measures Most Often Impacted by Turning Valves:	Ability of the worker to turn valve quickly to the desired position.
Typical Employee Comments about Turning Valves:	Employees typically complain about discomfort and/or stiffness in the back, wrists, and shoulders. The primary body regions of concern are: back/torso, shoulder/neck The secondary body regions of concern are: hands/wrists
Suggested Level II Analysis:	Postural Analysis, Grip Force Measurement, Push/Pull Force Measurement

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 (e.g., turning valves in boiler room) (see Figure 1.1) **Figure 1.1**	123. Raise the person • use a step stool, platform or ladder	✓	✓	med	med	med
		32. Lower the work piece/work surface • relocate frequently used valves to 38”-42” (92cm-107cm)		✓	high	med	high

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 too far away (eg., valve or lever location is too far away (see Figure 1.2) **Figure 1.2**	38. Move closer to the work location 132. Remove obstructions	✓ ✓		low low	med med	med med
2. Arm forces; contraction of the muscles of the hand or holding/carrying materials	• Valve condition makes turning difficult • Valve design requires high force	101. Provide control which does not require excessive forces • inspect and replace valves to minimize force • remove rust/lubricate valves as needed • provide alternative lever/valve design	✓	✓ ✓	med low high	med med med	high high high

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too high (see Figure 1.3) **Figure 1.3**	123. Raise the person • use a step stool, platform or ladder to read gauges • provide an adjustable platform 32. Lower the work piece/work surface • lower gauges	✓	✓ ✓ ✓	med high med to high	med med med	med high 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 (see Figure 1.4) **Figure 1.4**	136. Rotate the work piece • turn the gauge	✓		low	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	• Valve is blocked or is in an inappropriate orientation	132. Remove obstructions		✓	med to high	med	high
	• Valve is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
		32. Lower the work piece/work surface • lower the valve		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

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	• Valves require high force to turn – large motions for small increments of change – high frictional forces of mechanics or valve due to design or maintenance of valve	101. Provide controls which do not require excessive forces • inspect and maintain equipment to ensure valves are maintained to minimize forces • design valves to reduce high force characteristics of valves	✓	✓	low to med high	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

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	• Valve location is too low (see Figure 1.5) **Figure 1.5**	124. Raise the work piece/work surface • place the valve location at 38”-42” (92cm-107cm) above the floor		✓	high	med	high
	• Work location too far away	38. Move closer to the work location • step over obstructions	✓		low	med	med
		132. Remove obstructions • re-design piping		✓	high	med	high
13. Twisting of the lower back	• Valve location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the valve orientation		✓	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
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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	96. Provide appropriate shoe inserts	✓		low	low	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges • Use a cushion eliminate exposure to pressure point	✓		low	low	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	low	med
	• Piping system on floor (if kneeling)	9. Eliminate exposure to hard edges • provide padding for edges/pipes and surrounding structure • provide knee pads	✓ ✓		low low	low low	med med
21. Awkward postures	• Valve that is too low may require worker to kneel or squat	124. Raise work piece/work surface • place valve location at 38”-42” (92cm-107cm)		✓	high	med	high
		9. Eliminate exposure to hard edges • provide knee pads	✓	low	low	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. Light levels are too low/too high	• Light levels are too low for reading gauges	22. Increase light levels • increase room lighting • clean gauge/replace glass	✓	✓	med low	med low	med low
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Tying/Twisting/Wrapping	
TASK TITLE: Tying/Twisting/Wrapping	
Task Description:	Tying/twisting/wrapping involves the use of hands or a manual tool to tie, seal or combine two or more strands of material together. Many times the material can either be thread, wire or cloth (e.g., laces). Jobs in which tying/twisting/wrapping is performed include (not necessarily limited to): • aircraft engine maintenance • life support • parachute packing • electrical maintenance Tying/twisting/wrapping can occur at any level on a work bench, the floor of an aircraft, or overhead.
Job Performance Measures Most Often Impacted by Tying/Twisting/ Wrapping:	• Quality of product (degree of tightness). • Speed of the tying/twisting/wrapping task.
Typical Employee Comments about Tying/Twisting/Wrapping:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists. If the individual is standing, a secondary complaint can be in the back/torso and legs/feet.
Suggested Level II Analysis:	Postural Analysis, Elemental Task Analysis, Grip Force Measurement.

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 an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
	• Arms must be manually supported, held or steadied (see Figure 1.1)	112. Provide support for the arms					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med
	Figure 1.1						
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		132. Remove obstructions	✓		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	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.2) **Figure 1.2**	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		13. Encourage ergonomic work techniques					
		• encourage person to look up frequently	✓		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
	• Work location is too high	123. Raise the person • use a step stool or ladder • provide an adjustable platform	✓	✓ ✓	med med	med med	med med
		32. Lower the work piece/work surface		✓	med	med	med
	• Light levels are too low during task	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	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	• Repetitive nature of the work task	66. Provide a power tool		✓	med	med	med
		20. Incorporate rest pauses	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	med	med	med
		32. Lower the work piece/work surface		✓	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
6. Repeated manipulations with fingers	• Repetitive nature of the work task.	20. Incorporate rest pauses 66. Provide a power tool	✓	 ✓	low med	med med	med med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Task requires material to be very tight • Diameter of tie requires pinch grip	66. Provide a power tool 20. Incorporate rest pauses	 ✓	✓	med low	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

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	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		med	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges		✓	high	med	med
		• Redesign work piece or component to eliminate hard edges					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		96. Provide appropriate gloves					
		• remove fingers to maintain dexterity	✓		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	• Work location is too low (see Figure 1.3) **Figure 1.3**	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide a chair/stool to sit on	✓ ✓	✓ ✓ ✓	med high med	med med med	med high med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 (see Figure 1.4) **Figure 1.4**	86. Provide an appropriate anti-fatigue mat 96. Provide appropriate shoe inserts	 ✓	✓	med med	med med	med med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges • lay a blanket or cushion over hard edges • Redesign work piece or component to eliminate hard edges	 ✓ ✓ ✓	 ✓	 low med low high	 med med med med	 med med med med
21. Awkward leg postures	• Rarely occurs	N/A					
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Visual Inspection	
TASK TITLE: Visual Inspection	
Task Description:	Visual inspection involves an employee inspecting the surface of a material, component, or system to determine the presence of material or processing defects (cracks, incomplete welds, frayed cables, etc.). This task is often done after a prior task has been completed (e.g., visual inspection of rivet depth after riveting.). The employee may use a flashlight or magnifying glass to highlight the area of interest. Additionally, gloves may be worn if the employee is required to inspect the surface using the fingers. Because visual inspection is required for the completion of many different tasks, the employees may be required to stand or sit by the work piece (e.g., riveting on an aircraft) or perform the tasks at a workbench (e.g., soldering electronic components). Typical jobs in which visual inspection is performed include (not necessarily limited to): • aircraft maintenance • sheet metal repair • facility maintenance • model shop • radio repair
Job Performance Measures Most Often Impacted by Visual Inspection:	• Quality of surface (consistency) • Speed of task completion • Error detection
Typical Employee Comments about Visual Inspection:	Due to the wide variety of work situations, employees may complain about discomfort or stiffness in any of the following areas: shoulders/neck, hands/wrists/arms, back/torso, legs/feet, or head/eyes. The primary body parts affected are typically: shoulders/neck, back/torso and head/eyes The secondary body parts affected are typically: legs/feet, and hands/wrists/arms
Suggested Level II Analysis:	Postural Analysis, Light Measurement

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					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	low	low
		41. Move work piece closer to body	✓		low	low	low
		112. Provide support for the arms					
		• rest arms on nearby surface	✓		low	med	med
		• provide flexible arm supports		✓	med	med	med
2. Arm forces: Repeated arm muscle contraction or holding/ carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

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 surface is too high or too low	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
		136. Rotate the work piece					
		• turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process					
		• modify assembly/inspection process so that visual inspection occurs throughout the process rather than at the final stage		✓	med	med	med
		84. Provide an adjustable mirror		✓	med	med	med
		60. Provide a magnifying glass		✓	med	med	low

Hands/Wrist/Arm

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	• Work location is too high	123. Raise the person • provide a step stool • provide an adjustable platform 38. Move closer to the work location 136. Rotate the work piece • manually turn the work piece to an upright position • provide a fixture to allow the work piece to be rotated	 ✓ ✓ ✓	 ✓ ✓ ✓	 med high low low med	 med med med med med	 med high low med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• The material to be inspected must be held or supported	118. Provide support for the work piece • provide a fixture or jig to aide in holding the material		✓	med	med	med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges • lay a blanket or cushion over hard edges • redesign work piece or component to eliminate hard edges	 ✓ ✓ ✓ 	 ✓ ✓	 low med low med to high	 low low low med	 low low low med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 23. Provide appropriate gloves	 ✓	✓ 	med low	low 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	• Work piece/surface is too low	31. Lower the person • provide a step stool	✓		low	high	med
		117. Provide support for upper body		✓	high	med	med
		124. Raise the work piece/work surface		✓	med to high	high	med
		136. Rotate the work piece • turn the work piece to an upright position	✓	✓	low	med	med
		• provide a fixture to allow the work piece to be rotated or raised		✓	med	med	med
		84. Provide an adjustable mirror • provides visual access to sides of part without bending back		✓	med	med	med
		60. Provide a magnifying glass		✓	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
13. Twisting of the lower back	• Work space is cramped or access is limited	117. Provide support for the upper body		✓	high	low	high
		63. Provide a padded, compressible surface to lay on	✓		low	low	low
	• Work piece orientation is too awkward	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	low med
		84. Provide an adjustable mirror • provide better visual access		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Chair is inadequate	87. Provide an appropriate chair/stool		✓	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
	• Work piece/surface is too low (see Figure 1.1) **Figure 1.1**	124. Raise the work piece/work surface	✓		low	low	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med
		8. Distribute intensive activities throughout the process • modify assembly/inspection process so that visual inspection occurs throughout the process rather than at the final stage	✓		low	med	med
		84. Provide an adjustable mirror	✓		low	med	med
		60. Provide a magnifying glass		✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
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 mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or footrest	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges	✓		med	med	med
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges					
21. Awkward leg postures	• Work surface is too low	124. Raise the work piece/work surface		✓	med	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light					
		• orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Glare directly from a light source: looking towards a task light (see Figure 1.2) **Figure 1.2** • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare. • turn off the task light. • shield task light to prevent it from shining into eyes.	✓ ✓	✓	low low low to med	med med med	med med med
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Welding	
TASK TITLE: Welding	
Task Description:	There are many different types of welding processes including TIG/MIG welding, Arc welding, and spot welding. Depending on the process, equipment such as torches, accompanying compressed gas canisters, wire feed units, or consumable electrodes may be used. Typical jobs in which welding is performed include: • metal fabrication • assembly/repair • structural maintenance Welding may be performed on flat or upright surfaces directly on aircraft, pipes, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Welding:	• Quality of weld (consistency, free of defects) • Speed of completion of welding task
Typical Employee Comments about Welding:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulders/neck, hands/wrists/arms, back/torso, legs/feet, or head/eyes. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Grip Force Measurement, Postural, 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	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓	✓	med	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
	• Welding tool or gas hose must be manually supported, held or steadied (see Figure 1.1) **Figure 1.1**	116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		med	med	med
		112. Provide support for the arms					
		• provide flexible armrests		✓	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 too far away (see Figure 1.2)	38. Move closer to the work location • remove obstructions	✓		low	med	med
	 Figure 1.2	41. Move work piece closer to body	✓		low	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
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		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
	• Light levels are too low	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
	• Use of head movement to lower face shield	11. Eliminate unnecessary tasks • provide face shield with a visor adjusts to different light levels and eliminates the need to constantly raise and lower the face shield		✓	med	med	med
		13. Encourage ergonomic work techniques • encourage person to raise or lower the shield with hand if feasible	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
bent or twisted							

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	• Using straight welding tool on horizontal surface	77. Provide a tool with an appropriate handle angle					
		• provide a tool with a pistol-type handle		✓	med	med	med
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		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

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too high	123. Raise the person • use a step stool or a ladder • provide a fixed platform • provide an adjustable platform or scaffolding 32. Lower the work piece/worksurface	✓	✓ ✓ ✓ ✓	med med high med	med med med med	med med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of welding tool with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two finger or a four finger trigger • extend trigger on existing tool (if feasible and safe) 10. Eliminate need to constantly hold trigger • provide a tool with toggle switches that allow continuous operation without holding the trigger down 45. Modify controls • use a foot pedal if feasible		✓ ✓ ✓ ✓	med med med med	med med med med	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
8. Hand/grip forces	• Welding tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		54. Provide a high friction gripping surface • wrap the tool handle • provide a tool handle with a compressible, high friction surface	✓	✓	low med	med med	med med
		113. Provide support for the cable or hose • provide a hook to hang cable in work area	✓		low	med	med
	• Tool is too heavy	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		59. Provide a lighter weight 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
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter of between 1"-1.5" is appropriate for this task		✓	med	med	med
	• Attaching/removing manual clamps is difficult	76. Provide a tool which requires minimal force to use • provide manual clamps which require no more than 8 lb. to operate		✓	med	med	med
		66. Provide a power tool • provide powered clamps		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

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 handle which is round and smooth with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length		✓	med	med	med
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges		✓	low	med	med
		• round off exposed edges	✓		med	med	med
		• provide elbow pads		✓	med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• modify the design the work piece to eliminate hard edges		✓	high	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	23. Increase room temperature	✓		low	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		96. Provide appropriate gloves	✓		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	• Work location is too low	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
		117. Provide support for the upper body					
		• provide a device to support the upper body while welding		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low (see Figure 1.3) **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
	• Work location is too far away (see Figure 1.4) **Figure 1.4**	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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
		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
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	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	med	med
		• provide a chair with adequate lower back support		✓	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
16. Lifting forces	• Lifting and handling compressed gas bottles on and off welding carts requires excessive force • (See Lifting case study for additional causes and corrective actions)	4. Change a lifting/carrying task into a rolling or sliding task • provide a fold-out ramp to allow gas bottles to be rolled up into position as opposed to lifted • lower the base of the gas storage area as close to the ground as possible to minimize the slope of ramp 61. Provide a mechanical lift device • to transfer gas bottles to and from the welding cart 11. Eliminate unnecessary tasks • provide remote, bulk supply of welding gas		✓ ✓ ✓ ✓	med med med med to high	med med med med	med med med med
17. Pushing or pulling	Pulling hoses and carts • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • keep floor free of debris • repair cracks or gaps in floor 19. Improve wheel condition • repair wheels • provide wheels that are roll more easily 67. Provide a powered cart	✓ ✓ ✓	✓ ✓ ✓	low low to med low med high	med med med med med	med med med med high
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	85. 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	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection					
		• provide knee pads	✓		low	med	med
		• provide a cushion to kneel on	✓		low	med	med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		med	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges		✓	med to high	med	med
		• redesign work piece or component to eliminate hard edges					

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 1.5) **Figure 1.5**	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	✓	✓	low to 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
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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Wiring	
TASK TITLE: Wiring	
Task Description:	There are two basic types of wiring tasks. The first task involves securing two or more objects by twisting or crimping them together. Often the employee will precut the amount of wire from a roll before joining the objects. It is also possible that the employee will have to remove the insulation (coating) from the wire once the task is completed. The tools most commonly used are pliers (e.g., needle-nose) and wire strippers and cutters. The second type of wiring occurs when electrical wires or pneumatic hoses are threaded or pushed between two structures. This commonly occurs when offices/automobiles/appliances are being repaired. Here, the wire can be either precut, or pulled from a roll. The most common tool used is pliers. In both cases, the location of the wiring task can vary tremendously, thus, this task can be performed while standing or sitting. Typical jobs in which wiring is performed include (but not necessarily limited to): • automobile maintenance • HVAC system maintenance • facility maintenance • radio maintenance
Job Performance Measures Most Often Impacted by Wiring:	• Time to completion • Integrity of wiring system (e.g., does it work)
Typical Employee Comments about Wiring:	The most common complaint from employees is discomfort and/or stiffness in the shoulders/neck and hands/wrists. The primary body parts affected are typically: hands/wrists/arms and shoulders/neck. The secondary body parts affected are typically: back/torso and legs/feet.
Suggested Level II Analysis:	Postural Task Analysis, Dynamic Task Analysis, Grip Force Measurement, Elemental Task Analysis, Light Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Repeated reaching or arms held away from body while unsupported	• Work location too high	123. Raise the person					
		• provide a step stool/ladder	✓	✓	med	med	med
		• provide a platform or scaffold		✓	med	low	med
		112. Provide support for the arms					
		• rest arms on near-by surfaces	✓		low	low	med
		• provide flexible arm rests that can be attached to nearby surfaces.		✓	med	low	med
	• The work piece must be manually supported or held	118. Provide support for the work piece					
		• provide a clamp for stabilizing or holding back any surrounding wires.	✓	✓	med	med	med
	• Work location is too far away (see Figure 1.1)	38. Move closer to the work location					
		• remove obstructions	✓		low	low	low
		• remove additional access panels	✓		low	low	low

Figure 1.1

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 exceeding 10 lb.	• Interference or "hang up" when pulling wires	140. Use alternative fasteners • use fish tape and pull wires with two hands • clear hang-up prior to pull	✓ ✓		low low	med med	med med
	• Many rolls of wire must be transported from one area to another	48. Provide a cart • provide a cart which mounts the spools horizontally and feeds the wire via rollers to a nozzle		✓	med	med	med
3. High speed, sudden shoulder movements	• The wire must be pulled / yanked to be joined	128. Reduce force required to install or remove the component • provide rollers at the wire roll and at the top and bottom edges of the openings to decrease frictional forces		✓	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
	• The wire must be pulled / yanked through the insulation	128. Reduce force required to install or remove the component • coat the wire with soapy water to decrease the friction required	✓		low	med	med
4. Head/neck bent or twisted	• Work location too low (see Figure 1.2) **Figure 1.2**	31. Lower the person • provide a chair or stool for the employee to sit on	✓	✓	med	med	med
	• Work location too high	123. Raise the person • provide a step stool/ladder • provide a platform or scaffold	✓	✓ ✓	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
	• Quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust - provide task lighting that allows for 20-25 foot-candles (200-250 lux).		✓	med	med	med
		60. Provide a magnifying glass • provide a stand supported magnifying glass that has a built in light		✓	med	med	med
		136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	low 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	• The type of tool used is not appropriate for the twisting/crimping required.	76. Provide a tool which requires minimal force to use • Provide an appropriate tool that allows for crimping and quick twisting		✓	med	med	med
		• crimp instead of using twist wires	✓		low	med	med
	• There is a large amount of insulation to be removed	34. Maintain hand tools/power tools	✓		low	low	med
		• provide tools which have sharp cutting edges and aligned jaws		✓	med	low	med
		• provide stripping tools which strip wire as pliers are closed.		✓	med	low	high
		• provide automatic wire stripper; pre-strip wires.					
	• Work surface is too high or too far away	123. Raise the person • provide a step stool	✓	✓	med	med	med
6. Repeated manipulations with fingers	• Repetitive nature of the work task • Unscrewing and tightening of terminal leads	20. Incorporate rest breaks	✓		low	low	low

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyperextension of finger/thumb or repeated single finger activation	• Pliers do not have a spring-loaded handle	91. Provide an appropriate tool • provide a tool that has a self-opening spring between the handles		✓	med	low	med
		66. Provide a power tool		✓	med	med	med
8. Hand/grip forces	• Wires or bundles must be held and manipulated.	118. Provide support for the work piece • provide a clamp that secures the work object or holds back wires during task	✓		low	low	med
	• The wire must be pulled / yanked through the pieces to be joined	128. Reduce force required to install or remove the component • provide rollers at the wire roll and at the top and bottom edges of the openings to decrease frictional forces and "hang-up"		✓	med	low	med
		• coat the wire with soapy water to decrease the friction required	✓		low	low	low
	• The tool used for twisting/crimping requires high grip forces.	76. Provide a tool which requires minimal force to use • provide an appropriate tool that allows for crimping and quick twisting		✓	med	med	med
		• provide a power crimping tool		✓	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
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges		✓	med	med	med
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length	✓		low	med	med
		• wrap the tool handles					
	• Work station has hard or sharp edges (see Figure 1.3) **Figure 1.3**	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges					

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	• Work area is too cold	93. Provide appropriate gloves	✓		low	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	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	• Rarely occurs	N/A					
13. Twisting of the lower back	• Work space is cramped or access is limited (see Figure 1.4) **Figure 1.4**	63. Provide a padded, compressible surface to lay on • provide a pad/mat 117. Provide support for the upper body	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Inadequate lower back support while seated • Inappropriate chair adjustment. • Inappropriate chair design	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	med	med
		• provide a chair with adequate lower back support		✓	med	med	med
	• Work location is too low • Work location is too far away	31. Lower the person					
		• provide a chair or stool	✓	✓	med	med	med
		38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	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
	• Quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust		✓	med	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Many rolls of wire must be transported from one area to another	48. Provide a cart • provide a cart which mounts the spools horizontally and feeds the wire via rollers to a nozzle		✓	med	low	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	52. Provide a footrail	✓	✓	med	low	med
		86. Provide appropriate anti-fatigue mat		✓	med	low	med
		96. Provide appropriate shoe inserts	✓		low	low	med
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • lay a blanket or cushion over hard edges	✓		low	med	med
21. Awkward leg postures	• Work surface is too low (kneeling)	31. Lower the person • provide a low stool	✓	✓	med	low	med
		95. Provide appropriate knee protection • if kneeling is required.	✓		low	low	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	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

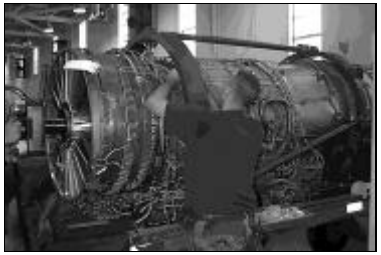
Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	 ✓ ✓	 ✓ ✓	 med med	 med med	 med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Wrenching/Ratcheting	
TASK TITLE: Wrenching/Ratcheting	
Task Description:	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. Typical jobs in which wrenching/ratcheting is performed include (not necessarily limited to): • assembly • general maintenance Wrenching may be performed on flat or upright surfaces directly on aircraft, equipment, or bench tops.
Job Performance Measures Most Often Impacted by Wrenching/Ratcheting:	• Constant torque • No errors (e.g. missing bolts, incorrect bolts) • Speed of completion of the job
Typical Employee Comments about Wrenching/Ratcheting:	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 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	• Work location is too high (see Figure 1.1)  **Figure 1.1**	123. Raise the person • 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 • modify existing table • provide an adjustable height work table	✓	✓	low high	med med	med high
		112. Provide support for the arms • 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
	• Work location is too far away	103. Provide extensions for tools • provide extensions and angles on wrenches in order to access bolt with minimal reaching	✓	✓	med	med	med
		38. Move closer to the work location • remove obstructions	✓		low	med	med
	• 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 • provide extensions for ratchets to increase access	✓		med	med	med
		77. Provide a tool with an appropriate handle angle • provide angled or off-set wrenches for tight spaces	✓		med	med	med
	• Repeated arm movements required for task	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

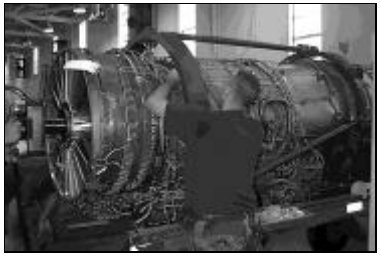
Shoulder/Neck (cont'd)

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	• Use of manual tool for high force or repeated torquing (see Figure 1.2) • Torque specifications require high forces	66. Provide a power tool • use a power tool whenever feasible (use manual tool at end of cycle if final torque check is required)	✓	✓	med	med	high
	 Figure 1.2	76. Provide a tool which requires minimal force to use • provide ratcheting tools with multiplying gears to reduce forces		✓	high	med	med
		• increase handle length on wrench to improve leverage		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • use tool of minimal weight		✓	med	med	med
	• Inadequate maintenance of tools can increase force requirements	34. Maintain hand tools/power tools • 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
	• Carrying tools and containers of nuts and bolts	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	✓	✓	med	med	med
	• Wear or corrosion of components	33. Maintain bolts and screws • use penetrating oil, if allowable to help reduce resistance		✓	low	med	med
3. High speed, sudden shoulder movements	• Work pace/work volume causes high speed arm movements while manually torquing bolts	66. Provide a power tool • use power tool whenever possible		✓	high	med	med
		• 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 • use smooth movements	✓		low	med	med
		• avoid rushing	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
	• Torque wrenches with torque releases cause sudden movements or "jerks"	66. Provide a power tool • 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		✓ ✓	med med	med med	med med
4. Head/neck bent or twisted	• Work location is too high (or is overhead) (see Figure 1.3)  **Figure 1.3**	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding 32. Lower the work piece/work surface • modify existing table • provide an adjustable height work table 114. Provide support for the head • for long duration wrenching tasks which are overhead, provide a chair with a reclining backrest, and head support. • provide a neck rest pillow	✓ ✓	✓ ✓ ✓ ✓ ✓ ✓	med med high med high med low	med med med med med med med	med med high med high med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
	• Work location is too low	124. Raise the work piece/work surface • 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
		31. Lower the person • provide a chair/stool to sit on	✓	✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low 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	• Manual wrenching can require awkward wrist and forearm movements (see Figure 1.4) **Figure 1.4**	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 final torque check)		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓		low	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	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
	• Work location is too low	124. Raise the work piece/work surface					
		• 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
	• Work location is blocked or is in an inappropriate orientation	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓	✓	low	med	med
		• provide a fixture to allow the work piece to be rotated			med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Wide spans on tools such as pliers or channel locks can 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 pliers-type tools					
		• provide a tool with a handle span less than 3"		✓	med	med	med
		• use crescent wrenches or appropriately sized sockets		✓	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	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • to support work piece		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		• wrap tool handle with friction tape	✓		low	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Tool is too heavy or not balanced	59. Provide a lighter weight tool		✓	med	med	med
	• 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

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • 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	• Manual torquing causes high speed movements • Use of power tools or impact wrenches exposes worker to vibration	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) 74. Provide a tool that minimizes exposure to vibration/impact/ torque • 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	• 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" in length		✓	med	med	med
		• wrap tool handle	✓		low	med	med
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges • lay a blanket or cushion over hard edges	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	93. Provide appropriate gloves		✓	med	med	med
		105. Provide portable heaters	✓		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	• Rarely occurs (see question #15)	N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation (see Figure 1.5) Figure 1.5	136. Rotate the work piece (bench work)					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• 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

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	• Corroded or stuck fittings	66. Provide a power tool • use power tool whenever possible		✓	high	med	med
		33. Maintain bolts and screws • use penetrating oil, if allowable to help reduce resistance	✓		low	med	med
		13. Encourage ergonomic work techniques	✓		low	med	med
		• use smooth movements	✓		low	med	med
		• avoid rushing					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		• raise the assembly (e.g., engine) using a hoist or other lift device)		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	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	115. Provide support for the lower back • 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	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
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 and enable a balanced two-hand grip		✓ ✓ ✓	med high 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 mat		✓	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 a pad or cushion to kneel on	✓		low	med	med
	• Work piece has hard edges	9. Eliminate exposure to hard edges • 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	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓		low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		• raise assembly (e.g., engine) using a hoist or other lift device		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓		low	med	med
		• provide knee pads, if kneeling is required	✓		low	med	med
		• provide a pad or cushion to kneel on	✓		low	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 • 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	• Rarely occurs	N/A					