

THE EFFECT OF AGE AND DAILY WORKING HOUR ON DRIVING PERFORMANCE FOR CONTAINER CRANE OPERATORS

K. Shawki*, A. Soliman* and M. Abou- Elenein

*Associate Prof., Construction & Building Department, College of Engineering and Technology, Arab Academy for Science, Technology and Maritime Transport Alexandria, Egypt.

** M.Sc. Student, Construction & Building Department, College of Engineering and Technology, Arab Academy for Science, Technology and Maritime Transport Alexandria, Egypt.

ABSTRACT

The operators of container crane shipping docks are the first pillar and fundamental to the success of companies handling and transport of containers. The performance and the ability of the operators are the main tasks for the success of shipping companies and thus the success of internal and external trade. The operators subjected to training courses on simulator before and during their practical life. The aim of this paper is to analyze the driving performance of container crane operators working in ALEXANDRIA-EGYPT terminal in daily working and suggest recommendations to improve their performance. Improving operator performance means maximize number of container moves per hour and maximize handling accuracy (or minimizing errors during handling). To reach this aim the following steps were done:

- 1- Analyzing database for the operators subjected to training courses and test before and during their practical life.
- 2- Analyzing database for the operator during their shifts.
- 3- Analyzing database for the operators during simulator tests but with no test time duration.

يعتبر سائقي أوناش الرصيف الموجوده داخل ساحات التحميل هي الركيزة الأولى والأساسية لنجاح شركات نقل وتداول الحاويات. قدرة أداء السائقين لأوناش الرصيف هي من أهم عوامل النجاح لشركات النقل البحري وبالتالي نجاح التجارة الداخلية والخارجية. معدلات الاداء لسائقي أوناش الرصيف تعتمد على عوامل متعددة منها الدورات التدريبية التأهيلية والتنشيطيه والقدرة الصحيه والقدرة البدنيه واستقرار حاله الاجتماعيه وعمر كل سائق. والهدف من هذه الدراسة هي قياس أداء سائقي أوناش الرصيف العملاقة في ساعات العمل اليومية داخل محطة الاسكندرية لنقل و تداول الحاويات. تحسين اداء السائقين يعني زيادة عدد الحاويات المنقولة في الساعة و زيادة الدقة في العمل. وسوف يتم قياس معدلات أداء سائقي أوناش الرصيف العملاقة طبقاً للفئات العمرية المختلفه والوصول لعدد ساعات العمل اليومي المناسبه لكل فئة عمريه علي ثلاثة مراحل :-

- 1- تحليل نتائج الاختبارات في نهاية الدورات التدريبية للسائقين داخل المحاكى.
- 2- تسجيل و تحليل معدلات اداء السائقين في ساعات العمل اليومية داخل الشركة.
- 3- اختبار عدد من السائقين لفترة طويلة داخل المحاكى و الخروج بنتائج و توصيات.

KEYWORDS:

Container crane operators – Daily working hours – Performance .

1. INTRODUCTION

A container crane (also container handling gantry crane or ship-to-shore crane) is a type of large dockside gantry crane found at container terminals for loading and unloading intermodal containers from container ships. [1]. There are two common types of container handling gantry crane: high profile, where the boom is hinged at the waterside of the crane structure and lifted in the air to clear the ships for navigation, and low profile, where the boom is

shuttled towards and over the ship to allow the trolley to load and discharge containers. Low profile cranes are used where they may be in the flight path of aircraft when the container terminal is located close to an airport. [2].

One of the world container ports is In Singapore; PSA Singapore Terminals operate four container terminals at: (Tanjong Pagar, Keppel, Brani and Pasir Panjang). [3].

Singapore is World’s busiest transshipment hub. PSA Singapore terminals handled 29.37 million TEUs in 2011, including 1.32 million reefer TEUs, while the Jurong port terminal handled 570,573 TEUs. PSA’s global terminal operations, including Singapore, handled 57.09 million TEUs in 2011 in 29 ports and 17 countries. [3].

Container ships are getting bigger and the ship-to-shore (STS) cranes that load and unload them are getting taller. One of the key technologies in this evolution is the remote control of STS cranes – an ABB innovation that is being rapidly embraced by container terminals worldwide for its ability to increase productivity and provide crane operators with a more ergonomic and comfortable working environment.[4].

A container crane operator (also container handling gantry crane operator, ship-to-shore crane operator, dock gantry crane operator) are considered the heart of the port. They are responsible for moving materials to and from ships in a timely and orderly manner, under very tight schedules. Crane operators need to: [5]

- Be responsible and careful at all times when operating a crane.
- Work well independently and in teams.
- Be patient and observant.
- Have good communication skills.
- Know basic first aid.
- Be good at decision-making.

Crane operators need to be reasonably fit, have good eyesight (with or without corrective lenses), and good hearing. Crane operators must also be comfortable working at heights. Crane incidents can cause massive production delays, devastating property damage, and loss of life. One of the causes of crane incidents is crane operator, and there are several main factors affecting the efficiency of crane operator:-

- 1- Health problems ; After several years of work, the crane operators of Container crane complained about pain in the neck, shoulders and upper extremity. Their workplace was located in a special cab at the top of a so. The crane operator sat in a simple, rotating seat using joysticks to operate a clamshell crane to transport the Container into stores or ships. [6]
- 2- Drugs and alcohol intoxication; while both age and legal intoxication affected driving performance, older men were no more sensitive to ethanol in terms of peak BACs, driving performance or awareness/judgment than middle-aged men. [7]

Healthy elderly people were differently affected by hypnotics than healthy young people. Our results

indicate therefore that hypnotics effects should not only be lead on healthy young subjects in drugs driving studies. [8]

2. ANALYSIS OF OPERATORS TRAINING COURSES AND TESTS DATA

Usually crane operators subjected to training courses and tests on simulator before and during their practical life's. In training courses on simulator the operators learn operation skills. After each training course they tested to measure their performance. In training courses the productivity i.e. number of moves of containers per hour from the ship to the port yard and the accuracy of container movement during transportations were recorded. The professional operator must maximize production and minimize errors during handling (or maximize accuracy of handling).In this part the database for crane operators on Alexandria –EGYPT terminal (CAT) were analyzed. The database of each operator includes name, academic qualifications, date of birth , number of training times, moves per hour and the accuracy of movement...etc. The selected numbers of trainees were 97 and the numbers of training courses were 357. Neglecting training courses and trainees who have one or two training courses only. Grouped them to six age groups and calculating the average results of training per trainee leads to the following shown in Table(1).

Table (1): Groups of age in AT

| GROUPS | DATA-1 | | DATA-2 | |
|---------------------------------|-----------------|----------------|----------------------|----------------|
| | No of trainings | No of trainees | Avg. No of trainings | No of trainees |
| Group 1(up to 25 years) | 56 | 19 | 19 | 19 |
| Group 2(26 to 30 years) | 75 | 35 | 35 | 35 |
| Group 3(31 to 35 years) | 84 | 42 | 42 | 42 |
| Group 4(36 to 40 years) | 81 | 31 | 31 | 31 |
| Group 5(41 to 45 years) | 20 | 15 | 15 | 15 |
| Group 6(greater than 45 years) | 10 | 5 | 5 | 5 |
| TOTALS | 326 | 70 | 70 | 70 |

Then the relationship between ages, moves per hour and accuracy were shown in Figure (1) for age group two as an example. The equations governing these relations were also shown. For group two maximum

moves per hour at age 28. The maximum accuracy also at the same age.

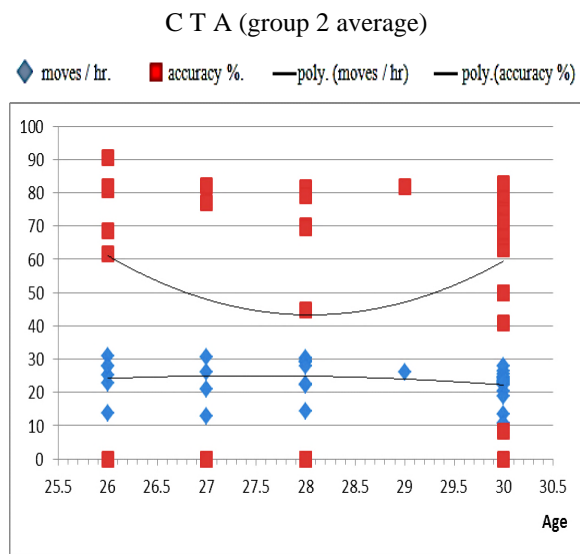


Figure (1) Moves/hr. and accuracy percent with age for group age two

The average numbers of moves per hour and accuracy for every age group were calculated as shown in Table (2) and drawn in Figure (2)

Table (2): Average moves per hour and accuracy for all age groups

| No of groups | C T A | | | | | |
|-----------------------|---------------|--------------------------|--------------------------|--------------------------|--------------------------|----------------------------|
| | 1 up to 25 | 2 from 26 to 30 years | 3 from 31 to 35 years | 4 from 36 to 40 years | 5 from 41 to 45 years | 6 graeter than 45 years |
| (Moves /hr average) | 23 | 24 | 25 | 25 | 24 | 23 |
| (Accuracy average %) | 61 | 63 | 63 | 64 | 68 | 58 |

◆ (Moves /hr average) ■ (Accuracy average %)

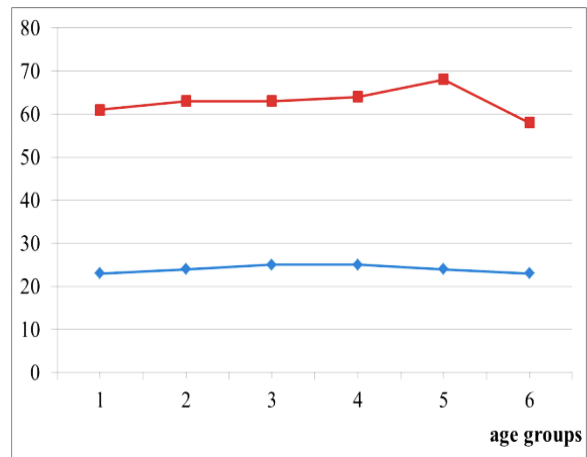


Figure (2) Average mover per hour and accuracy verses age groups

Maximum moves per hour lies on age groups three ,four and minimum moves per hour lies on age groups one, six .The maximum accuracy lies in age group five while minimum accuracy value lies in age group six.

3. ANALYSIS OF OPERATORS DATA DURING SHIFTS

In this step the same data for operators were recorded and analyzed during shifts (in field) for the same age groups the chosen number of operators at every age groups as shown in Table (3)

Table (3): Number of operators subjected to field tests (ATF)

| GROUPS | Number of operators |
|---------------------------------|---------------------|
| Group 1 (up to 25 years) | 2 |
| Group 2 (26up to 30 years) | 11 |
| Group 3 (31 up to 35 years) | 11 |
| Group 4 (36 up to 40 years) | 14 |
| Group 5 (41 up to 45 years) | 13 |
| Group 6 (greater than 45 years) | 19 |
| TOTAL | 70 |

The moves per hour and the accuracy were drawn for each age groups. As example age groups two and four were shown in Figures 3 and 4.

Group 2 (A T F)

◆ moves / hr. ■ accuracy % — poly. (moves /hr) — poly.(accuracy %)

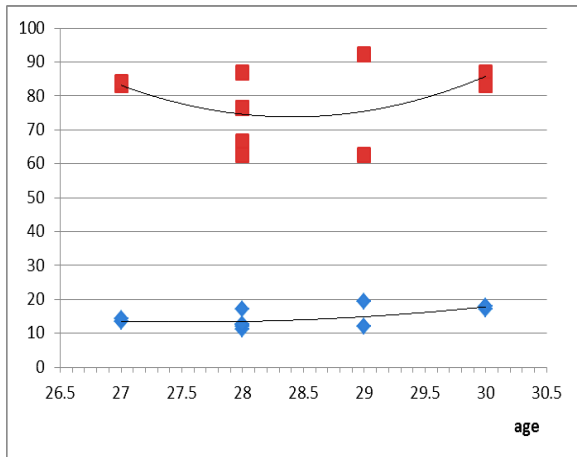


Figure (3) Moves per hour and accuracy with age for age group two

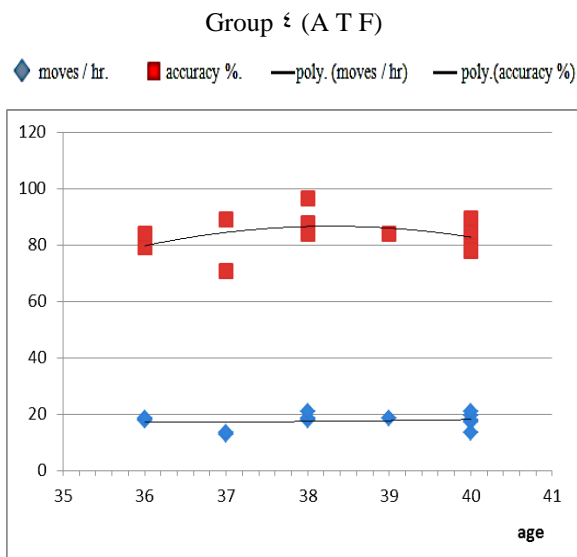


Figure (4) Moves per hour and accuracy with age for age group four

The average of moves per hour and accuracy for Alexandria crane operators (OCA) each age group were calculated and shown in Table (4). The average of moves per hour and accuracy for each age group were drawn and shown in Figure (5).

Table (4): Average moves per hour and accuracy for six age groups during shifts

| No of groups | OCA | | | | | |
|----------------------|---------------|--------------------------|--------------------------|--------------------------|--------------------------|----------------------------|
| | 1 up to 25 | 2 from 26 to 30 years | 3 from 31 to 35 years | 4 from 36 to 40 years | 5 from 41 to 45 years | 6 graeter than 45 years |
| (Moves /hr average) | 12 | 15 | 16 | 18 | 19 | 15 |
| (Accuracy average %) | 71 | 78 | 81 | 83 | 82 | 78 |

◆ (Moves /hr average) ■ (Accuracy average %)

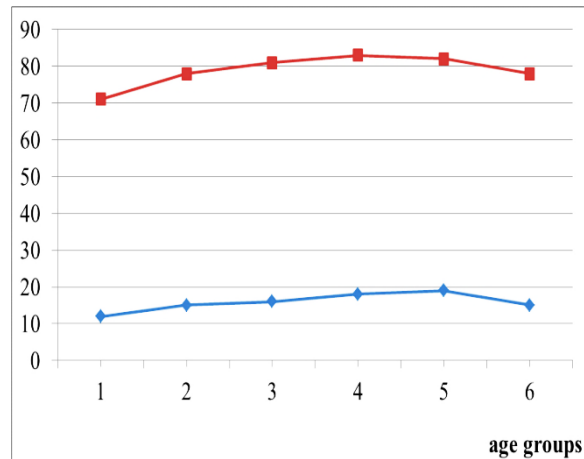


Figure (5) Average moves per hour and accuracy for each six age groups

Maximum moves per hour lies on groups four and five and the minimum moves per hour lies on group one. Maximum accuracy percent lies on groups four, five and the minimum accuracy percent lies on groups one.

4. ANALYSIS OF OPERATORS DATA DURING TESTS WITH OPEN TEST TIME

In this step one operator from each age group was selected to test. The selections based on high performance on moves per hour and high accuracy during container movements, but in this test the driver spend in testing processes more than one hour to measure his efficiency for long time. The test terminated till the accuracy reaches unaccepted value .The selected operators form different ages were shown in Table (5)

Table (5): Selected test operators

| GROUPS | Code No of crane operators |
|---------------------------------|----------------------------|
| Group 1 (up to 25 years) | CTA 154 |
| Group 2 (26up to 30 years) | CTA 135 |
| Group 3 (31 up to 35 years) | CTA 099 |
| Group 4 (36 up to 40 years) | CTA 153 |
| Group 5 (41 up to 45 years) | CTA 022 |
| Group 6 (greater than 45 years) | CTA 017 |

The results of the operator tests were shown in Table (6) .The results includes, age ,total number of moves,

accuracy during test and the test time ... etc).It can be seen that the maximum moves per hour were in groups two ,three, and the maximum accuracy lies in the first age group .During test the impacts for each operator every hour were recorded The impact during test was an indication for operator performance . The impacts during test were shown in Table (7) it can be seen that the number of impact (errors) increases with time.

Table (6): Operator test results

| grouping | code no | date of birth | O C A Testes | | | | | | | No of training | |
|----------|---------|---------------|--------------|-----------------|-----------------|------------------|------------|--------------|--------------|----------------|------------|
| | | | age | total container | total time (hr) | total time (min) | moves / hr | major impact | minor impact | | accuracy % |
| group 1 | CTA 154 | 04/09/1988 | 24 | 104 | 04:20 | 260 | 24 | 0 | 11 | 89 | 5 |
| group 2 | CTA 135 | 27/06/1982 | 30 | 145 | 04:44 | 284 | 31 | 2 | 49 | 65 | 5 |
| group 3 | CTA 099 | 21/09/1980 | 32 | 139 | 04:26 | 266 | 31 | 2 | 38 | 71 | 6 |
| group 4 | CTA 153 | 22/05/1976 | 36 | 115 | 04:00 | 240 | 29 | 0 | 36 | 69 | 4 |
| group 5 | CTA 022 | 10/12/1971 | 41 | 99 | 04:00 | 240 | 25 | 0 | 35 | 65 | 5 |
| group 6 | CTA 017 | 29/05/1966 | 46 | 95 | 03:21 | 201 | 28 | 0 | 34 | 64 | 4 |

The relationships between different age groups and total container, total time, moves per hour, accuracy percent were shown in Figure (6)

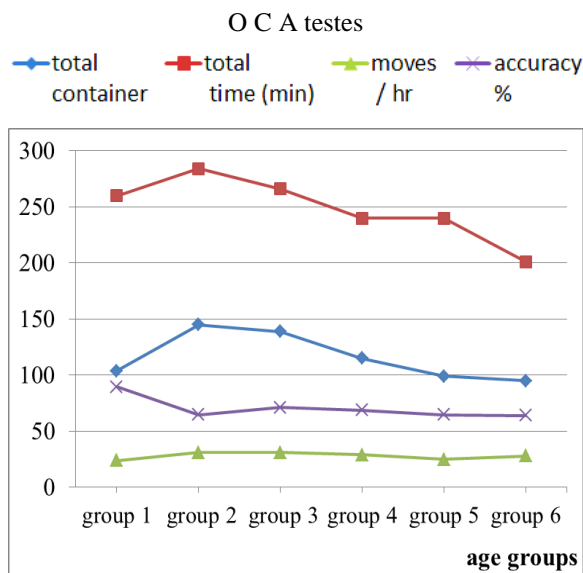


Figure (6) Relationship between total containers, total time, moves per hour and accuracy with age groups

Table (7): the impacts during test hours

| grouping | code no | date of birth | O C A testes impact | | | | | | |
|----------|---------|---------------|---------------------|-----------------|------------------|-----------------|------------------|-----------------|------------------|
| | | | total impact | total time (hr) | total time (min) | first hr impact | second hr impact | third hr impact | fourth hr impact |
| group1 | CTA 154 | 04/09/1988 | 11 | 04:20 | 260 | 2 | 3 | 3 | 3 |
| group2 | CTA 135 | 27/06/1982 | 51 | 04:44 | 284 | 7 | 13 | 14 | 17 |
| group3 | CTA 099 | 21/09/1980 | 40 | 04:26 | 266 | 8 | 10 | 11 | 11 |
| group4 | CTA 153 | 22/05/1976 | 36 | 04:00 | 240 | 5 | 6 | 11 | 14 |
| group5 | CTA 022 | 10/12/1971 | 35 | 04:00 | 240 | 6 | 7 | 10 | 12 |
| group6 | CTA 017 | 29/05/1966 | 34 | 03:21 | 201 | 10 | 12 | 12 | 0 |

•. DATA ANALYSIS

In part of paper comparison between the above three steps was done The relationship between average number of moves per hour, average accuracy for training, field and tests with ages groups were drawn in Fig (7, 8) .

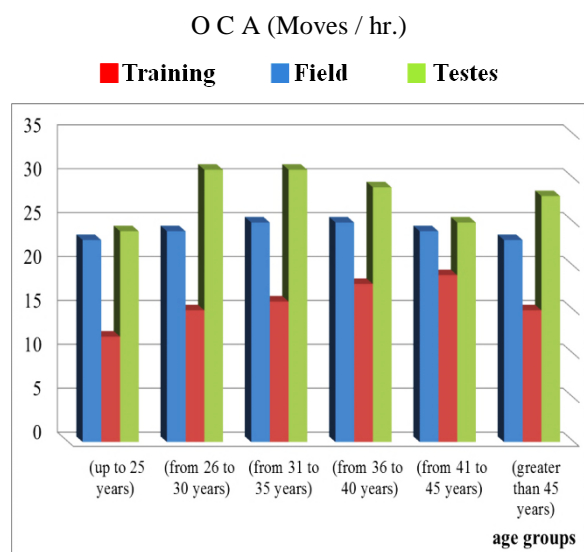


Figure (7) Average moves per hour with age groups in training, field and tests

It can be seen that the maximum moves per hour always in tests because the selected operators have high operation skills. While the minimum moves per hour lies on fields because the operator faces problems.

O C A (Accuracy %.)

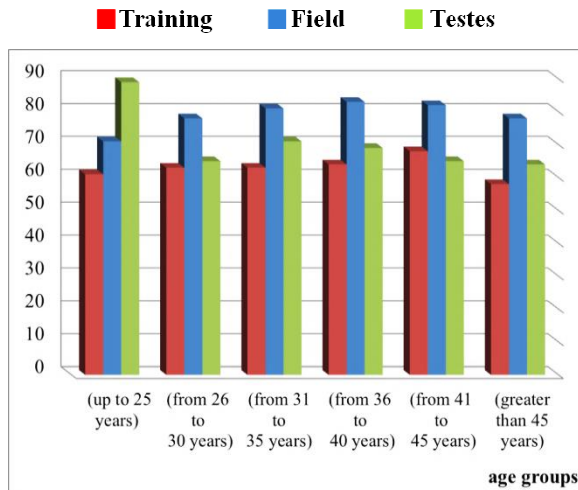


Figure (8) Average accuracy with age groups in training, field and tests

It can be seen that the maximum accuracy always in field.

Table (8): Average moves per hour with age groups in training, field and tests

| NO of groups | O C A (Moves /hr) | | | | | |
|--------------|-------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| | (up to 25 years) | (from 26 to 30 years) | (from 31 to 35 years) | (from 36 to 40 years) | (from 41 to 45 years) | (greater than 45) |
| Training | 23 | 24 | 25 | 25 | 24 | 23 |
| Field | 12 | 15 | 16 | 18 | 19 | 15 |
| Testes | 24 | 31 | 31 | 29 | 25 | 28 |

Table (9): Average accuracy with age groups in training, field and tests

| NO of groups | O C A (Accuracy %) | | | | | |
|--------------|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| | (up to 25 years) | (from 26 to 30 years) | (from 31 to 35 years) | (from 36 to 40 years) | (from 41 to 45 years) | (greater than 45) |
| Training | 61 | 63 | 63 | 64 | 68 | 58 |
| Field | 71 | 78 | 81 | 83 | 82 | 78 |
| Testes | 89 | 65 | 71 | 69 | 65 | 64 |

6. CONCLUSIONS

Referring to the above analysis we can conclude the followings to maximize number of moves of containers per hour and accuracy of movement:

- The operator must subject to training courses before working on cranes to learn more skills

(The accuracy percent increases with the number of training courses).

- It is recommended that the operator doesn't spend more than two working hours on crane for all age groups (the optimal is one to two hours).
- The existing working shift is eight hours and six operators it is suggest to select one operator from each age group to be six operators in shift working during shift with the same order or reducing the number of operators per shift to be four selecting them from the first four age groups (one operator from each age group and working in the same order during shifts).

7. REFERENCES

- [1] Quang Hieu Ngo, Keum-Shik Hong, 2009, Skew control of a quay container crane, Journal of Mechanical Science and Technology 23, page 3332.
- [2] "Container crane - Wikipedia, the free encyclopedia." See http://en.wikipedia.org/wiki/Container_crane (accessed 16 -7-2013).
- [3] Kevin Cullinane , Wei Yim Yap , Jasmine S.L. Lam , 2006, Chapter 13 The Port of Singapore and its Governance Structure , Research in Transportation Economics , volume 17 , Pages 285–310.
- [4] "Bigger ships, taller cranes, better crane control." ABB Group - Automation and PowerTechnologies.see [http://www04.abb.com/global/seitp/seitp202.nsf/c71c66c1f02e6575c125711f004660e6/4965e1a151d7b704c1257b79002dd1bd/\\$FILE/ABB_infographic_remotely+operated+cranes_2013.pdf](http://www04.abb.com/global/seitp/seitp202.nsf/c71c66c1f02e6575c125711f004660e6/4965e1a151d7b704c1257b79002dd1bd/$FILE/ABB_infographic_remotely+operated+cranes_2013.pdf) (accessed 31-7-2013).
- [5] "Crane Operator - How to enter the job." Homepage: Careers New Zealand. See <http://www.careers.govt.nz/jobs/construction/crane-operator/how-to-enter-the-job> (accessed 18-7- 2013).
- [6] European Agency for Safety and Health at Work, 2008, Work-related Musculoskeletal Disorders: Prevention Report: a Summary, European Agency for Safety and Health at Work, page 51.
- [7] Quillian, Warren C. Cox, Daniel J, 1999, The effects of age and alcohol intoxication on simulated driving performance, awareness and self-restraint, Vol. 28 Issue 1, p.58.
- [8] Hypnotics drugs residual effects on monotonous simulated driving in elderly drivers. (Pdf file) See http://www.icadts2007.org/print/poster81_hypnoticsdurgs.pdf (accessed 31 /07/ 2013).