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**FACULTY OF ENGINEERING**  
**INDUSTRIAL ENGINEERING**

30<sup>th</sup> INTERNATIONAL CONGRESS OF OCCUPATIONAL HEALTH

"CORRELATION ANALYSIS AMONG THE VARIABLES OF TEMPERATURE,  
 FORCE, AND CYCLES PER MINUTE THROUGH THE HORIZONTAL  
 REPETITIVE MOVEMENTS OF THE WRIST"

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## 1. INTRODUCTION

- ✗ The need to protect the workers.
- ✗ Prevention of work risks.

This study is aimed to determine the existence of correlation between the changes of temperature and force, as well as, the number of movements per minute, all of this through horizontal repetitive movements, which can frequently be found at work sites. These experiments were conducted on a man and on a woman.

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## CONTENT

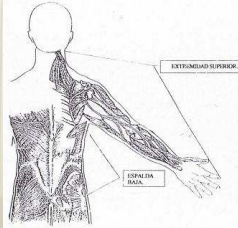
1. Introduction.
2. Objectives.
3. Materials and methods.
4. Results of the experiment.
5. Conclusions and recommendations.
6. References.

### 1.1. CUMULATIVE TRAUMA DISORDER- CTD

"It's a physical injury that develops gradually over a period of time as a result of repeated efforts on a specific part of the muscle – skeletal system."

**They occur in two areas of the body:**

- ✗ Upper extremity.
- ✗ Low back.

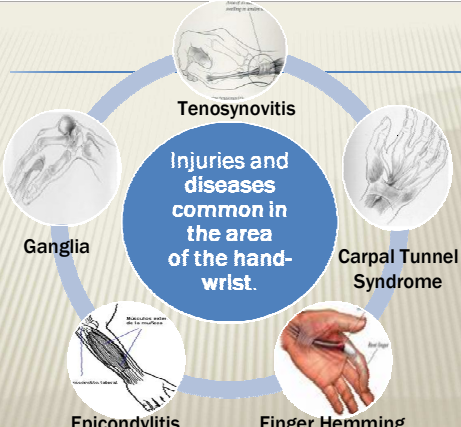


Putz-Anderson, Vern. Cumulative Trauma Disorders; Ed. Taylor and Francis, 1988.

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# 1. INTRODUCTION

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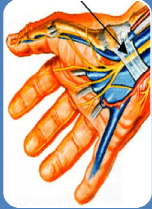
**Injuries and diseases common in the area of the hand-wrist.**

Institute of Arthritis and Musculoskeletal and Skin Diseases, 2009.

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## 1.2 CARPAL TUNNEL SYNDROME

### Symptoms:



- Numbness.
- Pain or irritation at the thumb and fingers.
- Burning and dryness in the hands and forearms.
- Loss of strength in his hands.

www.ilo.org/global/lang-es/index.htm International Labor Organization (OIT), 1996-2009.  
http://www.cgbbva.net/derechos/salud\_laboral/cuadernos/gsl07.pdf, Labor Health guide, 1997.

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## 1.4 SENSORY AND INFRARED THERMOGRAPHY

•Ming, et. al. (2005) classified compassionate pathology in carpal tunnel syndrome and the use of infrared thermography. An exercise was conducted in which subjects were kept at room temperature between 22 and 25°C for 15 min. include the ambient temperature of testing room as an important factor.

•Gold J., et. al. (2004) identify differences in skin temperatures between 3 groups of office workers through dynamic thermography, there is the experiment for writing with computer keyboard for 9 minutes straight.

## 1.4 SENSORY AND INFRARED THERMOGRAPHY

• Cherniack, (2009) demonstrated that through the use of infrared thermography, It is possible to measure the temperatures of the hand under controlled conditions of environmental temperature.

• López, (1992) states that thermography has its historic base in the development of undersea digital thermographs used to measure the temperature under water in natural environments, and potential applications in areas such as oceanography, marine ecology, industry, among others ( ).

• Up to date, no studies have been found in the human body with Sensory thermography.

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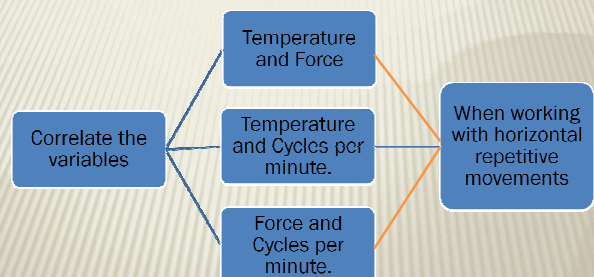
# 2. OBJETIVES

## 1.4 SENSORY AND INFRARED THERMOGRAPHY

•E.Y.K.N.G et al (2008): mentions that thermography has various fields of application because it is a noninvasive technique and used in fields such as medicine in a way very extensive. A study using advanced techniques for breast cancer screening was performed by thermography.

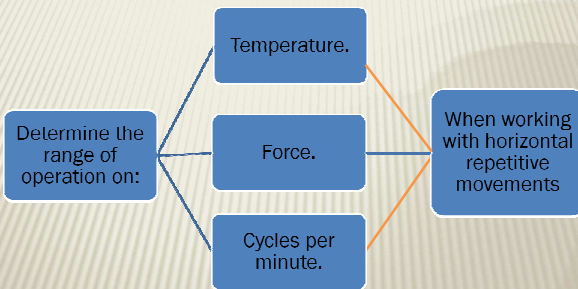
•Ferreira, et. al., (2007): determined thermographic changes of temperature associated to elderly and young people, doing knee bends with a weight of 1 kilogram added to it for 3 minutes.

## 2. OBJETIVES



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## 2. OBJETIVES



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## 3.2 METHOD OF THE EXPERIMENT.

- ✗ Man (operator 1) and woman (operator 2), 24 years of age.
- ✗ Dominant hand (right hand).
- ✗ Horizontal repetitive movements, during an eight-hour journey (with only a 30 minute-break) during seven days.
- ✗ Measure of movements, force, and temperature each 10 minutes.

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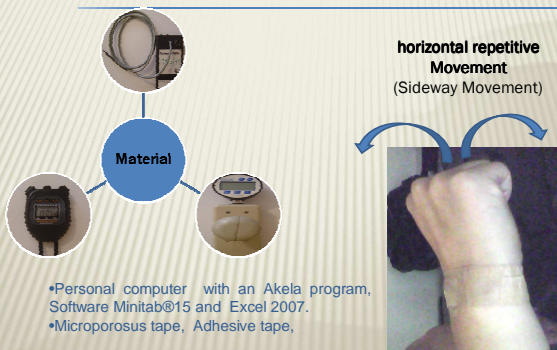
## 3. MATERIALS AND METHODS.

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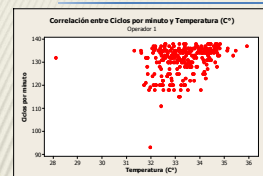
## 4. RESULTS OF THE EXPERIMENT

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### 3.1 MATERIALS OF THE EXPERIMENT.

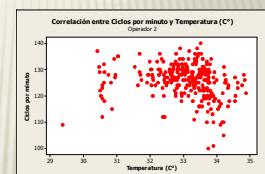


### 4.1 SOME CORRELATIONS FOUND PER WEEK



$r = 0.292$

Critical value of  
 $r = 0.119$



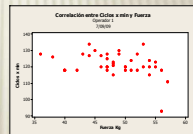
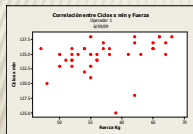
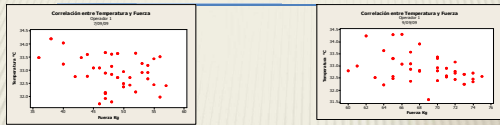
$r = 0.172$

1. Figure with graphics of some of the correlations from the 7 days of the operators 1 and 2.

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#### 4.2.1 SOME OF THE CORRELATIONS FOUND PER DAY OPERATOR 1



Critical value = 0.316

2. Figure with graphics of some of the correlations for days of the operator 1

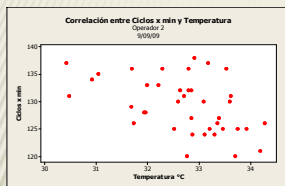
#### 5.1 CONCLUSIONS

Based on the study conducted, the following was concluded:

- There exist correlation between the temperature and the cycles per minute when working with horizontal repetitive movements.
- There exist correlation between cycles per minute and force when working with horizontal repetitive movements.
- There is not any correlation between the temperature and force when working with horizontal repetitive movements.

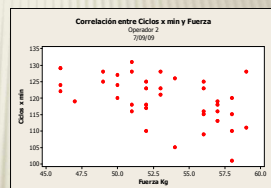
Correlations	Operator 1	Operator 2
Temperature versus Cycles per minute	√	√
Cycles per minute versus Force	√	√
Temperature versus Force	x	x

#### 4.2.2 SOME OF THE CORRELATIONS FOUND PER DAY OPERATOR 2



r = 0.471

Critical value = 0.316



r = 0.508

3. Figure with graphics of some of the correlations for days of the operator 2

#### 5.2 RECOMMENDATIONS FOR FUTURE TESTS

Analyze the behaviour of:

- Temperature
- Force
- Cycles per minute
- Time, etc.

On

- Forearm
- Shoulder
- Dominant hand and non dominant hand

- Carry out studies in the industry, in which repetitive work is done to evaluate the study.
- Perform a group analysis (several operators).
- Carry out future tests based on statistical inference (Lineal regression, difference of mediums, ANOVAS), etc.).
- Analyze if there exist any difference between genders in the average of temperatures, force and cycles per minute

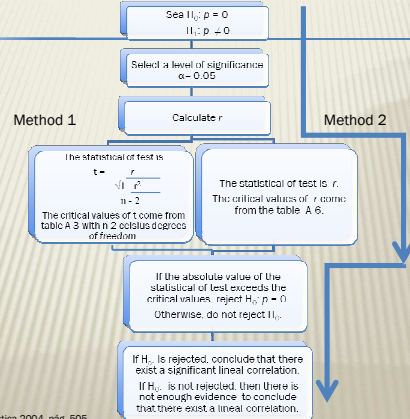
## 5. CONCLUSIONS AND RECOMMENDATIONS

## 6. REFERENCES.

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- Cherniack Martin, Dropkin Jonathan, Gold Judith, Hanlon Alexandra, T. Dennerlein, Skin temperature in dorsal hand of office workers and severity of upper extremity musculoskeletal disorders, *Int. Arch. Occup. Environ. Health*, 82:1281-1292, 2009.
- E.Y.K NG and E.C. KEE, Advanced integrated technique in breast cancer Thermography, *Journal of Medical Engineering & Technology*, Vol. 32, 103-114, March/April 2008.
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- López Bonilla Roberto Oscar, *Instituto de Investigaciones Oceanológicas, Universidad Autónoma de Baja California, Termógrafo digital submarino, Instrumentación y desarrollo*, Vol. 3 No.2, 1992.
- Ming Zhiyong , Zaproudina Nina, Siivola Jouko, Nousiainen Unto, Pietikainen Seppo, Sympathetic pathology evidenced by hand thermal anomalies in carpal tunnel syndrome, *ISP Pathophysiology*, pp. 137-141, 2005.

## Hypothesis Test for a lineal correlation



THANK YOU FOR  
YOUR ATTENTION.

## CRITICAL VALUES OF THE CORRELATION COEFFICIENT r

n	Valores críticos del coeficiente de correlación de Pearson r	
	α = 0.05	α = 0.01
4	0.950	0.999
5	0.879	0.959
6	0.811	0.917
7	0.754	0.875
8	0.717	0.834
9	0.686	0.795
10	0.659	0.758
11	0.635	0.725
12	0.613	0.694
13	0.593	0.664
14	0.575	0.636
15	0.558	0.611
16	0.543	0.587
17	0.529	0.565
18	0.516	0.544
19	0.504	0.525
20	0.493	0.508
25	0.468	0.475
30	0.449	0.453
35	0.435	0.440
40	0.424	0.430
45	0.415	0.422
50	0.408	0.416
60	0.395	0.404
70	0.385	0.395
80	0.378	0.388
90	0.373	0.383
100	0.369	0.379
273	0.319	0.316

Critical value of correlation per day.

Critical value of correlation per week.