出國報告（出國類別：其他）

參加「2017年第八屆應用人因工程國際研討會」

服務機關：行政院勞動部勞動及職業安全衛生研究所
姓名職稱：陳志勇 研究員兼組長
派赴國家：美國
出國期間：106年7月16日至7月23日
報告日期：106年8月10日

摘 要

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出國類別：開會
派赴國家：美國
出國期間：106 07 16-23
報告日期：106 08 10
關 鍵 詞：人因工程、危害評估、肌肉骨骼傷病

內容：AHFE (Applied Human Factors and Ergonomics Conference)提供一個類似平台的功能，作為各國人因工程專家交換與散播研究資訊的場域。大會安排專題演講(keynote presentation) 、論文發表(parallel sessions) 、海報論文(poster sessions)以及展示(exhibitions)等活動。近年來每年都有來自各國人因工程專家近千人與會，上千篇論文發表。今年在在美國洛杉磯舉行，明年會議預計7月22-26日，在美國佛羅里達舉行。本次主題涵蓋目前人因工程在各領域的研究包括職業人因工程(occupational ergonomics)、認知人因工程(cognititve ergonomics)、文化與行為決策(cross-cultural aspects of decision making) 、人因工程模式(ergonomics modeling)等等數十個議題。本次參加發表本所研究成果: Assessments of Ergonomic Risk and Physician Diagnosis of Musculoskeletal Disorders at Work: cases in Taiwan。因應國內事業單位工安人員日愈關注人因工程危害與職業性肌肉骨骼傷病，我們特別關注肌肉骨骼傷害危害因子風險評估，人因工程在職業安全衛生相關論文等議題。

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壹、目 的

AHFE (Applied Human Factors and Ergonomics Conference)提供一個類似平台的功能，作為各國人因工程專家交換與散播研究資訊的場域。大會安排專題演講(keynote presentation) 、論文發表(parallel sessions) 、海報論文(poster sessions)以及展示(exhibitions)等活動。近年來每年都有來自各國人因工程專家近千人與會，上千篇論文發表。今年在在美國洛杉磯舉行，明年會議預計7月22-26日，在美國佛羅里達舉行。本次主題涵蓋目前人因工程在各領域的研究包括職業人因工程(occupational ergonomics)、認知人因工程(cognititve ergonomics)、文化與行為決策(cross-cultural aspects of decision making) 、人因工程模式(ergonomics modeling)等數十個議題。

本次參加AHFE國際研討會主要有兩個目的:

一、 發表本所研究成果: Assessments of Ergonomic Risk and Physician Diagnosis of Musculoskeletal Disorders at Work: cases in Taiwan，持續與與會專家交流此方面議題。

二、 因應國內事業單位工安人員日愈關注人因工程危害與職業性肌肉骨骼傷病，我們特別關注肌肉骨骼傷害危害因子風險評估與人因工程在職業安全衛生方面相關論文。

貳、過 程

一、參加AHFE國際應用人因工程研討會

本次AHFE（國際應用人因工程年會）有上千篇論文發表。AHFE參與之人員與論文規模相當大，只要是涵蓋12個次領域的子研討會，包括人因在設計、決策、先進製造、健康照護、安全管理、軟體工程、服務工程、運輸、以及數位模擬模型等之應用。可以說包括了人因工程在各領域的應用，詳如下文。

The **8th International Conference on Applied Human Factors and Ergonomics (AHFE 2017)** includes several conferences under one roof, covering topics such as:

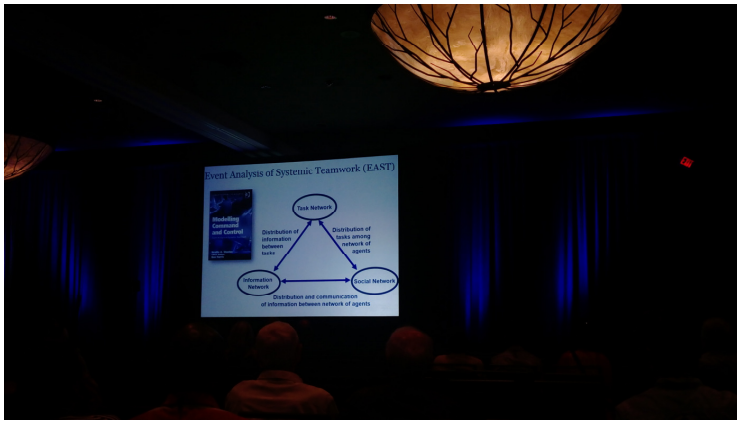
- Ergonomics In Design
- Cross-Cultural Decision Making
- The Human Aspects of Advanced Manufacturing Enterprises in a Digital World
- Human Factors and Ergonomics in Healthcare
- Human Factors and Sustainable Infrastructure
- Science, Technology, Higher Education, Society in the Conceptual Age
- **Safety Management and Human Factor**s
- IBM Symposium on Human Factors, Software, and Systems Engineering
- Affective and Pleasurable Design
- The Human Side of Service Engineering
- Human Factors in Transportation
- Digital Human Modeling & Human Factors

圖 本次大會在美國洛杉磯舉行（圖左為我國嘉南藥理大學鄭教授）2018年預計在7月 22-26日在美國佛羅里達舉行

圖 大會專題演講與會人員相當多，**Professor Neville A Stanton 主講 "Future Ways of Working – Human Factors Engineering in Sociotechnical Systems Design and Evaluation"**

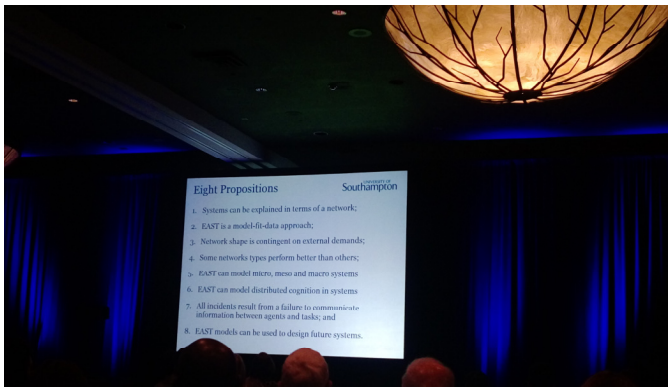
本次專題演講談未來工作方式—人因工程在社會技術系統的設計與評估，這是資深研究者談的題目，主講者**Professor Neville A Stanton**，Chair in Human Factors Engineering，Transportation Research Group，University of Southampton, United Kingdom。他的研究領域包括人因模型 (modelling)、系統中人員績效之預測、分析與評估 (predicting, analysing and evaluating human performance in systems)，以及人與技術系統間之介面與互動之設計 (designing the interfaces and interaction between humans and technology)。Professor Stanton從事汽車、飛機、船舶以及控制室有關之人因工程人機或技術系統之設計30多年，累積相當豐富之經驗，出版35本書，發表270篇以上之論文。

關於 “future ways of working” 主講者的說明 such as supervising semi and fully automated systems in automobiles, aviation and central control rooms (on land and at sea)，(我的解讀)也許白話一點的說法是，智慧化或半智慧化的控制系統，將IOT或AI技術應用的控制系統，在此一系統中人與技術 (機)之互動關係。一個sociotechnical system要如何界定與模擬，本身就是一門學問。透過講者過去豐富經驗，說明如何應用Event Analysis of Systemic Team-work (EAST) method。EAST這種方法模擬系統時，會透過三個網絡包括任務或工作、社會、以及資訊(task, social and information networks)，去模擬一個系統。



任務網絡模擬任務、任務順序、以及其間之關係。社會網絡模擬角色與機構間之溝通(communications taking place between the actors and agents working in the system)。至於訊息網絡則是模擬任務執行時角色與機構間之訊息傳遞。講者提到系統失誤或意外，多少都與系統間之角色訊息溝通失誤有關。

“ all models are wrong, but some are useful” 這是George Edward Pelham 這位統計學教授所提出的觀點，顯然本次專題演講者非常認同此一關點。同時他認為EAST模式，至少在他過去的研究經驗與發表的論文來看，是一可用的模式。可以用來模擬未來工作中的”人—技術”系統。對於訓練、設計、評估、以及績效預測，都有相當助益。以下是部分投影片，有興趣者可以進一步參考。



大會的研討議題

本次大會由於子研討會相當多，以至於同時段之Parallel Sessions很多，總計有274 sessions，以下以SMHF (safety management and Human Factors)為例，說明其有關之sessions:

Parallel Sessions:

Accident analysis and Prevention
Safety Culture and Training
Human Factors and Safety
Risk Prevention and Assessment
Safety Management and Loss Prevention
Safety Analysis Approaches
Safety and Ergonomics
Fatigue and Performance
Safety Culture and Organizational Aspects
Safety Management in Industry

本次研討會也有生物力學方面的session，在展示區Michigan 大學人因工程中心所展示的3SSPP， 就是這方面成果與應用最廣的生物力學3D 靜態軟體。我們在後續攜回資料處有詳細資料可以參考。至於，其它生物力學研究比較屬於學術基礎研究，應用研究而言密西根大學的軟體是目前比較多人使用。

大會之展示區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Center for Ergonomics


THE NEXT EVOLUTION
IN TYPING
TREWGRIP
WEARABLE

與外賓交流

本次研討會來自歐美亞洲學者專家，交流對象包括瑞士Menozzi教授，幾位德國 美國專家，有些學者沒有交換名片的習慣，只是以大會名牌顯示名字。展示區跟我們比較有關的是來自University of Michigan的Center of Ergonomics，這是由人因工程專家包括Armstrong教授等人所組成的團隊，主要展示3D SSPP(3D Static Strength Prediction Program™)。有來自日本湘北短期大學的由美子教授，由美子教授專長是人因工程在照護方面的研究，也有涉及相關輔助設施的調查研究。總合研究所的戴博士，戴博士是大陸過去日本讀書的學者。戴博士與本所的研究比較接近，都是屬於職業安全衛生方面的領域。來自我國龍華科大的胡教授，胡教授專長是工業工程專長。北科大的黃教授，是人因工程人機系統或心智方面的專長。嘉南藥理大學的鄭教授，是職業安全衛生方面專長。另外國內也有部分論文由學生發表。

就本所論文發表之內容而言，與會外賓(沒有交換名片)有幾項記憶深刻的意見或問題。 例如，我們是否有完整的人因工程肌肉骨骼傷病危害現場檢核標準，或是類似的程序等資訊? 未來是否有流行病學方面的研究，作為危害認定的參考? 我們的法規是類似2000年美國草案---人因工程標準嗎? 由於勞工肌肉骨骼傷病的普遍性，可以想見諸如此類的議題，在國際間不論研究或行政，都會有廣泛的討論。

二、本次與會本所發表之論文與交流

本次參與”Safety and Ergonomics ” Session論文發表，與會論文包括:

1 來自瑞士Menozzi教授與台灣北科大黃教授發表的”Training visual vigilance in a complex and naturalistic work environment” 。這一篇主要是討論 attention 在訓練上的應用，特別是複雜系統的人機安全問題方面。

2 幾篇來自巴西，有關body discomfort與人因評估的論文。

3 本所發表過去在我國有關勞工肌肉骨骼傷病現場危害評估與理學檢查的案例研究，如下文摘要。

針對本所論文與會人員提出下列問題交流:

(1) 我國是否有人因工程法規?

我說明主要是我國勞工肌肉骨骼傷害相關職業病案例仍然很多，為預防此類傷病，目前是在職安法內有一關於重複性傷害預防的條文，並沒有專法。

(2) 我國是否有人因性危害檢查?

我回答的確有相關檢查，由檢查人員執行。

(3) 是否有評估的方法或標準之類可以參考?

我們目前正在努力，本研究主要也是在評估歐盟正在使用的KIM檢核評估技術，是否適合我國使用。相信將來會有一本土的參考資料，可以提供更多資訊給事業單位參考。

(4) 未來是否考慮進行流行病學方面研究?

我們正在與生物統計專家、職業醫學團隊與人因工程團隊合作規劃並嘗試較長期的流行病學研究。

Assessments of Ergonomic Risk and Physician Diagnosis of Musculoskeletal Disorders at Work: cases in Taiwan

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Abstract

Musculoskeletal disorders (MSDs) are common at workplaces worldwide. The Institute of Labor, Occupational Safety and Health has started to promote scientific research dealing with the MSDs at works. A project studying the prevalence of MSDs in the precision machinery factories in Central Taiwan Science Park was performed to study the prevalence of MSDs and to identify the ergonomic risk at selected work stations in the targeted companies. Nordic Musculoskeletal Questionnaires survey was conducted for 1583 worker. The Safety managers of five companies were interviewed to identify work stations required risk assessment for these companies. Ergonomic risk assessments using the Key Indicator Method (KIM) were conducted at twelve work stations in five factories having high percentages of MSDs symptoms. For these work stations, nine KIM manual handling operations (MHO), six lifting, holding, and carrying (LHC), and two push-pull (PP) assessments were conducted by reviewing video tapes taken in the selected work stations. According to the KIM, tasks may be classified into one of the four categories considering the risk of MSDs: low, medium, medium-high, and high exposures. The high exposures implied high risk of MSDs and need for immediate job redesign. The risk score for each of the selected work station was calculated. The category of risk level was determined based on this score. For the nine MHO assessments, the task of one worker was identified as high exposure, six workers were determined to be medium-high exposure, and two workers were medium exposures. For the six LHC assessments, one worker was determined to have high exposure, three workers were identified as medium-high exposure, and two workers were classified as medium exposure. For the two PP assessments, one worker was identified as medium-high exposure and the other one was medium exposure. Six of the workers from these work stations were selected for physician diagnosis for the MSDs. Four of them were diagnosed as positive. These workers were performing assembling, welding, grinding, and packing tasks each. The body segments with musculoskeletal symptoms included neck, back, and wrist. Recommendations for job redesigned were discussed.

Keyword：Musculoskeletal disorders, key indicator method, job assessment, manual operation


ETH zurich
Training of visual attention in a complex and naturalistic work environment
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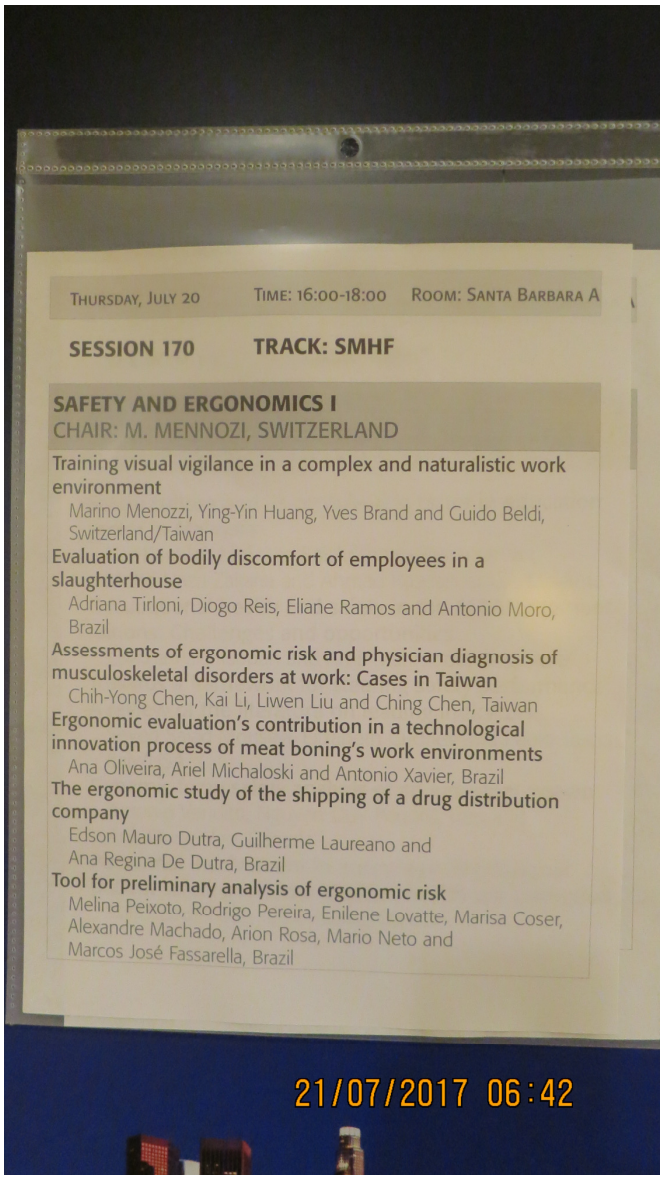
Assessments of Ergonomic Risks and Physician Diagnosis of Musculoskeletal Disorders at Work: cases in Taiwan
EXIT
21/07/2017 06:44



THURSDAY, JULY 20 TIME: 16:00-18:00 ROOM: SANTA BARBARA A

SESSION 170 **TRACK: SMHF**

SAFETY AND ERGONOMICS I
CHAIR: M. MENNOZI, SWITZERLAND

Training visual vigilance in a complex and naturalistic work environment
Marino Menozzi, Ying-Yin Huang, Yves Brand and Guido Beldi, Switzerland/Taiwan

Evaluation of bodily discomfort of employees in a slaughterhouse
Adriana Tirloni, Diogo Reis, Eliane Ramos and Antonio Moro, Brazil

Assessments of ergonomic risk and physician diagnosis of musculoskeletal disorders at work: Cases in Taiwan
Chih-Yong Chen, Kai Li, Liwen Liu and Ching Chen, Taiwan

Ergonomic evaluation's contribution in a technological innovation process of meat boning's work environments
Ana Oliveira, Ariel Michaloski and Antonio Xavier, Brazil

The ergonomic study of the shipping of a drug distribution company
Edson Mauro Dutra, Guilherme Laureano and Ana Regina De Dutra, Brazil

Tool for preliminary analysis of ergonomic risk
Melina Peixoto, Rodrigo Pereira, Enilene Lovatte, Marisa Coser, Alexandre Machado, Arion Rosa, Mario Neto and Marcos José Fassarella, Brazil

21/07/2017 06:42

由於本部在新修訂的〝職業安全衛生法〞中，第二章第六條第二項提到〝雇主對於下列事項，應妥為規劃並採取必要安全衛生措施，以保護勞工身心健康〞，該項提到〝重複性作業等促發肌肉骨骼疾病之預防〞。從勞保傷病給付資料來看，近年來申請肌肉骨骼傷病的案例以及給付的案件數很多，可見有關的事業單位與勞工非常多，值得重視。後續如何提出指引供事業單位參考，以及檢查單位依據何種標準作檢查，都值得研究並進一步取得共識。我們整理過去IEA研討會部分資料如下，以為後續研究之參考。

在第十七屆IEA(國際人因工程學會)大會，Symposium: Prevention of Work Related Musculoskeletal Disorders 這一部份有相當多的論文，談到〝國際上對於勞工工作場所發生的肌肉骨骼傷害危害因子現場評估方法與技術。在歐洲有OCRA評估檢點方法，美國也有學者*A.Garg* 提出 strain Index ，ACGIH 也有上肢評估方法由密西根大學教授提出，這些方法具有一致性，使用細節與評估危險因子稍有不同，將來如何應用於國內供事業單位使用，值得進一步探討〞。第十八屆IEA大會特別值得一提的是: IEA/WHO toolkit for WMSDs prevention，這是國際人因工程學會與世界衛生組織的合作案，主要目的是提供一套職業性肌肉骨骼傷病危害因子風險評估方法，協助給非專業人因工程專家使用，以為後續現場風險評估及預防參考。

1990年代陸續發展出許多檢核表，包含針對上肢姿勢、施力、動態評估的RULA系統(Rapid Upper Limb Assessment)、對物料抬舉作業及危害分析的NIOSH Lifting Equation、針對上肢作業評估及危害因子分析的Strain Index、對於不同類型工作評估身體姿勢、施力、重複性動作的OCRA檢核表(Occupational Repetitive Action)以及2001年對手部動作、施力作危害暴露評估的ACGIH HAL(Hand Activity Level)。近年來，國際標準組織針對職業性肌肉骨骼傷病危害因子評估與管理，成立工作小組開發系統方法，嘗試將上述檢核技術加以整合。這一項合作案所提出的系統性評估方法，基於(1)

Acting on a step-by-step approach，(2) Taking into account the presence of multiple influencing factors，兩項原則，已經整合了目前已開發的技術，針對不同評估階段作為風險確認、評估與管理之參考。不同評估階段包括:

(1) A *Basic Step* devoted to hazard identification by operative "key-enter" questions, that can be operated also by non-experts。

(2) A *First Step*, (quick assessment), for identifying 3 possible conditions: acceptable; high risk present; more detailed analysis (via tools presented at second step) necessary. This step can be operated by non-experts with only some specific training.

(3) A *Second Step*, where recognized (i.e. from international standards or guidelines) tools for risk estimation are used. This step can be operated only by persons with some specific training.

Table 1

Key enters to the evaluation of different conditions of biomechanical overload as considered in ISO 11226 and 11228 (parts 1-2-3)

	THE KEY-QUESTIONS		
1	***Application of ISO 11228-1***		
	Is there manual lifting or carrying of an object of 3 kg or more present?	NO	YES
	if NO, this standard is not relevant, go to the next Key Question regarding the other standards **If YES** then go to step 2 (quick assessment)		
2	***Application of ISO 11228-2***		
	Is there manual whole-body pushing and pulling present?	NO	YES
	if NO, this standard is not relevant, go to the next Key Question regarding the other standards **If YES** then go to step 2 (quick assessment)		
3	***Application of ISO 11228-3***		
	Are there one or more repetitive tasks(*) of the upper limbs in a shift? (*)where the definition of "repetitive task" is: *one or more tasks characterized by cycles lasting 1 hour or more per shift* *or* *when the same working gestures are repeated for more than 50% of the time, lasting 1 hour or more per shift.*	NO	YES
	If NO, this standard is not relevant, go to the other Key Question regarding the other standards **If YES** then go to step 2 (quick assessment)		
4	***Application of ISO 11226***		
	Are there static or awkward working postures of the HEAD/NECK, TRUNK and/or UPPER AND LOWER LIMBS maintained for more than 4 seconds consecutively and repeated for a significant part of the working time? For example: *- HEAD/NECK (neck bent back/forward/sideways, twisted)* *- TRUNK (trunk bent forward/sideways', bent back with no support, twisted)* *- UPPER LIMBS (hand(s) at or above head, elbow(s) at or above shoulder, elbow/hand(s) behind the body, hand(s) turned with palms completely up or down, extreme elbow flexion-extension, wrist bent forward/back/sideways)* *- LOWER LIMBS (squatting or kneeling) maintained for more than 4 seconds consecutively and repeated for a significant part of the working time*	NO	YES
	if NO, this standard is not relevant **If YES** then go to step 2 (quick assessment)		

Table 2

Quick assessment for manual lifting activities: check of an acceptable condition (green area)

LIFTING: QUICK ASSESSMENT : ACCEPTABLE CONDITION			
3 TO 5 Kg	Asymmetry (e.g. body rotation, trunk twisting) is absent	NO	YES
	Load is maintained close to the body	NO	YES
	Load vertical displacement is between hips and shoulders	NO	YES
	Maximum permissible frequency: less than 5 lifts per minute	NO	YES
5,1 TO 10 Kg	Asymmetry (e.g. body rotation, trunk twisting) is absent	NO	YES
	Load is maintained close to the body	NO	YES
	Load vertical displacement is between hips and shoulder	NO	YES
	Maximum permissible frequency: less than 1 lift per minute	NO	YES
MORE THAN 10 Kg	Loads more than 10 kg are not present	NO	YES
If all the listed conditions are **YES**, the examined task is ACCEPTABLE and it is no necessary to continue the risk evaluation If one is **NO**, **APPLY THE STANDARD: ISO 11228-1**			

三、人因工程在肌肉骨骼傷病危害預防相關之國際資訊

本節是過去IEA會議論文 (Ergonomics and Occupational Safety and Health: **An ILO Perspective** By Dr. Shengli Niu Senior Specialist on Occupational Health International Labour Organization Geneva, Switzerland)，在此重複說明有助於了解肌肉骨骼議題，不只是IEA WHO 關注，ILO 以及ISO EN等機構也相當關注此一議題。

ILO估計每年約有230萬勞工因職業災害或疾病死亡。 在美國製造業意外造成的損失約為 190 billion US dollars. 在挪威直接損失約為40 billion NOK，英國約為£19 billion。至於人因工程在工作場所所引起的相關問題，也是上述經濟損失的原因之一。同時，這些人因工程問題也是導致肌肉骨骼傷害的原因之一。包括長時間站姿、坐姿、不良姿勢等姿勢所引起的壓力 (postural stress)以及重複性作業等都可能導致慢性肌肉骨骼傷害。重複性用力(repeated or forceful efforts)、持續靜態姿勢(sustained static loading)、解剖學上不自然姿勢 (anatomically non-neutral posture)、加速的動作(accelerated movement)等這些都可能危害肌肉骨骼系統。特別是當多個危害因子同時存在時，更可能導致傷害。暴露與傷病關係資料(exposure-response data)顯示 即使是一天2小時的暴露 (25% or less of the day)也可能有危害。

ILO的回應 ***The ILO's Response***

關於這些職業病問題包括肌肉骨骼傷害， ILO 在2003 Global Strategy 中要求開發新的儀器、方法針對人因工程危害預防。Relevant Conventions and Recommendations : Convention No. 127 and Recommendation No.128。 ILO 配合Global Strategy，與IEA合作，由Dr. Wendy Macdonald (Health Sciences, La Trobe University, Melbourne, Australia) 所領導的小組，發展國際版regulations, standards and laws on ergonomics at the workplace。

ILO 認為工作環境的改變，人因工程問題已成為重要的勞工安全衛生議題，需要進一步關注。政府、雇主以及勞工三方面都希望ILO發展人因工程相關的方案，特別是下列議題。

(1) 人因工程相關危害資料建立 The surveillance of ergonomics hazards needs to be established in response to rapid and complex changes in the world of work.

(2) 工作組織與危害因子研究 Studies and investigations need to be conducted on the occurrence of ergonomic risk factors and work organizations.

(3) 危害因子評估技術發展 It is an increasing important challenge to address risk assessment in occupational situations in which the physical work load and MSDs develop through an interaction between the workplace, leisure time activities, and individual factors.

(4) 同時注意社會心理因子。Ergonomics is often viewed in a simplified way as it focuses mainly on the physical aspects of work: force, repetition rate and posture. Psychosocial factors are often misunderstood and ignored.

(5) 非工會員以及女性勞工肌肉骨骼傷害問題 Few studies have examined differences in MSDs injury rates for men and women and for unionized and non-unionized workers. There have been reports that non-union and women workers have higher rates of MSDs. Explanations for these phenomenon could include differences in training in safer work practices and in working experiences, different job assignments, age, sex in relation to physical size and strength, health care seeking behaviour, etc.

(6) 指引與技術手冊開發 Guidelines are needed on the major work-related risk factors that

should be eliminated or minimized such as manual handling of materials, repetitive work, static work, segmental vibration, and poor psychosocial work environments. Studies and evaluations on the technological and economic feasibilities of the application of these guidelines need to be conducted.

ILO 推行兩個人因工程技術合作案: WISE (ILO) and WIND (ILO & Kawakami T, et al., 2008)。 "Work Improvements in Small Enterprises" –. WISE，在泛太平洋、拉丁美洲以及非洲推行，其中一個訓練計畫"Higher Productivity and A Better Place to Work" 協助中小企業推行簡單有效的技術改進工作環境以及效率。中文版WISE在2008年發行。WISE programme 是以六個訓練原則為基礎，build on local practice, focus on achievements, link working conditions with other management goals, use learning-by doing, encourage exchange of experience and promote workers' involvement。"Work Improvement in Neighbourhood Development" –. WIND，主要是針對農業作業改善。主要方法是參考WISE。 在解決人因工程問題上，ILO與UN以及其他國際組織合作，包括IEA, ICOH and IOHA等，者可能也是ILO在IEA、ICOH等國際會議上說明其作為的原因。The Ergonomic Checkpoints是由 IEA and the ILO 共同發展出來的手冊，ILO1996發行(ILO & IEA, 1996)。ILO目前正在與IEA合作修改此一Ergonomic Checkpoints。

IEA會議論文(**ISO 11226 and EN 1005-4** N. J. Dellemana,b, J. Dulc a *TNO Human Factors, P.O. Box 23, 3769ZG Soesterberg, the Netherlands (nico.delleman@tno.nl)* b *Paris Descartes University, UPRES Ergonomie, Laboratory of Applied Anthropology, Paris, France c RSM Erasmus University, P.O. Box 1738, 3000DR Rotterdam, the Netherlands (jdul@rsm.nl)*。

ISO 11226 in 2000 and EN 1005-4 in 2005 這兩個標準主要是用來評估勞工工作姿勢與動作，以預防勞工肌肉骨骼系統疲勞、酸痛以及傷害。約有歐盟(European Union) 1/3勞工在工作中感受到不舒適的工作姿勢，並有50 %勞工從事週期短的重複性工作。

EN 1005-4 說明如何設定機械操作時勞工的靜態姿勢與動作，以避免傷害。EN 1005-4 中關於機械操作時危險工作姿勢風險分析流程。分析結果分成三部分，

(1) **‘acceptable’** (the health risk is considered low or negligible for nearly all healthy adults. No action is needed)，

(2) **‘conditionally acceptable’** (there exists an increased health risk for the whole or part of the operator population; the risk shall be analyzed together with contributing risk factors, followed as soon as possible by a reduction of the risks, i.e. redesign, or if that is not possible, other suitable measures shall be taken, for example the provision of operator guidelines to ensure that the use of the machine is acceptable),

(3) **‘not acceptable’** (the health risk cannot be accepted for any part of the operator population; redesign to improve the working posture is mandatory).

參、心得與建議

1. 本次論文發表時，與會人員提出許多問題。主要可以歸類為兩部分，(1) 職業性肌肉骨骼傷病與人因工程危害分析之關聯性研究，以及(2) 我們是否有比較完整的檢核技術作法。這些與會者關注的議題，是現在國際上研究的重點，也是我們未來規畫時可以參考的方向。
2. 人因工程除了應用在職業性肌肉骨骼危害評估外，在工作安全或意外分析上，也常常扮演重要角色。例如，在重要交通工具意外分析，飛機、船舶、以及大型機械設備或製程意外事故分析。過去許多飛機意外往往被歸類為人為因素，就是一個應用例子。當然，人有疲勞或注意力無法集中的現象，這些都需要進一步透過人機或人技術系統設計來彌補，這也是過去飛行器更為安全的原因之一。所以，我們未來在研究職業安全衛生案例時，也可以考慮加入人為因素此一因子。
3. 本次研討會也有生物力學方面的session，在展示區Michigan 大學人因工程中心所展示的3SSPP， 就是這方面成果與應用最廣的生物力學3D 靜態軟體，可參考攜回資料處有詳細說明。至於，其它生物力學研究比較屬於學術基礎研究，應用研究而言蜜西根大學的軟體是目前比較多人使用。因此，我們建議本所未來在人因工程與肌肉骨骼傷病危害因子之關聯研究方面，除了應用現有的檢核技術，如歐盟推廣之 KIM (key Indicator Method) 外，針對關節與肌肉受力之評估，也可以參考此一軟體。

肆、研討會攜回之資料

此次研討會帶回來兩項資料（1)大會之議程資訊與1000多篇之論文摘要電子檔；(2)大會展示區中密西根大學人因工程中心提供之人因工程人工物料搬運生物力學分析軟體（3D SSPP）參考資料。

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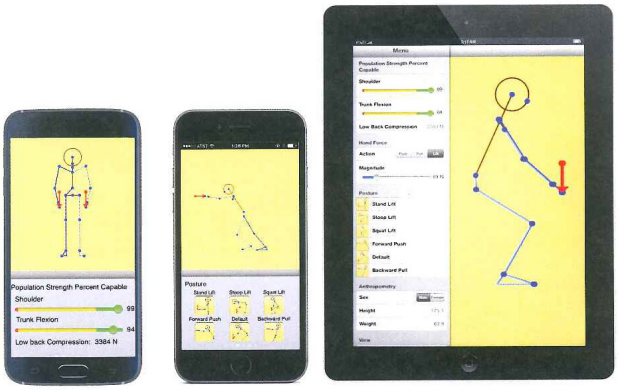

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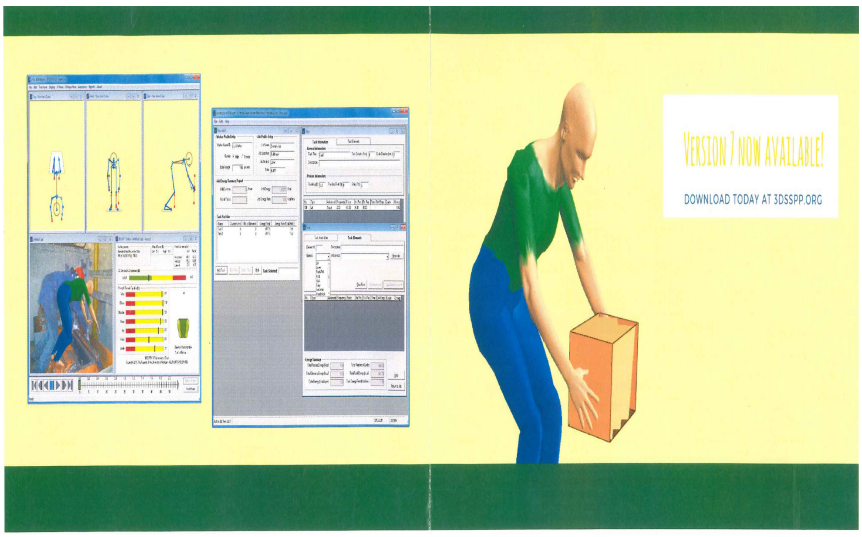

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FEATURES

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FEATURES

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