Ergonomics Within the Workplace

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Background

The workplace has become a centre for numerous health concerns. In a typical automotive factory environment, the workers perform the same task every minute for 8 hours a day. As the automotive assembly process has evolved, the subcomponents placed into the vehicle have grown in size and weight. Consequently, the likelihood of injury due to strain or repetitive stress has increased.

In this study, we will be taking a look at the subject of lifting and moving of heavy objects in factories, using trolley systems. We plan to investigate the forces that the human body exerts in a typical translational move operation. There have been technological advancements to make these trolley machines more efficient and easier to use, but no studies have been done to quantify the effect on the worker. Our motivation for this project included the large number of unnecessary injuries in the automotive manufacturing industry as well as our interest in the human body and its muscular response to certain ergonomic conditions.

Purpose

Using several case studies, the aim in this science fair topic is to improve the workplace ergonomic conditions, therein reducing wear and tear on the worker's body. We have set goals to find the most prominently used muscle groups, the relationship between the amount of mass being moved and the level of muscle contraction, and to quantify the effects of several work-place variables on muscle contractions.

Procedure

The four cases studies will be done to find: the most used muscle group, the variables that affect forearm muscle group, the variables that affect lower-back muscle group, relationship between amount of weight and level of muscle contraction.

Only one muscle group was examined during each trial for each case study. The Myoexorciser III output the minimum, maximum and average muscle contractions for each trial. We performed each trial at least three times and averaged the results. Due to the repetitive nature of the work and the number of trials, we used randomization to obtain the best data possible. All the cases went through a predetermined course which simulated actions done on the assembly line. The course included pushing and pulling actions along with 90 and 180 degree turns.

Essential Materials

iTrolley – a powered-assist trolley system using magnetic induction and cable-angle sensing to greatly reduce weight-inertia, standard trolley system, Weights (12.5lbs, 25lbs, and 45lbs), Ergonomic Back-support Belt, Ergonomic Gloves, and Myoexercise III (with electrodes+alcohol swabs)

Results

In the first study, the Longisiimus (lower back muscle) and Flexor Carpi Radialis (forearm muscle) had the largest muscle contractions. The iTrolley reduces muscle contraction in each muscle group.

	Effect of iTrolley on Muscle Contractions					
	Study 1 - Muscle Investigation		**SUBJECT 1- PETER W**		Erector Spinae Group	Neck
	Flexor Carpi Radialis	Trapezius	Pectoralas major	Deltoid	Longissimus	Splenius Capitis
Range% reduction=	**58.7**	**2.9**	**57.8**	**43.8**	**5.1**	**55.2**
Average% reduction=	**28.0**	**9.5**	**51.8**	**49.6**	**28.0**	**29.7**

In the second study all methods of analysis showed that the variables with the largest effect on muscle contractions of the flexor carpi radialis are temperature, duration, and trolley system. The Regression analysis allowed for the following linear equation to be obtained:

Y= 13.2 - 3.1 (Trolley System) + 3.8 (Duration) - 4 (Temperature)

In the third study all methods of analysis showed that the variables with the largest effect on muscle contractions of the longissimus are temperature, backbelt, and height of trolley system. The Regression analysis allowed for the following linear equation to be obtained:

Y= 7.3-2.3 (ergo belt) -0.8 (height TS)-1.6(Temperature)

In the fourth case study, six linear equations were obtained.

Note: variables in equation have binary values (1 or 0)

Conclusion

The iTrolley system should be used within workplace to reduce the strain on the workers. For the user to be ergonomically healthy and most efficient the temperature should be around 21-23°C. Any temperature lower can result in higher muscle contractions which make the user more vulnerable to injuries, and any higher temperatures would decrease work efficiency. The elbow should be bent at 90 degrees and lower arm held perpendicular to the body to reduce the risk of injury. Furthermore, ergonomic aids should be used in the work place. The longer the duration of an action is, the less strain there is on the muscle. These conclusions we draw are important because they can reduce the strain on the user and lead to a better work environment. They have potential to be used in manufacturing companies.

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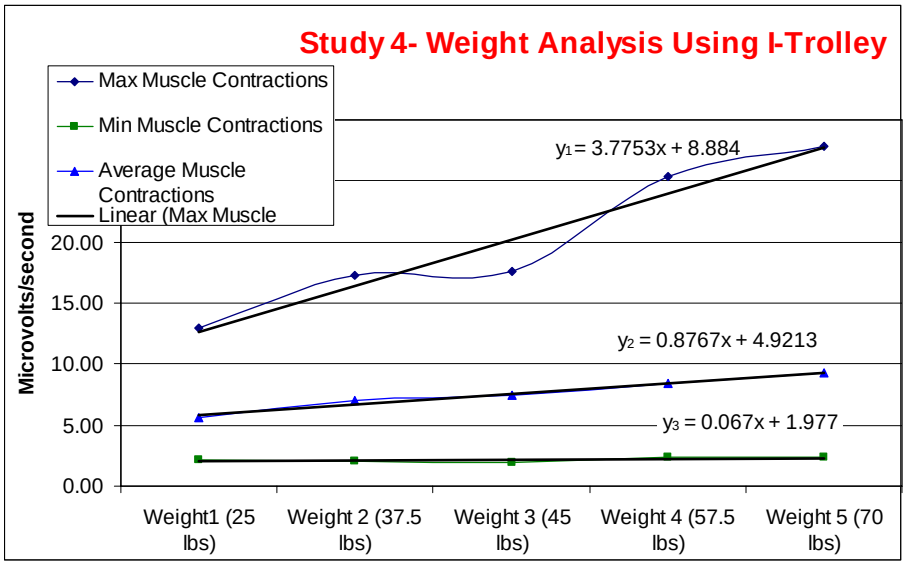
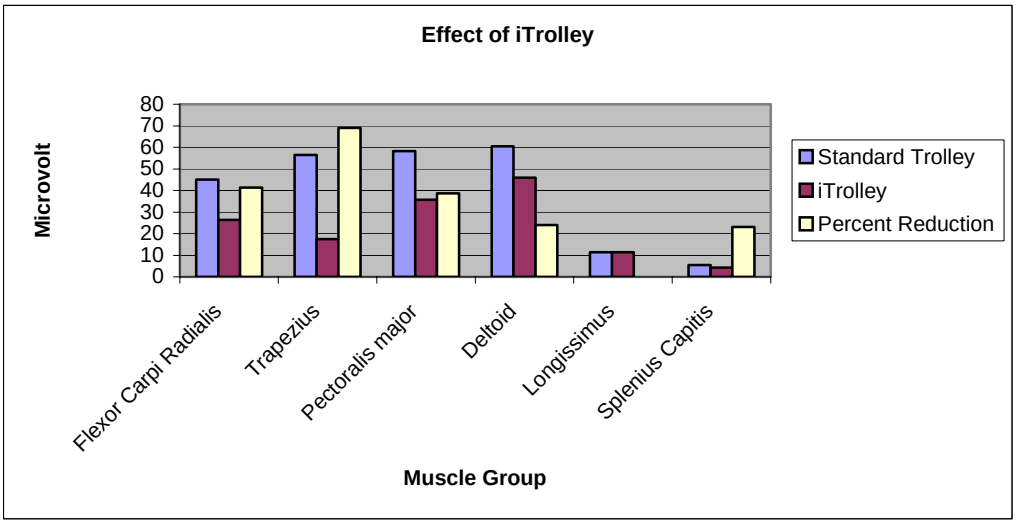
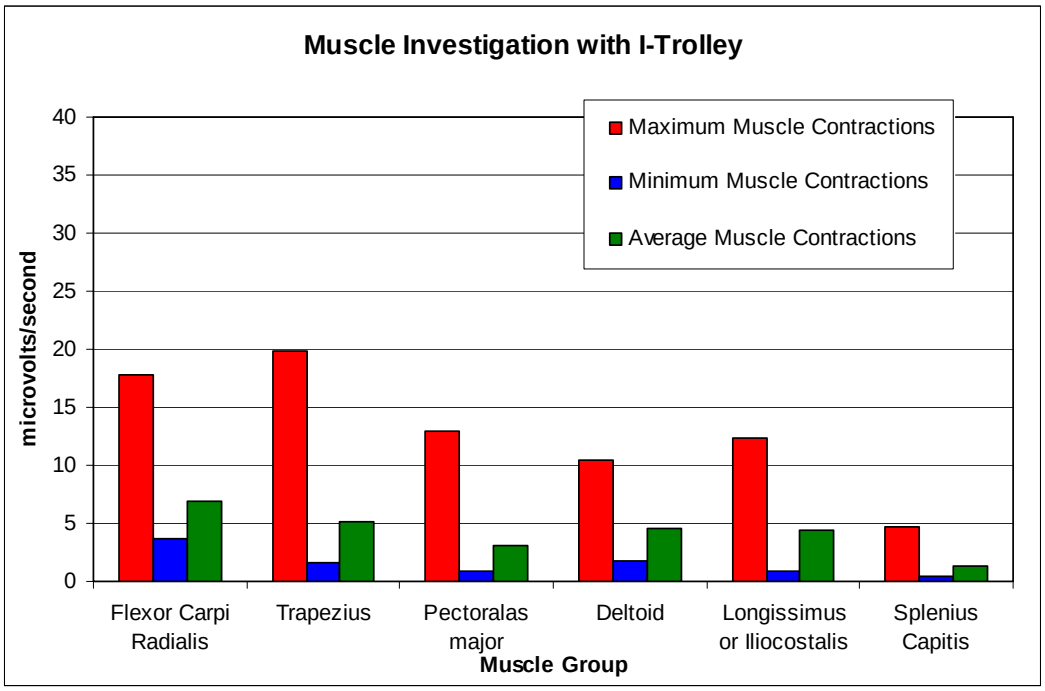
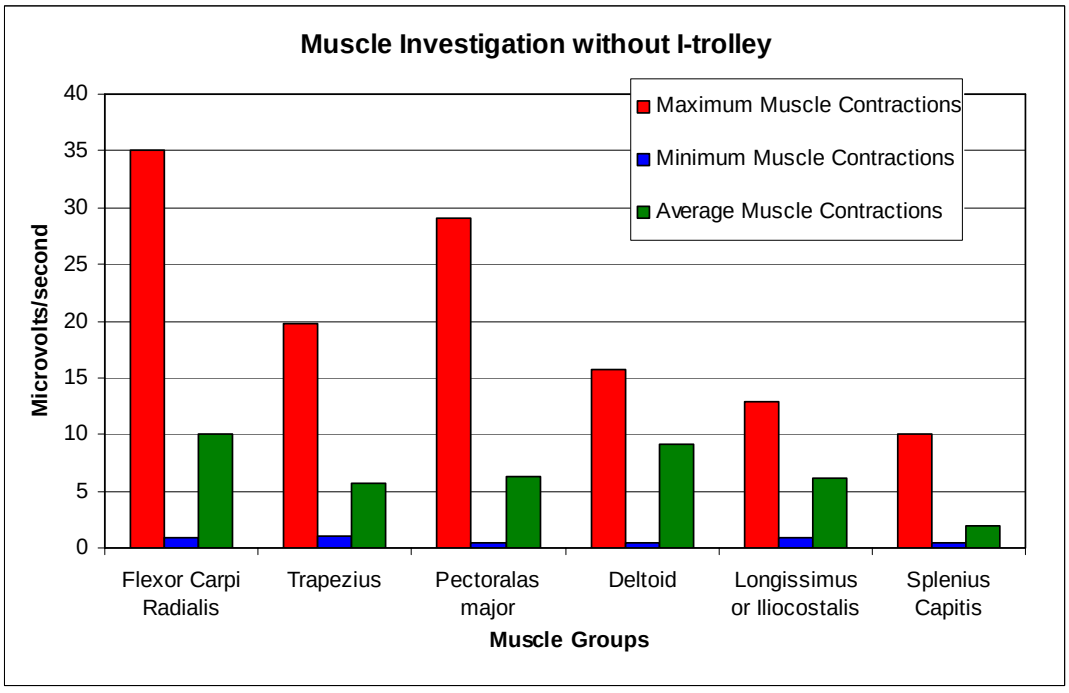
Attachments






Muscle Investigation with I-Trolley
Maximum Muscle Contractions
Minimum Muscle Contractions
Average Muscle Contractions
microvolts/second
40
35
30
25
20
15
10
5
0
Flexor Carpi Radialis
Trapezius
Pectoralas major
Deltoid
Longissimus or Iliocostalis
Splenius Capitis
Muscle Group


Muscle Investigation without I-trolley
Maximum Muscle Contractions
Minimum Muscle Contractions
Average Muscle Contractions
Microvolts/second
40
35
30
25
20
15
10
5
0
Flexor Carpi Radialis
Trapezius
Pectoralas major
Deltoid
Longissimus or Iliocostalis
Splenius Capitis
Muscle Groups

Appendix - Bibliography

"Healthy Computing." Welcome to Healthy Computing. 01 Jan. 2005 <http://www.healthycomputing.com/>.

"iTrolley." 2003. The Stanley Works. 03 Oct 2006 <http://www.stanleyassembly.com/products/MaterialHandling/iTrolley.aspx>.

Adams, Chris. What is a Repetitive Strain Disorder?. 2006. About, Inc.. 3 Nov 2006 <http://ergonomics.about.com/od/repetitivestressinjuries/f/whatisrstraind.htm>.

Ergonomics. May 2006. Wikipedia. 03 Oct 2006 <http://en.wikipedia.org/wiki/Ergonomics>.

Ergonomics - Pushing and Pulling. 27 Nov 1997. Canadian Centre For Occupational Health and Safety. 3 Oct 2006 <http://www.ccohs.ca/oshanswers/ergonomics/push1.html>.

Ergonomics At Work. Allscan . 01 Jan. 2005 <http://www.combo.com/ergo/atwork.htm>.

Gregory J Lehman, Day Deans Buchan, Angela Lundy, Nicole Myers, Andrea Nalborczyk. Variations in muscle activation levels during traditional latissimus dorsi weight training exercises: An experimental study. 30 June 2004. BioMed Central Ltd.. 3 Nov 2006 <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=449729>.

Kerin, Kirsty. "NEW ERGONOMICS RESEARCH SHOWS MANY EXTENDED HOURS WORKERS MAY BE AT UNECESSARY RISK OF INJURY." 2004 Ergonomics Study Release. Circadian Technologies, Inc.. 01 Jan. 2005 <http://www.circadian.com/media/2003_press_Ergonomics.htm>.

MacArthur, Catherine T.; D, John. MUSCLE TENSION. 09 2003. 01 Jan. 2005<http://www.macses.ucsf.edu/Research/Allostatic/notebook/muscle.html>.

McPeck, Christopher . "The Cause of Internet and TV Addiction?." Suggestions for Muscle Tension. 01 Jan. 2005 <http://pages.prodigy.net/unohu/suggtension.htm#Extra>.

Posture at work. 2006. Spine-Health.com. 3 Oct 2006 <http://www.spine-health.com/topics/cd/ergo/ergo03.html>.

Rickover, Robert. "Ergonomics.org - Posture, Movement and Ergonomics." Ergonomics. 2006. ALEXANDER TECHNIQUE. 03 Oct 2006 <http://ergonomics.org/>.

Riley, Dan. Push-pull routine. 2006. J&Q Fusion. 15 Oct 2006 <http://www.houstontexans.com/fitness/news_detail.php?PRKey=1330>.

The MYOEXORCISER III Operation Manual. 2 ed. : Verimed International Inc., 1995.