出國報告（出國類別：其他）

參加第四十五屆北歐人因工程學會研討會

服務機關：行政院勞工委員會勞工安全衛生研究所
姓名職稱：陳志勇 研究員兼組長
派赴國家：冰島
出國期間：102年8月8日至8月17日
報告日期：102年　月　日

摘 要

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出國期間：102 08 8-17
報告日期：102 0
關 鍵 詞：人因工程、肌肉骨骼傷病、職業安全與衛生

內容：NES人因工程學會是由北歐五國(丹麥、芬蘭、瑞典、冰島、挪威)人因工程學會組成，NES成立時約有150個會員，也是IEA的會員國。NES每年在北歐五國輪流辦研討會(NES Nordic Ergonomic Society conference)，2012年在瑞典、2013年在冰島、2014年在丹麥。今年會議主題包括人力資源管理、職業安全衛生、設計與使用性、視覺人因工程等數個議題。本次參加發表本所研究成果: The Prevention of WMSD in Taiwan。因應職安法新修法中有關人因工程的部分，我們特別關注肌肉骨骼傷害危害因子風險評估。

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壹、目 的

NES人因工程學會是由北歐五國(丹麥、芬蘭、瑞典、冰島、挪威)人因工程學會組成，NES成立時約有150個會員，也是IEA的會員國。NES每年在北歐五國輪流辦研討會(NES Nordic Ergonomic Society conference)，2012年在瑞典、2013年在冰島、2014年在丹麥。今年會議主題包括人力資源管理、職業安全衛生、設計與使用性、視覺人因工程等數個議題。

本次參加IEA國際研討會主要有兩個目的:

一、 發表本所研究成果 The Prevention of WMSD in Taiwan。

二、 鑒於職安法中有部分與人因工程相關的條文，特別是〝重複性作業等促發肌肉骨骼疾病之預防〞，在此次會議中我們也特別注意收集相關研究，以爲後續有關預防指引編撰之參考。

貳、過 程

一、參加NES人因工程研討會

1. 北歐人因工程學會簡介

北歐人因工程學會(The Nordic Ergonomics and Human Factors Society (NES)) http://www.nordicergonomics.org/. http://www.ergonom.no/, 成立於1969年，約有1400個會員。我們台灣人因工程學會(Ergonomics Society of Taiwan)在1993年成立，成立時約有150個會員。NES 是由北歐五國(丹麥、芬蘭、瑞典、冰島、挪威)人因工程學會組成，

Selskab for Arbejdsmiljø (SAM), Danmark.

Suomen Ergonomiayhdistys / Finska Ergonomiföreningen (ERY)

Ergonomisällskapet Sverige (ESS)

Vinnuvistfræðifélag Íslands (VINNÍS)

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除了聯繫會員國與會員之外。NES 對於人與環境(生活與工作兩部分)交互作用有關知識的增進，以及推動應用人因工程於環境、設備與方法的設計相當重視。北歐五國對於人因工程在工作與生活上的應用發展的比較早，特別是在工作環境與設施的應用。在生活上我們可以發現許多符合人的需求、簡樸的實用設計，一般交通或街道設施的標示，簡明易懂。 北歐也非常重視老年或中高齡的工作與生活。就國際人因工程組織的角度來看，NES 是歐洲人因工程學會聯盟 (Federation of European Ergonomics Societies (FEES))的會員組織(member organization)，當然也是國際人因工程學會(協會)(International Ergonomics Association (IEA))的會員組織。NES 研討會是該學會年度大事，作爲會員知識傳播、討論與交誼的機會。

2. NES 2013 議題與 Keynote speech

本次會議冰島人因工程學會主辦，於其首都雷克雅未克(Reykjavik) Grant Hotel 舉行。本次大會主要圍繞在四大主要議題，包括人力資源管理、職業安全衛生、設計與使用性、視覺人因工程等，每天都有四個主題的論文發表。視覺人因工程是結合視覺生理學與人因工程兩部分，更具體的說是兩者的交互作用對人的影響。設計與使用性在討論人因工程如何導入設計，儘而增進使用性。每天早上會先安排Keynote Speech，接著是四個主要議題的論文發表。

本次研討會主題Ergonomics for Equality，顯示出NES對於應用人因工程促進"人":老年 年輕 男 女等等"，在生活與工作環境之平等與尊嚴，此一價值的重視。一個人不會因爲年齡而輕易被迫離開職場，或是生活中遇到很大的困難。

表 NES主要研討議題

A	Human Resource Management 人力資源管理
B	Occupational health and safety 職業安全衛生
C	Design and usability 設計與使用性
D	Visual Ergonomics 視覺人因工程

Keynote Speech

12, Aug. "The future of ergonomics"
Jan Dul is a professor of Technology and Human Factors at the Rotterdam School of Management, Erasmus University, the Netherlands.

演講者是IEA未來人因工程委員會的主席，這一篇報告人因工程研究如何隨著時代改變進行調整，以及可貢獻的方式，基本上是一概念性的說明。人因工程(Human factors and Ergonomics,HFE) 具有三個基本特性：(1) HFE的研究是採取系統性的方法，(2)是以設計爲導向，以及(3)同時著重效率與人員的舒適. HFE 要能貢獻於未來的系統設計，必須證明其價值 (In order to contribute to future system design, HFE must demonstrate its value more successfully to the main stakeholders of system design.) 演講者同時從未來工作環境改變，文化多樣性，高齡趨勢等方向說明未來的改變。

Global change of work systems

過去，工業先進國家大量參與貨品製造，然而過去20年來，這些歐美國家大量將製造與服務外包到發展中國家。這一將製造型工作轉變爲服務型的工作(including healthcare services)，使的更多工作系統的設計轉變爲顧客服務與人機介面 (resulting in

more focus on the design of work systems for service production, and on the design of non-work systems such as services for customers and human-computer interactions.)。此外，這種轉變也刺激了更多企業家，衍生出許多小型與非正式企業(small-sized and informal businesses)。機械化與自動化的趨勢，不僅在製造業同時也在服務業出現。引進更多機械與技術，機械能力的增進往往超越了人的能力，進而改變了人與技術的關係。

Cultural diversity

世界扁平化不免會面臨到不同文化背景的問題，這些地區人們的特徵甚至願望都不同。這些問題都出現在現在或未來的工作/產品/消費系統。針對一個族群所設計的工作環境/產品，往往不見得適合其他族群所用。HFE 必須掌握這種文化多元的特性，貢獻於適用於不同文化的設計(cross-cultural design)產品、通路與生產系統。

Aging

人口老化在許多地區已經逐漸出現，並已成爲一種趨勢。導致更長的預期生命、生育率下降，而且漸漸傳播至大量嬰兒潮世代。在美國工作人力正經歷老化過程，在歐洲中高齡工作人口比例遠高於其他地區，在印度退休年齡逐漸延後。因此，大量老化人口已成爲工作人力以及服務系統的一部分。目前工作系統是針對一般壯年者所設計，這一系統不適用於中高齡工作者。此一趨勢使得工作的設備、家具、IT 設備與服務等，必須適合中高齡的特徵。HFE 可以考慮age-related changes in physical, cognitive, visual and other capabilities, and different aspirations，以確保工作系統符合中高齡的需求。

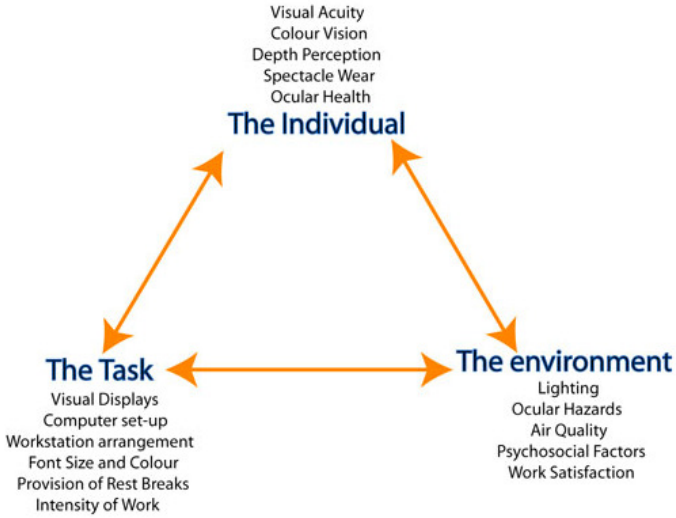
13, Aug. Visual ergonomics and the quest for equality

Jennifer Long is an optometrist and a Certified Professional Ergonomist in Sydney, Australia, and is the chairperson of the International Ergonomics Association (IEA) Visual Ergonomics Technical Committee. 本次演講的三個重點:

1.Describing some of her experiences working in a colour vision clinic where she regularly delivered bad news to (predominantly) young men who failed occupational colour vision standards

2. Presenting a visual ergonomics success story where a simple intervention in the workplace improved the comfort of a migraine sufferer – and had an unexpected benefit for others within the workplace

3. Discussing the role of visual ergonomics in the design of industrial control rooms.



Visual Ergonomics 概念上與人因工程是一樣的，從個體(individual)、工作、環境三者間，尋求平衡。工作與環境設計必須相當程度考慮個體的特徵，亦即，The task fits the people。

視覺人因工程之目的在創造一個工作、居家、休閒環境，以適合於使用者的視覺能力。透過個體視覺能力、工作以及環境三者間平衡，以達到上述目的。如何評估檢驗，以及設計，這就是人因工程得責任。不恰當的平衡關係，會導致 discomfort, errors, accidents and injury 等的出現。

視覺吸引力(Visual attractiveness)對於產品、工作、環境具有影響力。因此，視覺人因工程與視覺顯示、產品或建築的美學也有關係。視覺人因工程也會整合美學概念到產品、工作、環境的設計之中，而不會對 comfort and performance 造成影響。視覺人因工程可能參與整個產品或工作週期的設計，例如，一個視覺人因工程師可能:

- Provide advice during the design phase of a visual display to ensure that the visual elements will be easy to see

- Participate during the installation of new technology to ensure it is set up correctly and the user is comfortable
- Solve visual ergonomics problems post-occupancy of a work environment
- Provide assistance and advice to individuals with specific visual needs to ensure their comfort and productivity.
- Provide assistance and advice to individuals with specific visual needs to ensure their comfort and productivity.

二、簡報與北歐國家肌肉骨骼傷病危害預防的作法

1 我國肌肉骨骼傷病現場危害預防成果與技術發展簡報

我們報告的題目是: The Prevention of WMSD in Taiwan，主要是介紹我國人因工程在肌肉骨骼傷病現場危害因子預防的技術發展，以及近三年來的現場改善績效。如同在EU-OSHA 一樣，與會人員對於我們的努力與成果，均表示肯定與贊同。近年來，肌肉骨骼傷病一直是我國職業病勞保給付的主要項目，約在80%的職業傷病個案。雖然，退化是一個重要因素，但是工作中重體力負荷以及高重複性動作，也絕對是一個危險因素。除了骨骼肌肉傷病是否爲職業引起的，這一個判定基準或爭議外，勞工肌肉骨骼傷病這一議題，在勞工安全衛生研究所而言，主要是如何預防現場危害，這也是本所近年來努力的重點方向。

過去幾年，我們以現場輔導方式，逐一協助現場發覺問題，討論並提供改善設計圖，返回現場說明等方式，訪視300家事業單位，協助1200個改善。改善績效很好，雇主與勞工大致都不會反對，甚至歡迎。因爲，不會影響工作績效甚至提升，而最重要的是減少肌肉骨骼負荷，減少疲勞傷病。同時，也證明人因工程得改善是具有經濟效益。即便，我們非常努力開發現場改善技術，但是以專家訪視，協助設計改善的方式，其範圍畢竟有限。如何面對數十萬甚至百萬家的中小企業?

The percentage of reduction of L5/S1 compression force, complaints, and increase of performance after intervention

制定一個具有罰責的法令，某種程度確實可以喚起雇主的注意。但重點是要協助事業單位落實改善，最好是生產線佈置時，就可以考慮人因工程。對於中小企業而言，現場的安全衛生人員未必有機會接觸人因工程，更沒有肌肉骨骼傷病現場危害因子改善的經驗。我們要如何進一步協助他們落實? 這也是我們這一次簡報的重點，本研究提出一個”**3 phases Ergonomic Intervention system**”，此一系統結合本所過去現場輔導的案例經驗與專家的知識，使用者不用具有豐富的人因工程知識，也可以輕鬆入門，進行現場模擬改善。所謂3-phases 是指資料(影片 圖片)輸入—主要危害因子鑑別分析---改善建議與設計圖例等三步驟，在這三步驟當中使用中只要進行簡單的圖片或影像輸入，以及簡單基本資料keying，其餘工作由系統執行。此一系統使用上非常容易，我們相信後續開發成功之後，對於現場工安人員進行MSDs 危害因子分析與改善會有幫助。

由於本會在新修訂的〝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，應妥爲規劃並採取必要安全衛生措施，以保護勞工身心健康〞，該項第一款提到〝重複性作業等促發肌肉骨骼疾病之預防〞。在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。後續除了提出指引供事業單位參考，以及檢查單位檢查標準之參考外，國際上的研究現況與做法也值得借鏡。在第十七屆IEA大會，特別提到〝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，Symposium: Prevention of Work Related Musculoskeletal Disorders 這一部份有相當多的論文。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，以爲後續現場風險評估及預防參考。此一系統性方法考慮國際標準如ISO11226 (不當姿勢)、11228 (人工搬運、全身性推拉作業)，以及相對的歐盟準EN1005。此外，也參考了各國勞工安全衛生研究機構的檢核預防技術如美國NIOSH 〝Revised Niosh Lifting Equation (RNLE)〞、歐洲使用的〝OCRA checklist〞(針對重複性動與施力) 、〝Psychophysical Tables by Snook and Ciriello〞以及常用於工作姿勢評估的〝OWAS〞與〝REBA〞。我想這些都值得作爲我國未來指引制定之參考。

2 北歐國家勞工肌肉骨骼傷病現場危害預防的做法

(1) 丹麥

最令我訝異的是，北歐檢查機構竟然執行研究。從研究的角度執行檢查，我不清楚北歐勞工安全衛生進步到何種程度，不過這種爲了減少職場勞工肌肉骨骼傷病問題，而從研究的精神找出方法，雖然仍有檢查意涵，但這種方式我一直以爲是我們提升檢查效率的好方法，同時也是提升檢查員專業能力的好方法。

丹麥工作環境主管機構官員(The Danish Working Environment Authority)指出，至2020年希望可以減少20% 肌肉骨骼相關的工作負荷(傷病?)。簡報題目改成"Maintaining the workforce in the future: a holistic approach to reducing MSDs"，更可以顯示出MSD 對於工作人力的影響，相當比例的勞工是因爲肌肉骨骼傷病而請假或離開職場，所以基於未來勞動力的維持，必須降低職場對勞工肌肉骨骼傷病的衝擊。work life must be balanced，丹麥簡報的這一概念某種程度工作環境與勞動者間的平衡，傳統上人因工程的方法是以現場改善的方式，改善工作環境與設計對勞工體力與生理上的負荷，進而減少減少勞工肌肉骨骼傷病。當然丹麥檢查主管機構認爲，除了傳統這種預防的做法外，必須考慮其他影響肌肉骨骼傷病的因素。(balance is the keyword and the point that should get across is that intervention towards MSDs should aim at maintaining balance, to ensure this balance, focus on the traditional prevention methods must be maintained, the workplace should focus on a number of additional factors that can contribute to reduce the risk of MSDs.)

實務上，仍無明確的做法，因爲balance這一概念仍然不甚成熟。以下是他們的pilot。姑且不論這一 pilot 是否成熟或是研究水準如何，檢查員不是無奈或是開罰單，反而是問題解決的參與者。

Pilot

The pilot focuses on 20 cleaning enterprises and includes a targeted dialogue with the management.

In the targeted dialogue with the managements, messages about a balanced work life will be incorporated.

The inspectors participating in the pilot will have a dialogue with the management that will focus on trying to enable the enterprise to use the holistic approach in the work with their working environment.

It is important that the enterprise though the dialogue understand that MSDs is a multi-factorial challenge.

(2) 瑞典

Special prevention efforts for women´s wellbeing at work, focused on physical ergonomics Kersti Lorén1 .

瑞典政府要求 The Swedish Work Environment Authority發展並執行改善方法，以預防女性因爲包括肌肉骨骼傷病這類職業相關問題，而提早提開職場。這個計畫執行期間從2011-2014年，約2.35百萬歐元預算。這個計畫主要有下列三項：

• Information, gathering and dissemination
• Methodological and professional development and
• Supervision

瑞典選擇Dutch method to estimate risk for physical overload when performing repetitive tasks - HARM (hand arm risk assessment method) and the German KIM (Key Item Method) made for Swedish use 2012. The KIM methods estimate risk for physical overload due to manual handling. 其中HARM 是針對上肢作業，KIM則是人工物料搬運作業，亦即下背傷病。檢查員的訓練則是首要工作，此外如何執行檢查其SOP爲何，也是要考慮的事項。2013年8月之前，他們以實際進行720個廠訪，開出520個inspection notes。檢查員廠訪做什麼? 檢查的目的在於協助事業單位預防MSD，因此如何將危害評估資訊以及預防概念做法，提供給事業單位。事業單位如何篩選出危害作業，進而構思改善方法。我想這些都是本計畫執行的重點，如此才能預防職場人因工程危害。

(3) 挪威

THE RESULTS OF A SUPERVISION CAMPAIGN IN NURSERY SCHOOLS **Harald Gran1** , Bjørg Hegdal1 .

挪威勞工檢查機構選定肌肉骨骼傷病(MSDs)，作爲2008-2012 優先重點工作。2010年他們舉行prevention campaign(歐盟也有類似活動)。另外，他們也以護理照護工作(學校

nursery schools)爲例，主要是這類工作主要是女性，同時肌肉骨骼傷病案例較多。監督檢查同時也會提供事業單位相關的預防指引與資訊，作爲後續follow-up supervisions的參考。亦即，事業單位可以參考資訊進行改善。

參、結論與建議

本會在新修訂的〝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，應妥爲規劃並採取必要安全衛生措施，以保護勞工身心健康〞，包括〝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，值得重視。北歐國家實際的檢查經驗與做法，或許可以作爲我們的參考。包括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。我國未來實施新的職安法時，也可以考慮製作肌肉骨骼傷病預防指引，作爲檢查單位檢查的依據，以及事業單位改善的參考，以增進雙方的共識。

附錄一 研討會發表之論文

The Prevention of WMSD in Taiwan

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ABSTRACT: In Taiwan, the statistics of labor insurance showed that the compensated WMSD cases accounted for more than 60% of all occupational illness in recent years. In Taiwan, 97% of the enterprises are small and medium business. How to address musculoskeletal disorders in the workplace, before issuing a duty clause? We provide assistance to the small and medium business, including the free on-site ergonomic consultation and intervention, easy-to-follow intervention guides. To date, the project has counseled 300 factories, more than 1200 workplace cases. Results of on-site workplace improvement is highly recognized. Complains of pain and discomforts of workers drops and work performance increases significantly. After intervention, the lumbar compression force reduces about 20%-73%. The cost of each intervention for most of the cases were less than 50 thousands NT dollars. To further diffuse the WMSD prevention, we now try to integrated the improvement cases and methods to develop a query system.

Keywords: musculoskeletal disorder , ergonomic intervention, anthropometry

Introduction

The types and causes of occupational disease vary with the industrial development. In Taiwan, the statistics of labor insurance showed that the compensated work-related musculoskeletal disorders (WMSD) accounted for more than 80% of all occupational illness in recent years. In 2011, the cases of occuaptional lower-back-pain was about 24% of all occupational disease, and upper extremity diseases was about 63%. Among all the WMSD, manufacturing industry and construction contrubuted 28% and 21%, respectively (CLA, 2011). In USA, WMSD accounted for 33% of all workplace injuries requiring time away

from work in 2011 (DOL, 2012), compared to 29% of total days-away-from-work cases in 2007 and 30% in 2006. Six occupations accounted for 26 percent of the MSD cases in 2011: nursing assistants; laborers; janitors and cleaners; heavy and tractor-trailer truck drivers;registered nurses; and stock clerks.

WMSD often referred to as ergonomic injuries, are injuries or illnesses affecting the connective tissues of the body such as muscles, nerves, tendons, joints, cartilage, or spinal discs. There is debate concerning sources of risk, and mechanisms of injury. The complexity of the problem is further increased because the related risk factors interact and vary over time. Research is needed to clarify these risk factors, but research is complicated by the fact that estimates of incidence in the general population, as contrasted with the working population, are unreliable because the two overlap (NRC, 2001).Though, the mechanism of injury is elusive and further research is needed, WMSD has been recognized as one of the most prevalent occupational ailment affecting health care expenditure and work force resources. Some of WMSD cases do return to work after medical treatment, but many will face recurrence and worsen health conditions. Therefore, the prevention of WMSD is essential to the alleviation of occupational diseases and the productivity of labors.

To address musculoskeletal disorders in the workplace, OSHA developed a four-pronged ergonomics strategy through a combination of industrial-specific and task-specific guidelines, outreach, enforcement, and research. In Taiwan, however, 97% of the enterprises are small and medium business, in which about 76.58% of all labors are hired. Employees are less than 200 labors in every individual business.(MEA, 2009). On-site safety & health stuff do not have the abilities to evaluate the ergonomic risk and to implement ergonomic intervention. Furthermore, the exposure-disorder relation of MSD is not very clear. Rashly setting an ergonomic duty clause would face tough challenge. Though, none of the common musculoskeletal disorder is uniquely caused by work exposures, MSD is frequently associated with work environment. The intervention strategies to reduce these risks should be encouraged and extended. The proactive strategy has the potential of benefiting not just to improve quality of workers' life but also the productivity of the industry. For that majority of smaller employers facing the challenging of economic recession, government should provide more assistance to them, including the free on-site ergonomic consultation and intervention, easy-to-follow intervention guides.

Method and material

According to a nation-wide survey, 51.7% of labors considered that their work involved with awkward postures, and 60% with repetitive motions (IOSH, 2004). Among thee MSD risk factors, such as awkward posture, forceful exertion, repetitive motion, vibration, and extreme temperature, awkward posture is much easier to recognized and evaluated by workers, e.g. elevation of shoulder, bend back. Prolonged work in poor posture is one of the leading causes of WMSD, which results in fatigue, pain, or disease in the neck, shoulder, wrist, back, or other parts of body. To some extent, poor working postures are related with unsuitable design of workstations, which do not fit the labors' anthropometry.

To help labors further understand the relation between poor postures and anthropometry, first IOSH (Institute of Occupational Safety and Health) and National Tsing Hua University had had undergone a series of 1D and 3D anthropometrical database survey, which completed in 2004. The evolution of MSD prevention in Taiwan is depicted as following (Figure. 1).

The above database was used to compile a booklet "Collection of Ergonomic Working Postures" which contains 100 typical workplace designs based on the concept of "functional working posture" in 2005. A functional working posture is one that is natural and energy saving for task performance. The basic idea is to keep the trunk and neck upright as much as possi-ble, because bending of these two segments will result in excessive stress on the lumbar and neck. In addition, keep the hands as close to the body as possible to reduce stress.

In 2007, a pilot study on intervention was conducted and a second booklet "Method of Ergonomic Workplace Improvement" was compiled to instruct on-site S&H stuffs how to utilize the booklet "Collection of Ergonomic Working Postures" and understanding the concept of "functional working posture". First, through the posture comparison, such as standing or sitting, and heavy or light work, they can choose an appropriate typical workplace design from the booklet. Then adjust the size in the typical workplace design to fit the on-site situation and workers' anthropometry.

Based on intervention cases of pilot study, we put together these preliminary techniques of ergonomic intervention for experts. This preliminary techniques consist of a standardized chart of intervention process and a set of work sheets of standard procedure. To widely diffuse the ergonomic intervention, an easy-to-follow intervention guides was made. This rule-based technique, checking-typed process chart (Figure.2) and diagrammatic standard operation procedure (SOP), in reducing the dependency on ergonomics and engineering knowledge, so any personnel with basic training in ergonomics is able to improve workplace by him/herself based on this SOP.

With all these booklets served as guiding reference, we organized a consulting team to promote the MSD prevention in 2009. To achieve this objective, the following works were devised: (1) world-wide literature review on promotion of ergonomic hazard prevention, (2) design and print colored promotion leaflets on promotion of ergonomic hazard prevention, (3) held workshops on promotion of ergonomic hazard prevention, (4) held colloquiums on promotion of ergonomic hazard prevention (for recruiting participating factories), (5) conduct the on-site ergonomic intervention.

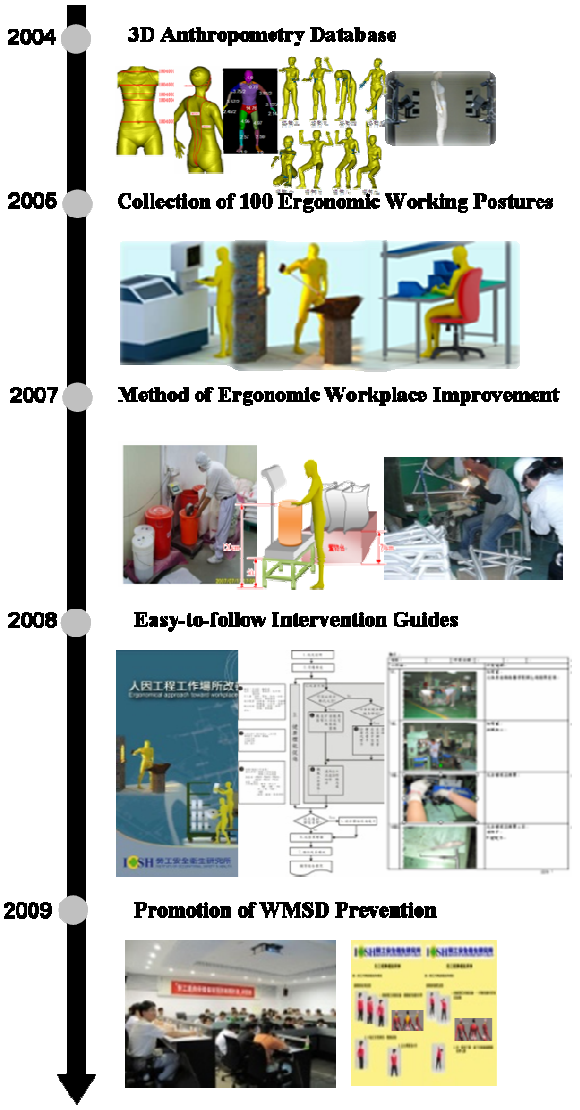


Figure 1. The evolution of WMSD prevention program

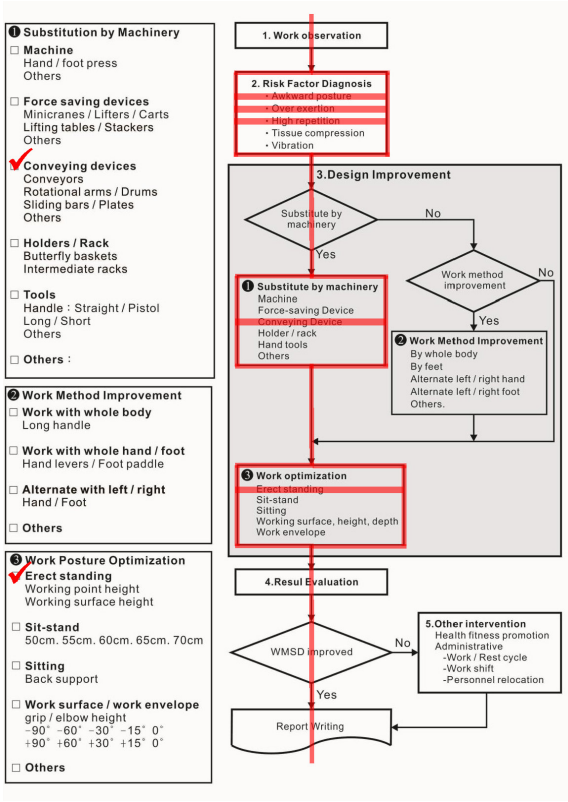


Figure 2. Ergonomic intervention process chart

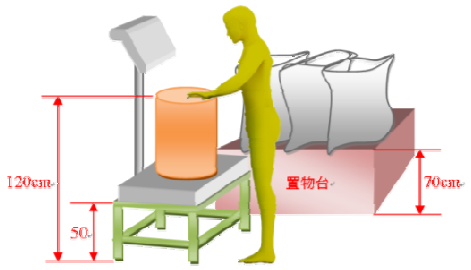
Before	After
Marble Sheet Crack Filling	
	
Ingredient Preparation	

Figure 3. examples of intervention.

Figure. 3 shows some examples of intervention. Though use of ergonomical intervention technolgies has achieved lots of successful improvement, this knowledge-oriented technology requires lots of professional knowledge and experience. It's not easy to carry the intervention for the on-site safety and health staffs in small and medium business. Therefore, the ergonomic experts did these interventions not the S&H staffs. How to further help them to do the ergonomic intervention? Then we integrated the improvement cases and methods to develop a query system. After the user inputs related parameters, including the basic data and operational characteristics, this query system will find out risks, for example, with NIOSH Lifting Equation. Then, according to the risks, the query system will provide some methods for improvement and real cases for reference.

Results and Discussion

To date, the project has counseled 300 factories, more than 1200 workplace cases. Results of on-site workplace improvement is highly recognized. Complains of pain and discomforts of workers drops and work performance increases significantly (Figure. 4). The cost of each intervention for most of the cases were less than 50 thousands NT dollars (Figure. 5).

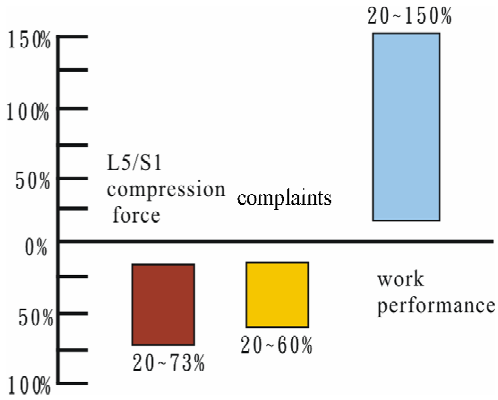


Figure 4. The percentage of reduction of L5/S1 compression force, complaints, and increase of performance after intervention

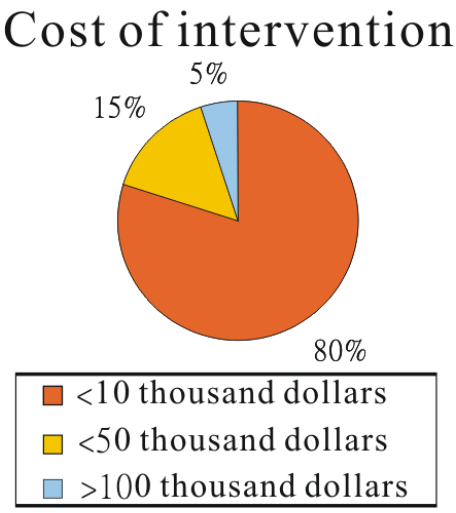


Figure 5. The cost distribution of intervention

This prevention project primarily focused on working posture improvement, through workstation redesign and use of easy supporting equipment. To reduce repetitive hand/wrist motion, it is sometimes involved with the use of machine or automation. The cost would be higher than that of the posture improvement and this higher cost investment may impede employer's attempt. We hope to acquire some more experience on improvement of repetitive hand/wrist motion and conquer this problem in the future.

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