30 April 2006

Naval Facilities Engineering Command
Ergonomics Risk Assessment

Introduction

This report summarizes the ergonomics risk assessments conducted at two dental clinics (Facilities A and B) in June of 2006. The Prosthetics Laboratories were observed in order to determine sources of ergonomics-related stress and recommend improvements. The Naval Facilities Engineering Command (NAVFACENGCOM) Hazard Abatement and Mishap Prevention (HAMP) occupational ergonomist based this assessment upon interviews with employees, supervisors, and health and safety personnel as well as on-site evaluations.

The risk assessment was conducted in conjunction with the Job Requirements and Physical Demands Survey (JR/PD). The JR/PD is an ergonomics survey designed to assess ergonomics risk in the workplace. The results of the JR/PD indicate the Prosthetics Lab at Facility A is an ergonomic problem area with a score of **7** on a scale of 1 to 9 where 9 is a maximum value. An Overall Job Priority score of five or greater establishes a task/job as an ergonomic problem area on a scale from one to nine (where nine is considered the highest priority for intervention). The JR/PD assesses five distinct body regions: shoulder/neck, hand/wrist/arm, back/torso, legs/feet, and head/eyes based upon identified ergonomic risk factors and employee reported discomfort. For the Prosthetics Lab, the back/leg and leg/foot regions were found to have significant ergonomic risk. Scores are based upon a combination of physical risk factors associated with the job and employee reported discomfort. A significant number of employees reported experiencing work-related pain or discomfort that does not improve when away from work overnight or over the weekend. All of the employees have seen a health care provider in the past 12 months for pain or discomfort that he/she feels is related to the job. A significant number of employees also reported pre-existing musculoskeletal disorders (MSDs), which place them at a higher risk of additional or more severe MSDs. Appendix I contains a summary of the JR/PD results for both areas as well as a description of the methodology.

The JR/PD results for Facility B were significant but did not qualify the laboratories as an ergonomic problem area. The relative young age and active duty status of the respondents may have contributed to the low score. During the assessment a number of employees noted discomfort and MSD symptoms. The employee comments are included in Appendix II.

The Prosthetics Laboratories were observed in order to determine sources of ergonomics stress and make recommendations to reduce the risk of work-related musculoskeletal disorders (WMSDs) and improve safety, health and productivity. Musculoskeletal Disorders (MSDs) are injuries and illnesses that affect muscles, nerves, tendons, ligaments, joints, spinal discs, skin, subcutaneous tissues, blood vessels, and bones.

Work-Related Musculoskeletal Disorders (WMSDs) are:

- ∞ Musculoskeletal disorders to which the work environment and the performance of work contribute significantly or
- ∞ Musculoskeletal disorders that are aggravated or prolonged by work conditions.

The operations reviewed present opportunities to reduce the risk of WMSDs. Recommendations to the command to reduce the probability of injury include considering equipment purchase[i], process redesign, and implementation of administrative controls[ii]. Representative vendor information is included in the recommendations to assist in the evaluation of products and services[iii]. Recommendations to the command include gathering input from the workers, safety specialists, and other personnel to evaluate equipment before purchasing. This process will increase product acceptance, test product usability, and durability, and takes advantage of employee experience.

The command has submitted a project for Facility A with solutions represented in this report through the Hazard Abatement and Mishap Prevention Program for FY07. The project number is 745AS and is currently pending.

Prosthetics Laboratory

Purpose of the Operation: Fabricate and repair prosthetic dental appliances

Population: Two military personnel at Facility A.
Six to eight military personnel at Facility B in 3 locations.

Injury Data: According to the Job Requirements and Physical Demands Survey results, all of the employees at Facility A have visited a health care provider for pain/discomfort that he/she feels is related to the job. One worker has radial tunnel syndrome. Employees at Facility B noted fatigue and discomfort as well as MSD symptoms such as tingling in the upper extremities.

Description of the Operation:
Employees perform a variety of operations at individual seated and standing workstations to fabricate and repair prosthetic dental appliances. Equipment varies by workstation and task but may include task lighting or loupe, ventilation intake and electric and manual tools.

Ergonomic Issue Description:
Repetitive Motions and Static, Awkward Postures. The major ergonomics risk factors for the Prosthetics Laboratory staff are repetitive hand and arm motions in unsupported, awkward postures. The exposure is in combination with contact stress from grasping tools while applying force, and applied contact stress from the sharp bench edges. The tasks also have high visual demands, which require workers to lean forward and assume static postures of the neck and torso for extended periods.

Static postures are positions that are held for extended periods. Static postures increase loads or forces on the muscles and tendons needed to maintain those postures, which contributes to fatigue. Fatigue is a pre-cursor to WMSDs. Muscles require movement in order to allow blood flow. Blood flow brings nutrients to the muscles and carries away the waste products of muscle metabolism.

The current workstations, shown in figures 1, have storage under the work surface which prevents the workers from raising the chair high enough to work in a neutral posture. Figure 2 shows a worker having to sit sideways because there is no leg room at his workstation. Working in an awkward posture can restrict blood flood and cause the employee to exert more effort to perform a task than working in a neutral position. The neutral posture is the optimal position of the body to exert the greatest force, promote blood flow and nerve conduction and reduce the risk of ergonomics related injury. Workers can spend 6 to 8 hours a day at the bench. Duration is an ergonomics risk factors which magnifies other risk factors such as awkward posture.

Figure 1: Seated workbench

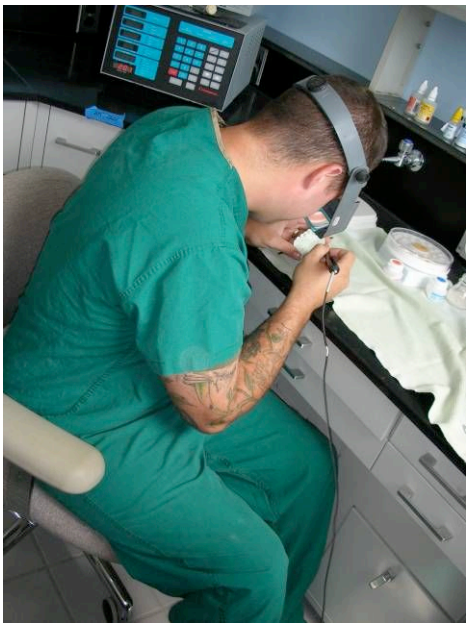

Figure 2: Workbench with no leg room

Prosthetics technicians exert sustained pinch grips while using small diameter tools some of which oscillate or vibrate, figures 3 and 4. Awkward postures combined with high repetition and vibration can fatigue muscles and cause the employee to exert more force than is necessary. The majority of the tasks involve repetitive hand, arm, and wrist motions, which utilize the same muscle groups thus reducing muscle recovery. Inadequate muscle recovery leads to muscle fatigue and possible overuse injuries.

Figures 3 and 4: Using hand tools

Contact Stress: Using tools with small diameter handles causes contact stress to the palms which contain numerous nerves close to the skin surface, figures 3 and 4. The work station edge presents another source of contact stress to the forearms as shown in figures 3 and 5. Contact stress results from compression of the soft tissue by a hard object. A concentrated force can reduce blood flow and nerve transmission as well as cause damage to tendons and tendon sheaths. Workers also use small diameter tools when stacking porcelain, figure 6. Workers stack porcelain for at least 2-3 hours and up

to 6 hours at a time. Tools with narrow handles require greater muscle force to grip, which can increase the contact force exerted on the hand. The force required to hold the tool is compounded by the force required to complete the task. Studies have linked forceful grips, and grips performed in awkward postures, to musculoskeletal disorders like DeQuevain's syndrome, arthritis, tendonitis, and carpal tunnel syndrome. Duration is an ergonomics risk factors which magnifies other risk factors such as contact stress.

Figure 5: Contact stress

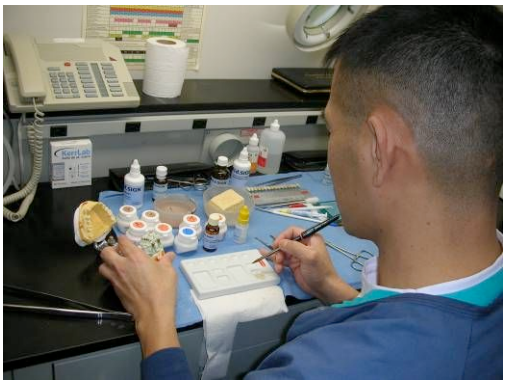

Figure 6: Stacking porcelain

Repeated and Prolonged Standing: Workers stand on the hard shop floor repeatedly while polishing and grinding prosthetics, figure 7. Standing for long periods can be a strenuous activity that promotes blood pooling in the legs and feet and can result in discomfort and fatigue.

Figure 7: Polishing

Recommendations

∞ Provide new workstations with proper ventilation, adequate lighting, and ergonomic seating to promote neutral postures and reduce ergonomics related stressors. New ergonomic hand tools and arm supports will also help reduce contact stress. Kavo has delivered a quote for $63,667.65 and ACCR has bid $23,013.56 for the installation at Facility A. Kavo and ACCR are drafting a bid for Facility B for FY08 project submission.

∞ With the new workstations, the workers can raise themselves to a more neutral posture but they may need to then utilize foot rests so their feet are resting comfortably. Refer to table 1.

Vendor Table 1 – Footrests			
Product	Vendor	Estimated Cost	Figure
Footrest	Your local office supply store	$30-$60	
	Alimed 1-800-225-2610	$37-$41	

∞ Anti-fatigue matting is recommended for the standing polishing and grinding workstations to reduce fatigue. Refer to table 2.

Vendor Table 2 – Anti-fatigue matting			
Product	Vendor	Estimated Cost	Figure
Anti-Fatigue Matting	Lab Safety 1-800-356-0783	Price varies by size.	
	Matting World 1-800-254-8557		

Vendor Table 2 – Anti-fatigue matting			
Product	Vendor	Estimated Cost	Figure
	Safeworker* recommended by NADEP Jax 1-888-456-3372	18" X 36 " Extreme Standing Mat with Beveled strips $43.46 3'X5' Extreme standing mat with bevel strips $156	
	Whiteside 470 363 1179	$200	
	C&H 1-800-558-9966	$386-$1629	
	Lab Safety	$916- $1214	

∞ An illuminated magnifier will encourage the employees to work in a more neutral posture and reduce eye strain. Refer to vendor table 3.

Vendor Table 3 – Magnifier			
Product	Vendor	Estimated Cost	Figure
Luxo Illuminated Magnifier	Lab Safety 1-800-356-0783	$290-$360	
	Medco Supply (800) 556-3326	$180	
	Office Depot	$109	

∞ The employees at Facility B would benefit from new chairs with more adjustability, an impervious surface, and smaller foot print. Refer to table 4 for vendor recommendations.

Vendor Table 4- Chairs			
Product	Product	Estimated Cost	Figure
Alimed 1-800-225-2610	Soma Hybrid chair	$479	
	Advantage surgeon's chair	$2495	
Hag www.haginc.com Ken Krauss/Bonnie Momsen Chicago, IL (312)321-0761	Hag Capisco*	$442	
ErgoResource Charles Hartman (919) 781-2772 (GSA Contract)	Hag Capisco*- Vinyl Cover Seat Height Adjusts from 16" to 20" Seat Height adjusts from 20" to 27" (ideal for bench work)	$436.25 $445.74	

Cessi Ergonomics Dan Reed 410-315-9360	Neutral posture Ab-stool	$336	
KAB Dental 1-800-422-3520 http://www.kabdental.com/products/crown_seating.htm	Crown Seating	$250-$375	
		$422-$682	
Orascoptic 800.369.3698 http://www.orascoptic.com/products/bodyGuard/index.cfm	Assistant's chair		
A-Dec 919-850-0905 http://www.a-dec.com/html/Products/seating/1622AssistantStool.asp	Assistant's Chair		

Brewer Design 1.800.558.8934 http://www.brewer-design.com/Dental_Optical_Folder/DO_seating.htm			
ETI http://www.eti-dental.com/ Go to Doctor/assistant chairs.	The ergonomic stool has an independent back and seat height adjustment. The synchronic is a straddle stool.		Go to the website for photos.
Ergo-dontic http://www.ergo-dontic.com/products.htm			

*The Capisco can be straddled and used to support the chest and upper extremities.

∞ Encourage workers to take stretching breaks during the day to relieve discomfort and encourage muscle movement. A physical therapist can instruct the workers in stretching exercises appropriate for their job or refer to the following websites. The following web sites include exercises that can be printed and posted. Sources should be cited when reproducing information. Web site links updated April 2006.

http://www.steelcase.com/na/knowledgedesign.aspx?f=10250&c=10213

www.shelterpub.com/_fitness/_office_fitness_clinic/OFC_online_stretches.html

www.safety.duke.edu/Ergonomics/90seconds.asp

Appendix I

Job Requirements and Physical Demands Survey Results

Prosthetics Lab

Summary
The Job Requirements and Physical Demands Survey (JR/PD) was administered to the employees of the Prosthetics Lab. Information regarding the development, instruction, and validation of the JR/PD can be found at http://www.brooks.af.mil/afioh/Health%20Programs/ergonomics_jrpd.htm. The JR/PD is an ergonomics assessment tool endorsed by the Department of Defense Ergonomic Working Group and used by the tri-services to collection occupational health data. The JR/PD is a survey used to assess ergonomics related risk in the workplace.

The results of the JR/PD indicate the Prosthetics Lab is an Ergonomics Problem Area (EPRA). The shop scored an Overall or Survey Priority Rank of **seven** (on a scale of 1 to 9), where nine has the highest priority for intervention. A score of five or greater indicates an Ergonomics Problem Area. The JR/PD assesses five distinct body regions: shoulder/neck, hand/wrist/arm, back/torso, leg/foot, and head/eye. The (body region) priority scores are a combination of identified ergonomics risk factors and employee reported discomfort. The back/torso, and leg/foot regions had significant priority scores. A significant number of employees reported experiencing work-related pain or discomfort that does not improve when away from. All of the survey respondents have seen a health care provider within the last twelve months for pain or discomfort that he or she feels is related to the job. A significant number of employees also reported pre-existing Musculoskeletal Disorders (MSDs), which places them at a higher risk of additional or more severe Work-Related Musculoskeletal Disorders (WMSDs).

Overall Priority Score

The results of the JR/PD indicate the Prosthetics Lab is an ergonomics problem area with an overall score of **seven**. An Overall Job Priority score of five or greater establishes a task/job as an ergonomic problem area. The Overall Job Priority score is determined by selecting the highest Body Region Score for the job which in this case is the leg/foot region.

The Overall Priority Rating Score is used to determine which jobs or areas are associated with the most significant ergonomic risk. It is important to note that a high Overall Priority Score (i.e. ergonomic problem area) does not necessarily mean that the risk of illness associated with a job or area is high. Rather a high rating indicates that the tasks expose workers to a considerable level of risk factors associated with WMSDs in comparison to jobs/tasks or areas that receive lower scores.

Demographics

2 (workers/respondents) completed the JR/PD survey, resulting in a 100% response rate. A survey population of at least 3 respondents is required for statistical significance but since the entire worker population completed the surveys the results should represent the population. The population demographics are contained in Table 1.

Table 1: Population Demographics

Gender:	Male: 100%
Group:	Military: 100%
Age:	50% between the ages of 21 and 30
	50% over the age of 40

Age is a contributing factor for the development of WMSDs.

Priority Score

The JR/PD prioritizes five distinct body regions based upon a combination of ergonomics risk factors and discomfort. Workers indicate their duration of exposure for different ergonomics risk factors. Ergonomics risk factors include posture, force, frequency, repetition, vibration, contact stress, and restrictive personal protective equipment. The frequency and severity factors are combined to evaluate discomfort in each of the five body regions. Table 2 demonstrates the relationship between body region, discomfort, and risk.

Table 2 Body Region, Discomfort and Risk

		Body Regions				
		Shoulder/ Neck	Hand/Wrist/Arm	Back/ Torso	Leg/ Foot	Head/ Eye
Priority Score		3	3	6	7	4
Risk	Prevalence	0%	0%	0%	100%	100%
	Rating	Low	Low	Low	High	High
Discomfort	Prevalence	50%	50%	100%	50%	0%
	Rating	Medium	Medium	High	Medium	Low

Risk Prevalence and Rating

The percentage of respondents exposed to specific ergonomics risk factors for a given body region, for longer than two hours per day, assesses the prevalence of risk. A low rating represents less than 30% prevalence, medium 31% to 60% and high is greater than 61% of the respondents have exposure greater than 2 hours per day. The leg/foot and head/eye regions have high levels or reported risk.

Discomfort Prevalence and Rating

The terms fatigue, numbness, and pain categorize discomfort. The percentage of respondents and their discomfort ratings determine whether discomfort is prevalent among the workers. Combinations of frequency and severity that indicate significant discomfort prevalence are shown with asterisks in Table 3. Low ratings represent less than 30% prevalence, medium 31% to 60% and high is greater 61%. The back/torso region has high levels of discomfort while the shoulder/neck, hand/wrist/arm and leg/foot regions are medium.

Table 3: Discomfort Matrix

FREQUENCY	**SEVERITY**		
	Mild	Moderate	Severe
Daily	*	*	*
Weekly		*	*
Monthly			*

The Priority matrix in Table 4 determines the overall prioritization of specific body regions. The relationship between discomfort and risk factors determines priority rating from 1 to 9 for each body region. A priority greater than four, indicated by an asterisk, is significant. The Overall Priority ranking for the Prosthetics Lab is equal to the highest body region priority value, which is a seven. The back/torso and leg/foot region had significant scores.

Table 4 Priority Matrix

	DISCOMFORT		
RISK FACTOR	High	Medium	Low
High	9*	7*	4
Medium	8*	5*	2
Low	6*	3	1

Organizational Information

Organizational factors contribute to ergonomic stressors. The organizational score for this area was **low**, which indicates job stress factors are not of concern. Survey respondents were asked if they understood their job responsibilities, if their workload was too heavy, if they are able to get pertinent information, if they received comments on performance, etc. Suggestions to improve stress associated with organizational

factors include providing workers with more autonomy and improving discussion and feedback between workers and supervisors.

Physical Effort

The survey resulted in a perceived physical exertion score of **8.5**. Respondents were asked to describe the physical effort required of their job on a scale of 1 to 15 where one is no exertion at all and fifteen is maximal exertion. The higher the score, the greater the level of perceived physiological exertion. A value of 8 is somewhat hard, indicating a nominally physically demanding task.

Health Care Provider Score

According to the health care provider score, **2 (100%)** of the respondents reported having been to a health care provider in the last 12 months for pain or discomfort that he or she thinks is related to his job.

Recovery Time Score

100% of the respondents reported experiencing work-related pain or discomfort that does not improve when away from work overnight or over the weekend. A score above 30% is of high importance. Lasting pain/discomfort is an indicator of inadequate recovery time for the muscles, tendons, and ligaments. Muscles, tendons, and ligaments that do not recover are more likely to be injured. Significant discomfort is apparent in the workers' inability to recover after the cessation of work.

Activity Interruption Score

0% of the respondents indicated that in the past 12 months, work-related pain or discomfort has caused difficulty in carrying out normal activities (e.g. job, hobby, leisure, etc.). A score above 50% is of high importance.

Previous Diagnosis Score

The survey asks if "a health care provider ever told you that you have any of the following conditions which you think might be related to your work?

Tendonitis/Tenosynovitis
Trigger Finger,
Bursitis
Thoracic Outlet Syndrome
Overuse Syndrome"
Ganglion Cyst
Epicondylitis (Tennis Elbow)
Carpal Tunnel Syndrome
Back Strain, Knee or Ankle Strain

100% of respondents indicated affirmatively. Pre-existing WMSDs can contribute to an employee's pain and discomfort levels; thereby affecting the overall priority score. Working conditions may exacerbate a pre-existing disorder. Workers with pre-existing

WMSDs are likely to experience additional or more severe WMSDs if the environment is unchanged.

Contributing Factors

Respondents were asked if they had ever had one or more of the following conditions:

Wrist Fracture	Hypertension	Kidney Disorders
Thyroid Disorders	Diabetes	Gout
Rheumatoid Arthritis		

0% of the respondents indicated positively. These health conditions are contributing factors and may increase one's risk of developing a musculoskeletal disorder; thereby affecting overall priority.

Process Improvement Opportunities

This section of the survey allows employees to write in responses to questions. All statements are included exactly as written by the employees with the exception of spelling errors and expletives.

1. Which tasks are the most awkward or require you to work in the most uncomfortable position?
   - ∞ Grinding
   - ∞ Grinding, craving, waxing

2. Which tasks take the most effort?
   - ∞ When I do grinding on the work bench
   - ∞ When I am grinding on the bench lathe. Hand piece grinding.

3. Are there any tools or pieces of equipment that are notoriously hard to work with?
   - ∞ The bench lathe redwing 22894

4. If you could make any suggestions that would help you do your job more easily or faster or better, what would you suggest?
   - ∞ Work benches with better arm support, overhead lighting
   - ∞ More lighting on the bench, back support, arm support, feet support

Process Improvement Opportunities

This section of the survey allows employees to write in responses to questions. All statements are included exactly as written by the employees with the

End Notes:

[i] Equipment purchase without proper and repeated training will not mitigate risk and may in fact increase hazards.

[ii] Administrative controls are management-controlled work practices and policies designed to reduce exposures to work-related musculoskeletal disorders (WMSDs) hazards by changing the way work is assigned or scheduled. Administrative controls reduce the exposure to ergonomic stressors and thus reduce the cumulative dose to any one worker. Examples of administrative controls that are used in the ergonomics context are employee rotation, employer-authorized changes in the pace of work and team lifting.

[iii] This report does not constitute an endorsement of any particular product. Rather, it is a recitation of how Navy personnel have addressed a particular work place safety issue. Neither the Navy nor its employees and agents, warrant any product described in this report for any use, either general or particular.