

肌肉骨骼危害防制 與現場改善

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課程內容



- 1 肌肉骨骼危害現況與我國法規
- 2 肌肉骨骼危害與形成之機轉
- 3 肌肉骨骼危害防制流程
- 4 肌肉骨骼危害防制改善案例
- 5 檢核工具之分類、選擇與使用



肌肉骨骼危害現況 與我國法規



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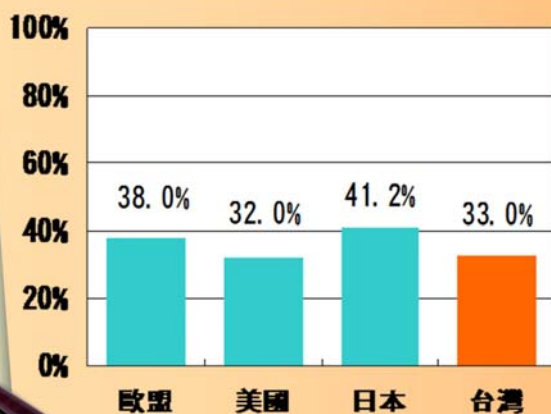
背景分析

- 肌肉骨骼傷害的嚴重性



肌肉骨骼傷害 / 職業傷害

MSDs%



損失(單位：億)



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相關法規



人因性危害防止計畫係指事業單位為執行「**職業安全衛生法**」**第六條第二項**以及其**施行細則第十條第二項**、**勞工安全衛生設施規則第三百二十四條之一條**等相關法規之規定要項，並參酌勞工安全衛生管理規章、勞工安全衛生管理計畫及台灣勞工安全衛生管理系統(TOSHMS)內容訂定。



職業安全衛生法第六條第二項



雇主對下列事項，應妥為規劃及採取必要之安全衛生措施：

- 一. **重複性作業等促發肌肉骨骼疾病之預防。**
- 二. 輪班、夜間工作、長時間工作等異常工作負荷促發疾病之預防。
- 三. 執行職務因他人行為遭受身體或精神不法侵害之預防。
- 四. 避難、急救、休息或其他為保護勞工身心健康之事項。

1. 違反規定致發生職業病，處新台幣三萬元以上三十萬元以下罰鍰。

2. 違反規定，經通知限期改善屆期未改善處新台幣三萬元以上十五萬元以下罰鍰。



職業相關之肌肉骨骼傷害



- 由於職業暴露於**人因相關危害**，因而引發或加重之肌肉、骨骼、周邊神經或神經血管系統疾病或傷害。
- **人因相關危害**指對於肌肉骨骼系統有可能造成傷害或疾病的生理壓力來源 (physical stressor) 或職場因子。



肌肉骨骼危害與 形成之機轉



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肌肉骨骼傷害的分類



急性：肌肉：刀傷、撞傷、拉傷
其他組織：（同）

慢性：肌肉

持續收縮→新陳代謝超負荷

（或微傷害）→乳酸積聚→疲勞→酸痛發炎

其他組織（關節面、韌鞘、滑液囊）

摩擦→發炎→碳酸鹽的沈積鈣化→ →
摩擦力急遽升高→病變



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常見的肌肉骨骼傷病



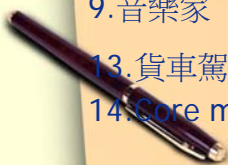
- **肩頸**：旋轉肌袖肌腱炎、緊張性頸痛、頸椎疾病
- **手臂/手肘**：肱上髁炎、胸廓出口症候群
- **手腕/手部**：腱鞘囊腫、肌腱炎、肌腱滑膜炎(奎緬氏症、扳機指)
- **下背部**：椎間盤突出症、坐骨神經痛、下背痛
- **下肢**：地毯工人膝、足部疼痛、膝關節炎
- **神經血管**：腕道症候群、雷諾氏症



工作相關之傷害及職業傷害成因 1/2



工作	傷害	職業傷害因子
1. 研磨	腱鞘炎、胸廓出口症、腕道症候群、奎緬氏症、旋前肌併合症	重複性腕部作業，肩部拉展，震動，劇烈尺偏，重複的前臂內轉
2. 沖壓	腕部及肩部肌腱炎、奎緬氏症	重複性劇烈腕部外展/屈曲，重複性肩部外展/屈曲，前臂外翻重複性尺偏於推移控制上
3. 頭頂上方組裝	胸廓出口症、肩部肌腱炎	手臂持續過度伸直，手部高舉過肩部
4. 生產線組裝	腕部及肩部肌腱炎、腕道症候群、胸廓出口症	手臂伸出，外展或屈曲小於60度；重複性腕部作業
5. 打字，打孔 收銀員	頸部緊繃、胸廓出口症、腕道症候群	靜態且受限的姿勢；手臂外展/屈曲；快速之手指作業；手掌中心受壓力；尺偏
6. 裁切	胸廓出口症、奎緬氏症、腕道症候群	重複性肩部屈曲，重複性尺偏，重複性腕部屈曲/外展，手掌中心受壓力
7. 小零件組裝	頸部緊繃、胸廓出口症、腕部肌腱炎、肱上髁炎	伸長受限姿勢，劇烈尺偏及拇指受力；重複性腕部作業；劇烈腕部外翻及內轉
8. 信差	肩部問題、胸廓出口症	肩部背負過重負荷
9. 音樂家	腕部肌腱炎、腕道症候群、肱上髁炎、胸廓出口症	重複性劇烈腕部作業，手掌中心受壓力，肩部拉伸外展/屈曲，劇烈的腕部外展及前臂內轉
13. 貨車駕駛	胸廓出口症	拉伸肩部外展及屈曲
14. Core maker	腕部肌腱炎	重複性腕部作業



工作相關之傷害及職業傷害成因2/2

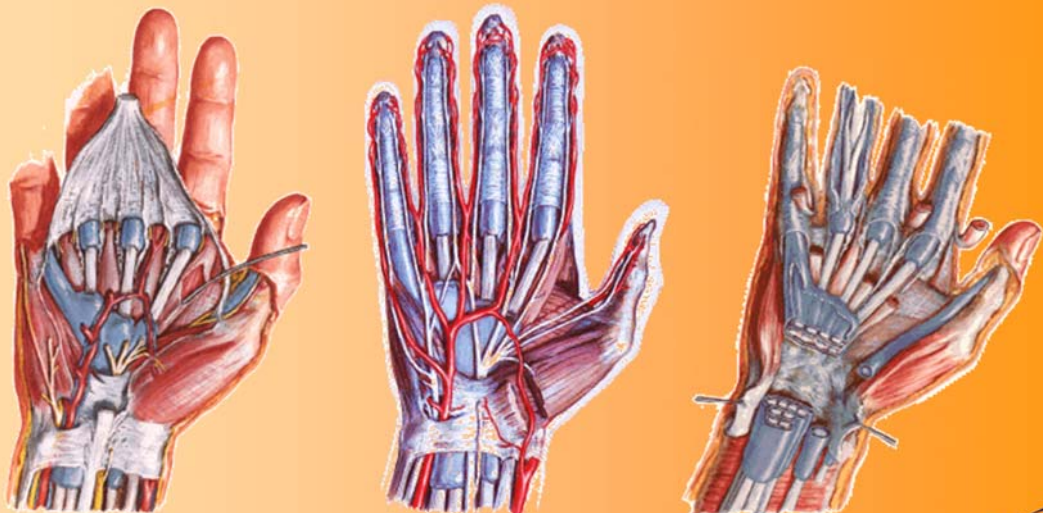


7.小零件組裝	頸部緊繃、胸廓出口症、腕部肌腱炎、肱上髁炎	伸長受限姿勢，劇烈尺偏及拇指受力；重複性腕部作業；劇烈腕部外翻及內轉
8.信差	肩部問題、胸廓出口症	肩部背負過重負荷
9.音樂家	腕部肌腱炎、腕道症候群、肱上髁炎、胸廓出口症	重複性劇烈腕部作業，手掌中心受壓力，肩部拉伸外展/屈曲，劇烈的腕部外展及前臂內轉
10.工作合作業	尺關節嵌制	持續手肘屈曲並施壓於尺骨連接處
11.手術室人員	胸廓出口症、腕道症候群、奎緬氏症	拉伸肩部屈曲，重複性腕部屈曲，尺偏(特牽開器)
12.包裝	腕部及肩部肌腱炎、頸部緊繃、腕道症候群、奎緬氏症	肩部拉伸負荷，重複性腕部作業，過度使用，劇烈尺偏
13.貨車駕駛	胸廓出口症	拉伸肩部外展及屈曲
14.Core maker	腕部肌腱炎	重複性腕部作業
15.家務，烹飪	奎緬氏症、腕道症候群	擦拭，清洗，快速腕部旋轉作業
16.木匠，泥水匠	腕道症候群、蓋式隧道症候群	錘打，壓力集中於手掌中心
17.倉儲，運輸	胸廓出口症、肩部肌腱炎	可及範圍高過頭部，肩部負重並處於非自然姿勢下
18.物料搬運	胸廓出口症、肩部肌腱炎	肩部背負負荷
19.伐木/建築	肩部肌腱炎、肱上髁炎	重複丟擲笨重之負荷(物件)
20.屠宰/肉品處理	奎緬氏症、腕道症候群	尺偏，費力屈曲手腕

過度使用傷害之病理機轉



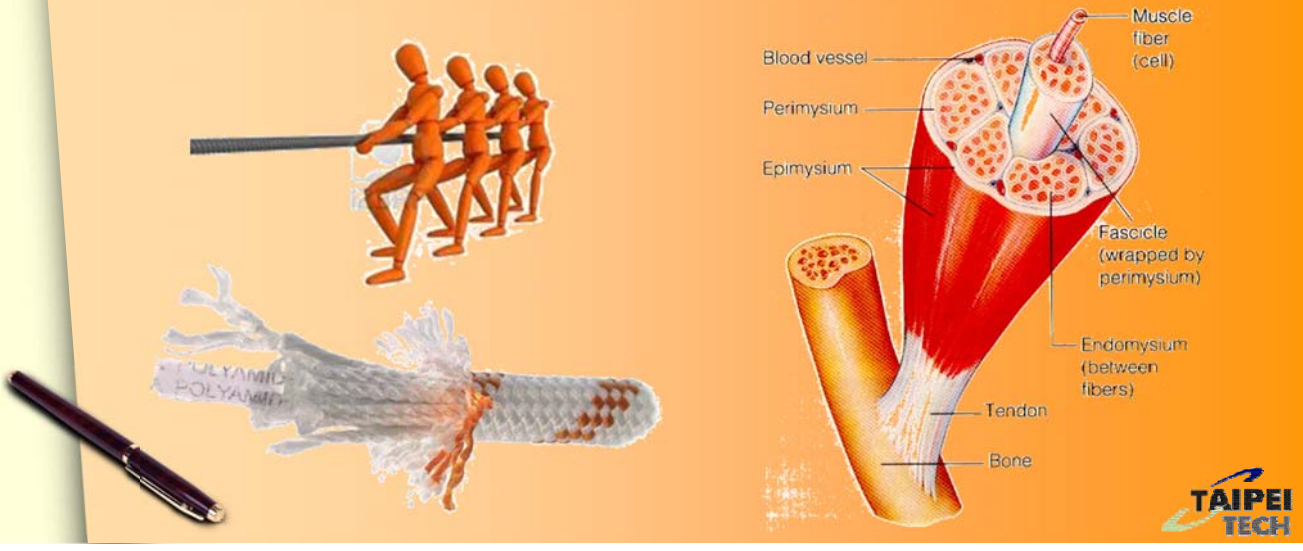
- **重複性張力 (repetitive strain)**
→發炎、腫脹、疼痛、血流供應減少、神經末梢過度刺激



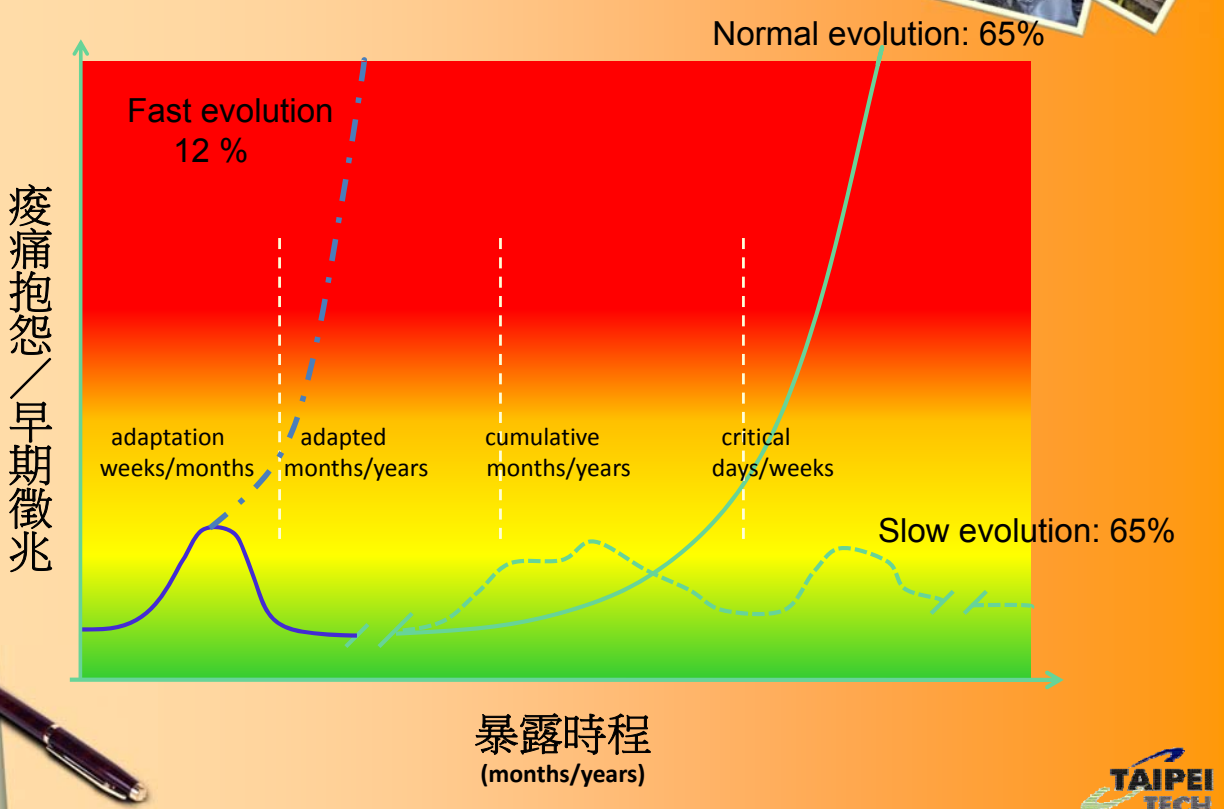
過度使用傷害之病理機轉



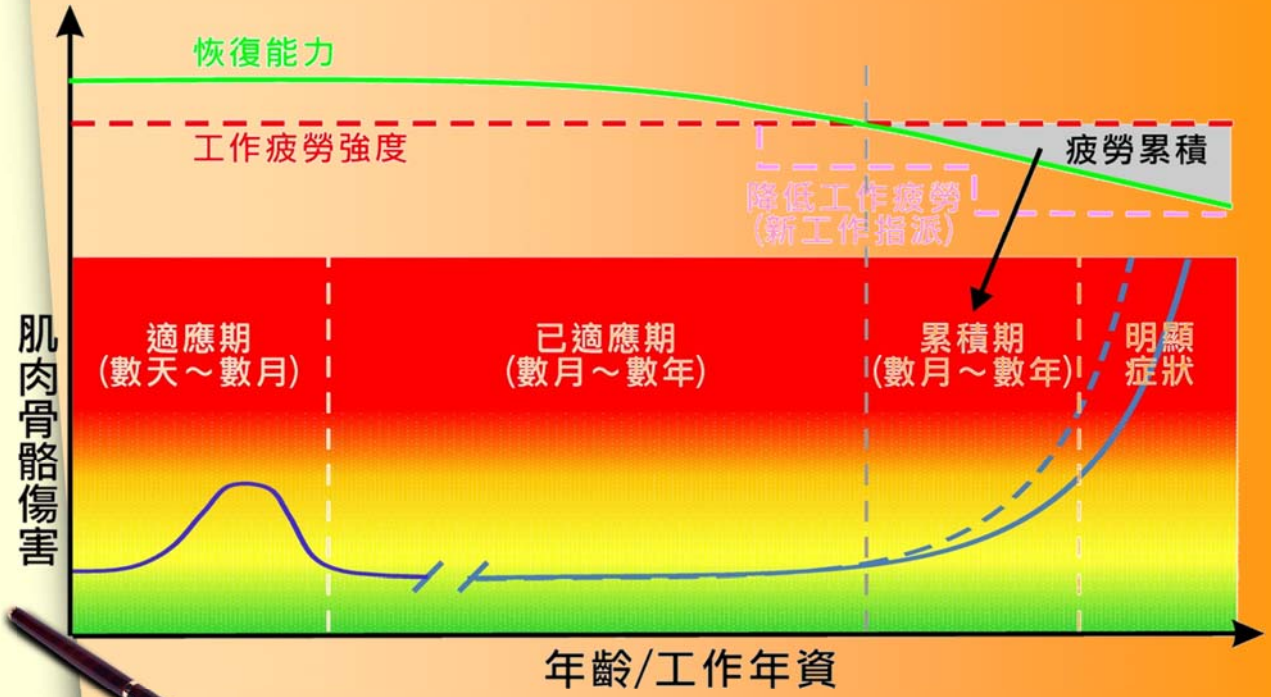
- 重複性張力 (repetitive strain)
 - 微小損傷
 - 組織變性
 - 肌腱病變、部分或完全斷裂



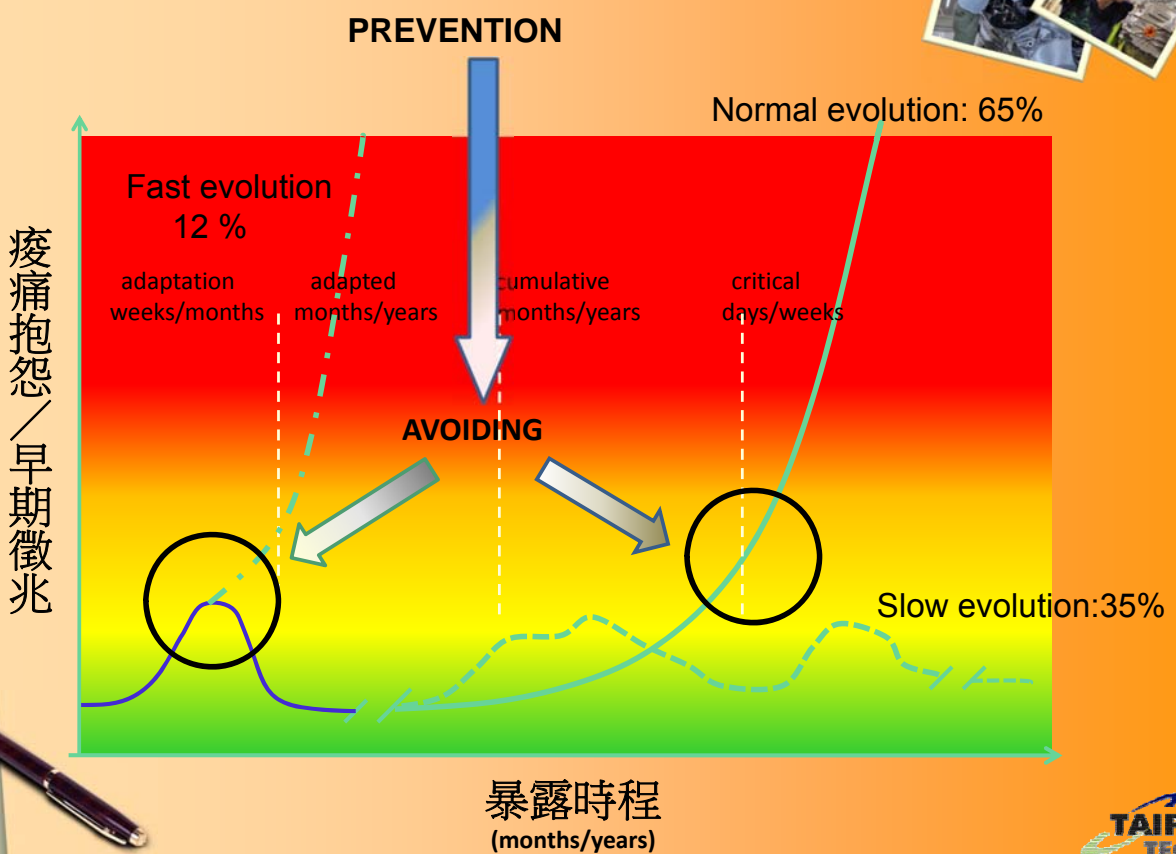
肌肉骨骼傷害形成 1/3



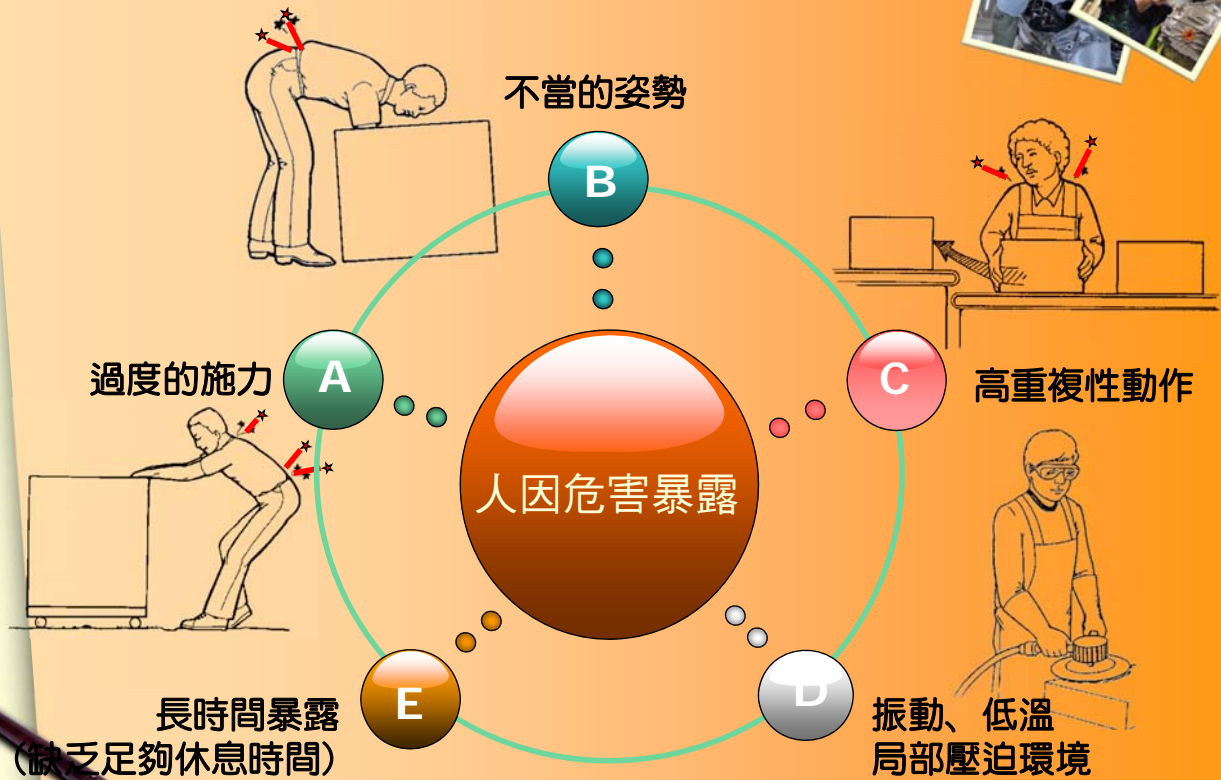
肌肉骨骼傷害形成 2/3



肌肉骨骼傷害形成 3/3

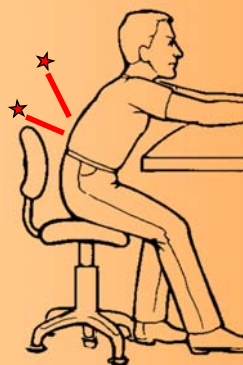


主要肌肉骨骼危害因子



危害因子範例 - 不當姿勢 1/2

- 手部高舉過頭
- 手肘高擡過肩
- 背部前彎或扭轉

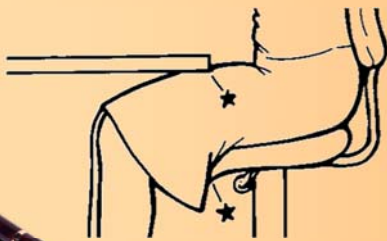


危害因子範例 - 不當姿勢 2/2



- 頸部前屈或後仰

- 距



職業相關危險因子(下背)



危險因子	強烈證據	足夠證據	證據不足
抬舉/用力活動	✓		
不當姿勢		✓	
全身性振動	✓		
重體力活動		✓	
靜態工作姿勢			✓



職業相關危險因子



危險因子	肩頸	肩膀	手肘	手部/ 手腕	肌腱炎
高重複動作	+	+	?	+	+
高施力	+	?	+	+	+
不良姿勢	++	+	?	?	+
振動暴露	?	?		+	
綜合因子			++	++	++

++ : 強烈證據 ; + : 足夠證據 ; ? : 證據不足



肌肉骨骼危害防制的困難度



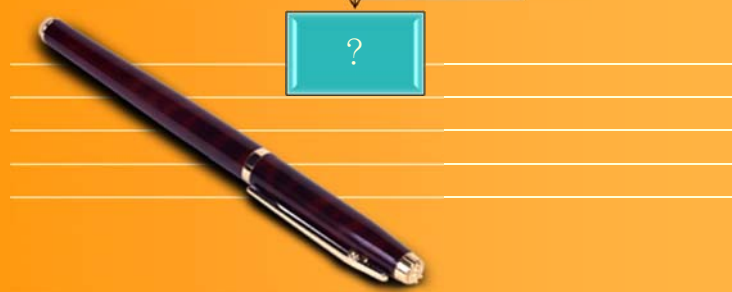
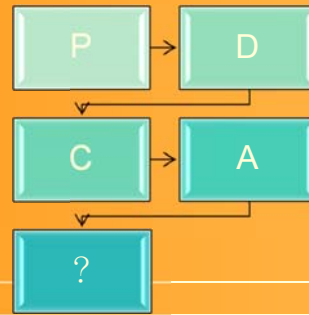
- 肇因於**多重危害暴露**，造成危害暴露量化（風險評估）上的困難
- **年齡老化因素**與**工作內容變化**增加評估上的困難度
- **個人**與**社會心理因素**





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肌肉骨骼危害防 制流程



人因改善三步驟



1

確認潛在或
存在問題
(文獻、傷
害、症狀報
告)

2

分析工作中
危險因子的
暴露(檢核
表、工作分
析)

3

評估工作危
害程度(等
級)擬定改
善方案



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勞工安全衛生設施規則第324-1



雇主使勞工從事重複性之作業，為避免勞工因姿勢不良、過度施力及作業頻率過高等原因，促發肌肉骨骼疾病，應採取下列危害預防措施，並將執行紀錄留存三年：

- 一. 分析作業流程、內容及動作。（辨識有危害作業）
 - 二. 確認人因性危害因子。（確認該作業之危害因子）
 - 三. 評估、選定改善方法及執行。（依據危害因子規劃改善）
 - 四. 執行成效之評估及改善。（評估危害及傷病是否消除）
 - 五. 其他有關安全衛生事項。
- 前項危害預防措施，事業單位勞工人數達一百人以上者，雇主應依作業特性及風險，參照中央主管機關公告之相關指引，訂定人因性危害預防計畫，並據以執行；於勞工人數未滿一百人者，得以執行紀錄或文件代替。

STEP 1. 分析作業流程、內容及動作

廠內職業病危害調查

廠內危害分析

STEP 2. 確認人因性危害因子

工作站1

工作站2, 3, 4...

工作站n

提出各工作站改善方案

STEP 3. 擬訂改善方法

危害風險排序

優先改善順序評估

執行改善

STEP 4. 執行成效之評估及改善

管控追蹤 / 評估改善成效

符合預期成果

STEP 5. 其他有關安全衛生事項

考核與紀錄

肌肉骨骼傷害調查



- 1) 現況調查：包含勞保職業病案例、通報職業病案例、就醫紀錄、病假與工時損失紀錄等。
 - 健康與差勤監測
 - 探詢員工抱怨
- 2) 主動調查：全體員工的自覺「肌肉骨骼傷害問卷調查表」
- 3) 確認改善標的：就上開現況調查的健康與差勤監測、探詢員工抱怨與主動調查等三項資料，將個案判定為確診疾病個案、疑似有危害個案、無危害個案三級



危害狀況判定



危害因子

有危害

無危害

人員反應

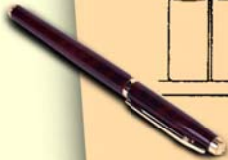
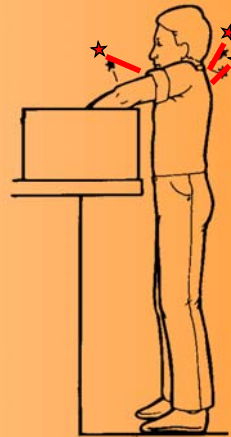
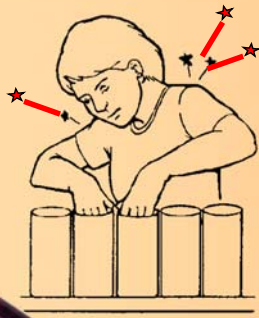
有抱怨

無抱怨

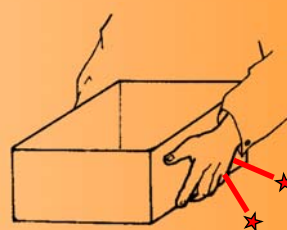
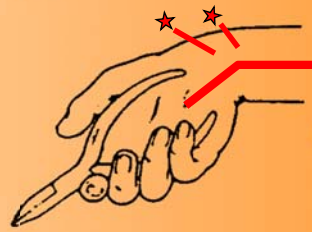
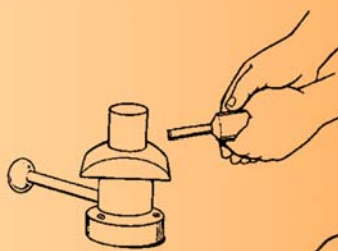
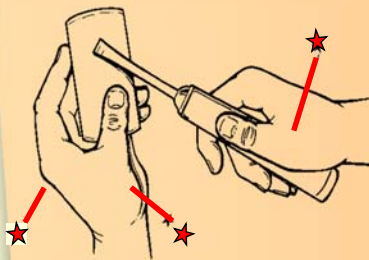
有抱怨		
無抱怨		



簡易改善 1/2



簡易改善 2/2



進階改善方案：SOP表單

改善方案：SOP表單(1)

- 以外力取代-1
- 改變工作方法
- 改變工作姿勢

① 外力取代人力									
<input type="checkbox"/> 沖床	<input type="checkbox"/> 自動迴轉盤	<input type="checkbox"/> 旋轉桌	<input type="checkbox"/> 檢料機	<input type="checkbox"/> 自動手臂	<input type="checkbox"/> 縫袋口機	<input type="checkbox"/> 切割機	<input type="checkbox"/> 攪拌機	<input type="checkbox"/> 拋光機	
<input type="checkbox"/> 旋轉盤	<input type="checkbox"/> 升降旋轉盤	<input type="checkbox"/> 氣動升降台	<input type="checkbox"/> 手推車	<input type="checkbox"/> 升降推車	<input type="checkbox"/> 升降桌	<input type="checkbox"/> 升降桌	<input type="checkbox"/> 升降桌	<input type="checkbox"/> 升降機	
<input type="checkbox"/> 倍力人	<input type="checkbox"/> 小型起重機	<input type="checkbox"/> 堆高機	<input type="checkbox"/> 輕便抱機	<input type="checkbox"/> 抱機	<input type="checkbox"/> 抱機拖板車	<input type="checkbox"/> 抱機推車	<input type="checkbox"/> 夾筒夾	<input type="checkbox"/> 椅子夾具	
<input type="checkbox"/> 輕便蜘蛛車	<input type="checkbox"/> 蜘蛛架(1)	<input type="checkbox"/> 蜘蛛架(2)	<input type="checkbox"/> 小天車	<input type="checkbox"/> 象鼻子	<input type="checkbox"/> 重物省力桌	<input type="checkbox"/> 踏車式起重機	<input type="checkbox"/> 檢料車		

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進階改善方案：SOP表單

改善方案：SOP表單(2)

- 以外力取代-2
- 改變工作方法
- 改變工作姿勢

<input type="checkbox"/> 滑板	<input type="checkbox"/> 輸送帶	<input type="checkbox"/> 迴轉盤	<input type="checkbox"/> 旋轉臂	<input type="checkbox"/> 滑桿	<input type="checkbox"/> 滑軌	<input type="checkbox"/> 懸吊式輸送帶	<input type="checkbox"/> 抽料管	
<input type="checkbox"/> 暫存架	<input type="checkbox"/> 摺紗架	<input type="checkbox"/> 傾斜架(1)	<input type="checkbox"/> 傾斜架(2)	<input type="checkbox"/> 傾斜架(3)	<input type="checkbox"/> 翻轉架	<input type="checkbox"/> 升降支柱(1)	<input type="checkbox"/> 升降支柱(2)	<input type="checkbox"/> 可移動式料架
把柄型式:		把柄長度:						
<input type="checkbox"/> 直柄	<input type="checkbox"/> 手推柄	<input type="checkbox"/> 短柄	<input type="checkbox"/> 長柄					
<input type="checkbox"/> 塑膠籃	<input type="checkbox"/> 網框籃	<input type="checkbox"/> 方形桶	<input type="checkbox"/> 圓形桶	<input type="checkbox"/> 其他	<input type="checkbox"/> 托板			

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進階改善方案：SOP表單

改善方案：SOP表單(3)

- 以外力取代
- 改變工作方法
- 改變工作姿勢

改善流程圖



◎ 改變工作方法

全身代替手
 腳代替手
 左右腳交替
 左右手交替
 其他

◎ 工作姿勢

直立站姿
 胸口高 (135)
 肘高 (105)
 握拳 (75)
 坐姿
 其他

高坐姿
 工作面角度 (50, 60, 70)
 其他

39



人因危害因子控制

1 工程/人因控制

2 行政控制

- 工作常規
- 訓練
- 員工派工評估

3 個人防護裝置 ← 部分裝置實際效用未明



肌肉骨骼危害防制改善案例



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簡易人因工程改善 1/6



- 工作站部件調整
- 工作台



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TECH

簡易人因工程改善 2/6



• 工作站部件調整

- 坐椅、其他設備工具



standing



squat



bending



pick up loads



sit/stand stool



portable seat



reconfigured cart



Insert balance



簡易人因工程改善 3/6

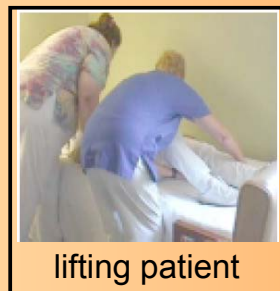


• 改變作業方式—應用輔具

- 省力設備



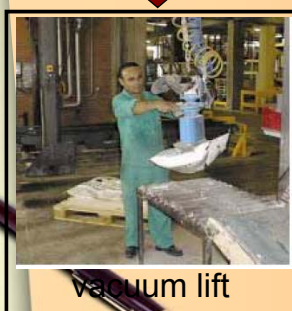
exertion



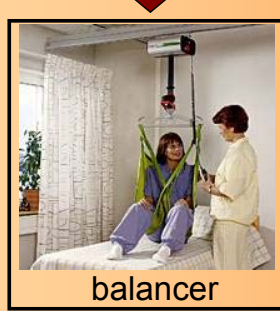
lifting patient



squat



vacuum lift



balancer



lifting table



簡易人因工程改善 4/6



• 改變作業方式—應用輔具

- 支架



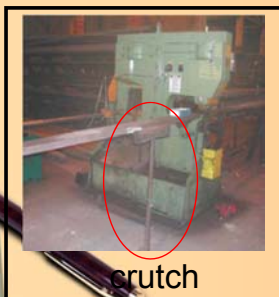
no support



no support



bending



crutch



provide frame



tilter



TAIPEI
TECH

簡易人因工程改善 5/6



• 改變作業方式—應用輔具

- 機器、輸送設備、手工具



lifting patient



heavy load



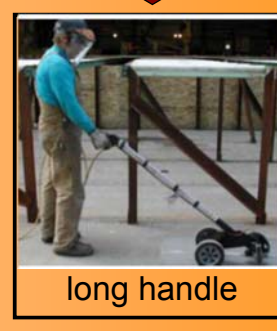
kneeling



lifting assist



adjustable trolley



long handle

TAIPEI
TECH

案例一 馬達外殼車削 1/4



• 現況說明

- 設施佈置

- CNC車床 (高度100公分)

- 工具、工件

- 馬達底座 (重量25公斤)
- 木箱深度 (約80公分)

- 作業員

- 男性1名，約40歲

→ 作業描述

- 彎腰 (0~90°)
- 抬舉、搬運 (80~100 cm)
- 12分鐘 (5/h, 40/8h)

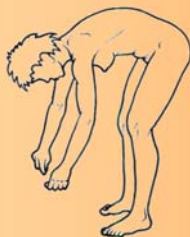


案例一 馬達外殼車削 2/4



• 問題陳述

- 過度施力
- 高重覆動作
- 低溫
- 震動
- 不良的姿勢

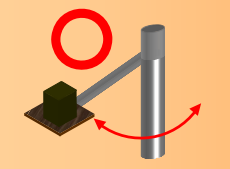


案例一 馬達外殼車削 3/4



改善方案

- 過度施力：以外力取代？（天車、省力設備、**支架**）
- 不良的姿勢：**自然**、省力的工作姿勢



施力
省力

姿勢
自然

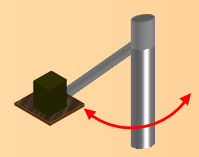


案例一 馬達外殼車削 4/4



改善方案：**旋轉臂**

升降架



案例二 TV模組包裝 1/2



工作狀況：

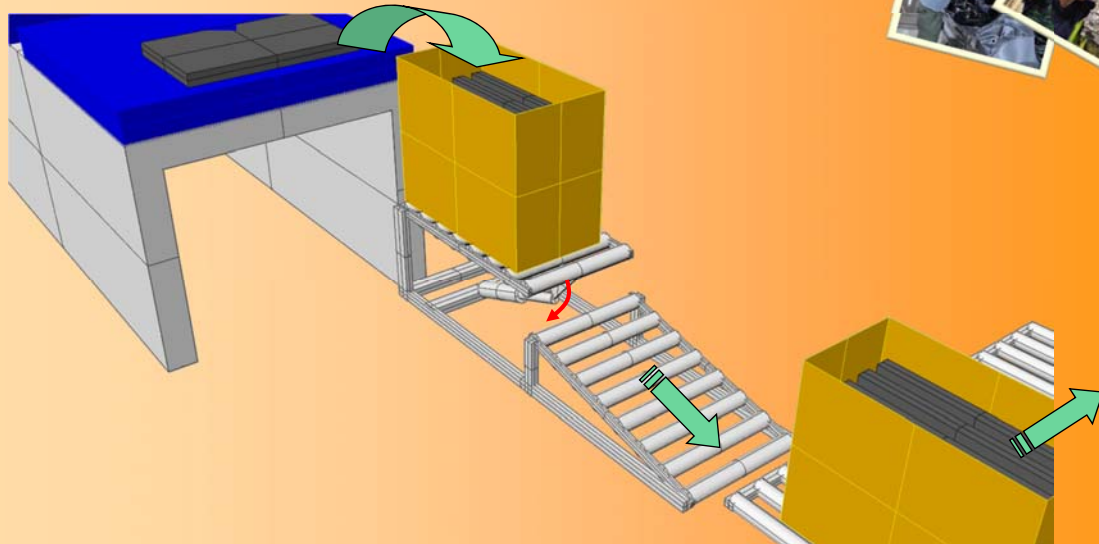
- ❖ 抬舉TV
- ❖ 攜行 2.5 m
- ❖ 放置裝箱（微彎腰姿勢）
- ❖ 4 TVs /箱

TV重量：10kg

時間：>1000次/班

Manual Material Handling (result)											
19	(Load + posture + (condition points)) x (#, duration or distance points)	Repositioning ¹⁾	(1.5 + 2)	Holding ¹⁾	(() + ())	Carrying ¹⁾	(1.5 + 1)	Pushing & Pulling short ¹⁾	(() + () + ())	Pushing & Pulling long ¹⁾	(() + () + ())
			x 10 = 35		x =		x 4 = 10		x =		x =
Handling = ∑ line 19			1) Maximal cumulative time points for all tasks of repositioning, holding, carrying as well as pushing & pulling all together = 15						= 45		

案例二 TV模組包裝 2/2



Manual Material Handling (result)											
19	(Load + posture + (condition points)) x (#, duration or distance points)	Repositioning ¹⁾	(1.5 + 1)	Holding ¹⁾	(() + ())	Carrying ¹⁾	(() + ())	Pushing & Pulling short ¹⁾	(() + () + ())	Pushing & Pulling long ¹⁾	(() + () + ())
			x 10 = 25		x =		x = 0		x =		x =
Handling = ∑ line 19			1) Maximal cumulative time points for all tasks of repositioning, holding, carrying as well as pushing & pulling all together = 15						= 25		



人因性危害檢核工具 之分類、選擇與使用

陳協慶 教授
國立臺北科技大學



Contents



- 1 Choose Appropriate Assessment Tools
- 2 Analysis & Measurement Tools
- 3 EAWS (part1~3)





Choose Appropriate Assessment Tools



生理負荷評估方法



Practitioners

Level 1

• (工作者) 問卷, 自述資料

危害存在

Level 2

• 簡易檢核表 (checklist)

----- 簡易改善

Ergonomics Experts

危害存在

Level 3

• 觀察法工具 (Observational methods)

----- 進階改善

評估過於複雜

Level 4

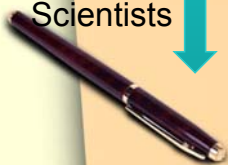
• 現場測量(Field measurements)

Scientists

評估過於複雜

Level 5

• 實驗室測量(Lab. measurements)



不同系統性觀察法之評估內容



方法	姿勢	負荷/施力	動作頻率	持續時間	恢復/休息時間	振動	* 其它
OWAS	√	√					
RULA	√	√	√				
EAWS	√	√	√	√	√	√	√
NIOSH Lifting Eq.	√	√	√	√			√
KIM	√	√	√	√			√
The Strain Index	√	√	√	√			√
OCRA	√	√	√	√	√	√	√
ACGIH TLVs		√	√	√			

*These include, mechanical compression, glove use, environmental conditions, equipment, load coupling, team work, visual demands, psychosocial and individual factors.

David GC, 2005, *Occupational Medicine*



Question



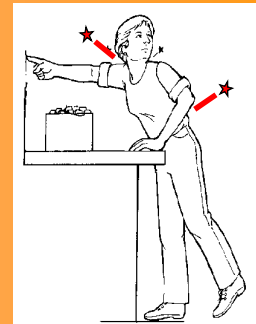
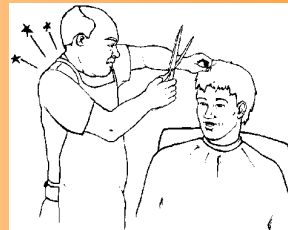
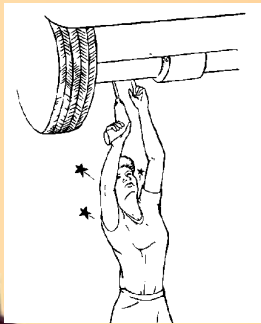
- 應該先選擇評估工具後再進行（暴露）資料收集，還是先收集現有資料再選擇可用的工具？



Question



- 選擇工具時應考慮以下哪些因素？
（ex. 工作姿勢、施力大小、重複次數、受傷部位、工作時程、環境因素、使用工具、工作內容/組成、性別、體型、年齡、??）



選擇評估工具之準備



確認存在的危害因子

調查疲勞、傷痛及肌肉骨骼抱怨部位

比對危害因子與傷痛部位之關係

瞭解各評估工具的應用範圍（傷害部位）與其所考量之危害因子



常見人因危害評估工具分類



分類	評估工具	評估部位	分級
上肢	簡易人因工程檢核表	肩、頸、手肘、腕、軀幹、腿	I, 篩選
	Strain Index	手及手腕	II, 分析
	ACGIH HAL-TLV	手	II, 分析
	OCRA Checklist	上肢, 大部分手	II, 分析
	KIM-MHO (2012)	上肢	II, 分析
	OCRA Index	上肢, 大部分手	III, 專家
背部	簡易人因工程檢核表	肩、頸、手肘、腕、軀幹、腿	I, 篩選
	KIM-LHC	背	I, 篩選
	KIM-PP	背	I, 篩選
	NIOSH Lifting eq.	背	II, 分析
	EAWS (3)	手臂、軀幹、腿	III, 專家
全身	RULA, REBA	肩、頸、手肘、腕、軀幹、腿	III, 專家
	OWAS	背、上臂和前臂	III, 專家
	EAWS (1-3)	肩、手、軀幹、腿	III, 專家

註) I級可謂篩選：是簡單的評估工具，不要求工作條件的詳細知識，不涉及姿勢或力的定量評估；可以由工人自己使用。II級可謂分析：工具需要更長的時間來使用（大約一小時），並需要考慮更多的因素。III級可謂專長：工具要複雜許多，需要更長的時間來使用，大多需要錄影分析、測量方法、與生物力學上的特定技能。

Question



- 若工作包含有多種的作業模式，需對工作中的不同作業挑選不同的評估工具？或是選擇危害風險最高的作業進行評估？



如以多種工具評估同一作業的危害風險，應採用風險較高的判定結果，以避免低估危害的存在

可整合不同作業條件之工具



評估工具	評估部位	評估作業
NIOSH eq.	背	抬舉
OCRA Index	上肢	上肢重複性動作
EAWS _{1~3}	全身	姿勢、施力、搬運



適用之肌肉骨骼危害風險 評估工具

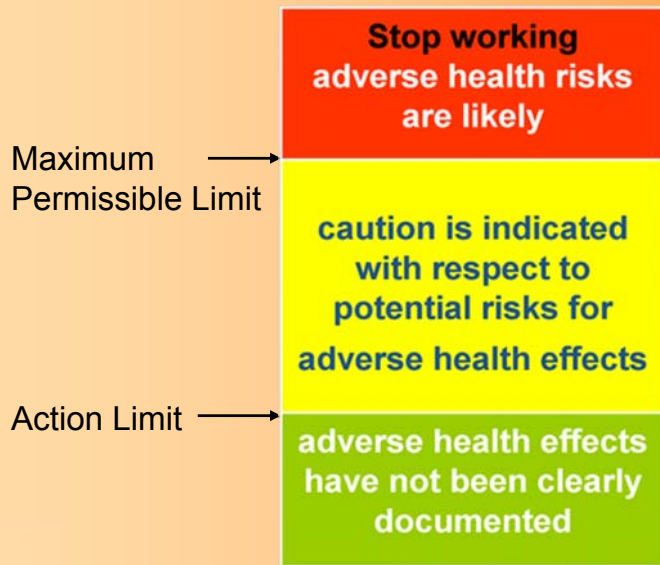


理想的評估工具(Chris Hamrick, 2006):

- 預測能力 → 靈敏度 (sensitivity)
- 健適性 → 涵蓋度/可用度 (usability)
- 便宜
- 非侵入性
- 快速
- 易於使用



評估工具危害風險判定



上肢重複性作業測試分析 (2014)



- 生產線(果醬瓶)裝箱
- 1kg 瓶 (10 min)
 - 250g 果醬瓶 x 2 (10 min)



- 沖床加工作業
- 900g 工件 (10 min)
 - 250g 工件 (10 min)



上肢重複性作業測試分析 (2014)



牆面油漆(10 min)



天花板油漆(10 min)



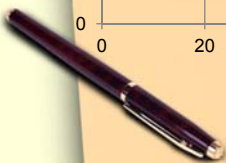
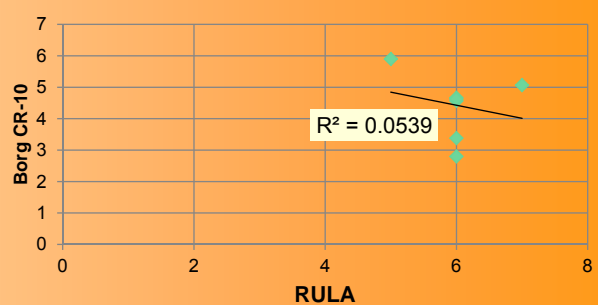
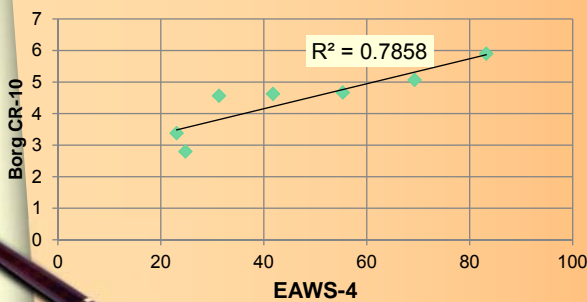
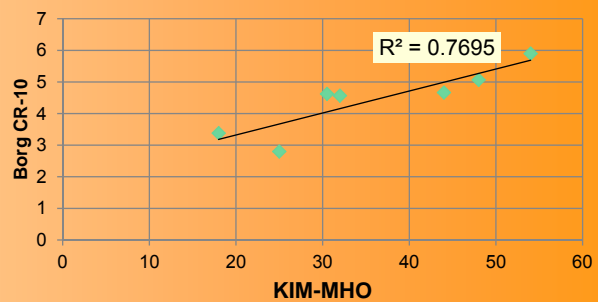
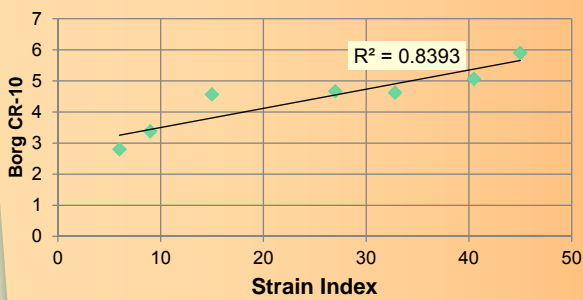
牆面刮漆(5 min)



牆面披土(5 min)



上肢重複性作業測試分析 (2014)



重複性作業肌肉骨骼危害風險 評估工具比較



	披士	漆天花板	漆牆	沖床900	裝罐1000	沖床250	裝罐250	Pearson r
Borg (CR-10)	5.9	5.1	4.7	4.6	4.6	3.4	2.8	
SI	45.0	40.5	27.0	32.8	15.0	9.0	6.0	0.92
OCRA	45.2	25.9	16.1	10.5	9.9	5.8	5.4	0.85
HAL	1.75	0.80	1.02	0.68	0.81	0.45	0.56	0.81
EAWS ₄	83.2	69.3	55.4	41.8	31.3	23.1	24.8	0.89
MHO	54.0	48.0	44.0	30.5	32.0	18.0	25.0	0.88
RULA	5	7	6	6	6	6	6	-0.27

↑ 高體力負荷界限

↑ 疲勞舒適界限



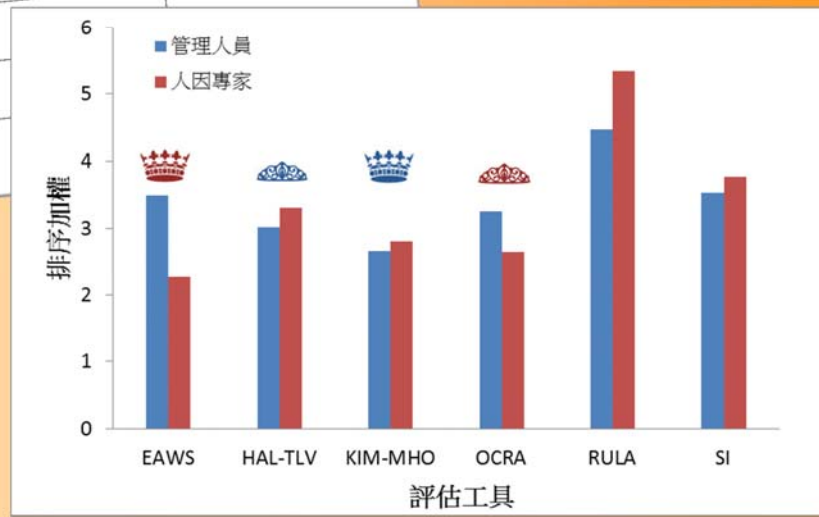
重複性作業肌肉骨骼危害風險 評估工具遴選



一、請分別以「(現場)管理人員」及「(人因)專家」者的立場，分別對三項原則的重要性給予適當權重(%)。項權重之總和為100%。

	管理人員	人因專家
準確性		
涵蓋性		
便利性		

原則 \ 立場	管理人員	人因專家
準確性	0.306	0.506
適用/涵蓋性	0.256	0.313
便利性	0.438	0.181



Summary



評估工具的選擇首重：

- Work nature & musculoskeletal risk factors
- Injuries (back, shoulder / neck, upper limb)
- Work type (continuous, intermittent, ...)
- Exposure (duration, rest / break arrangement, ...)



Analysis & Measurement Tools



Video Analysis



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Why doing video analysis



Postures in fast movement can not be registered easily.

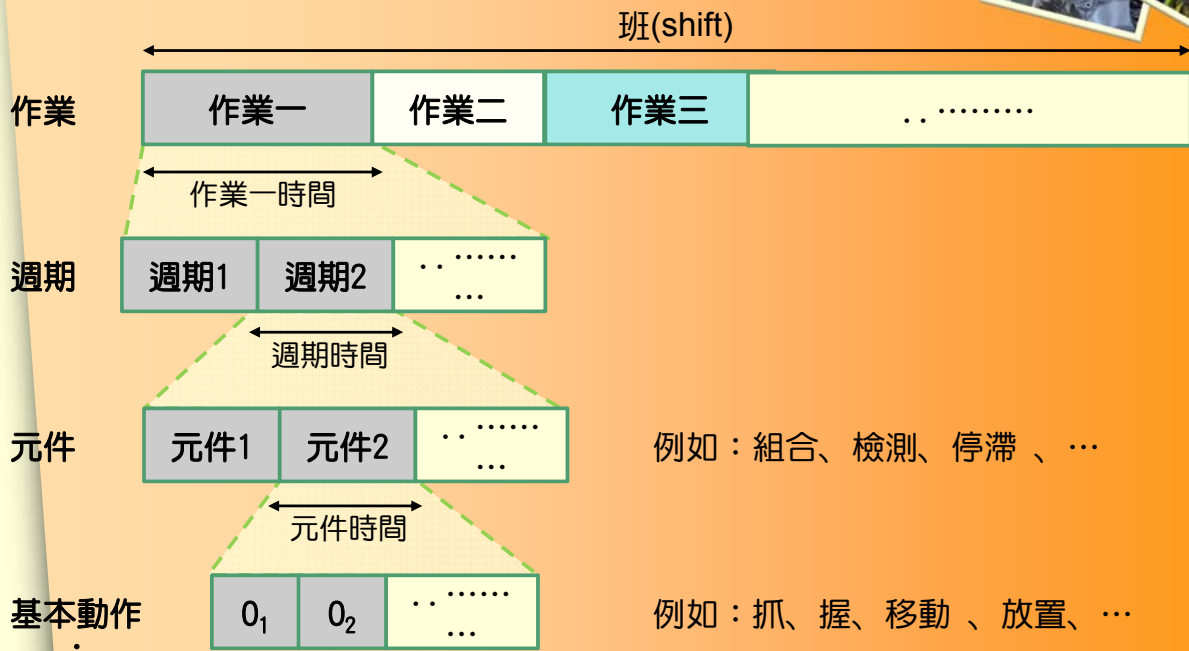
Complex movements requires to be recognized carefully.

Duration of each event is needed to be recorded and summarized.



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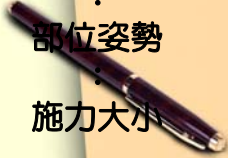
Composite Task



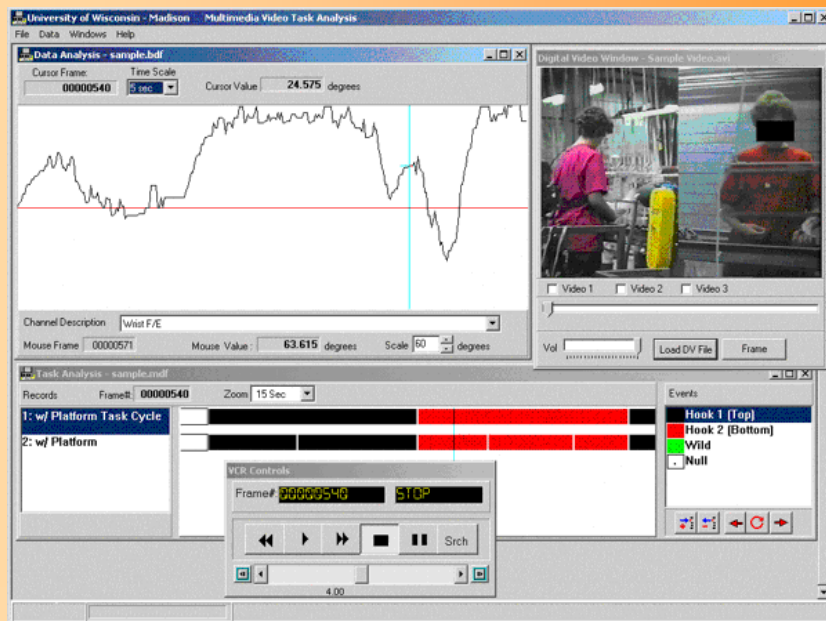
例如：組合、檢測、停滯、...

例如：抓、握、移動、放置、...

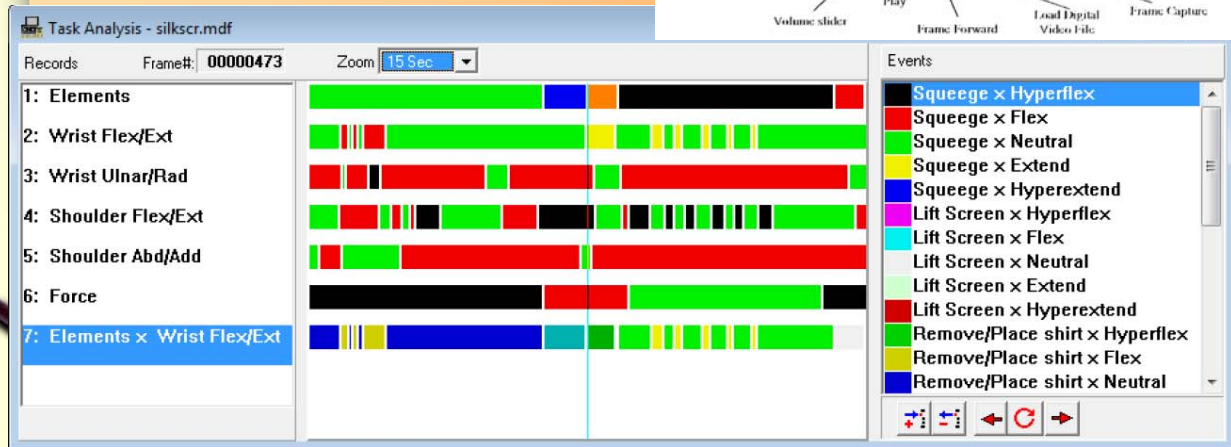
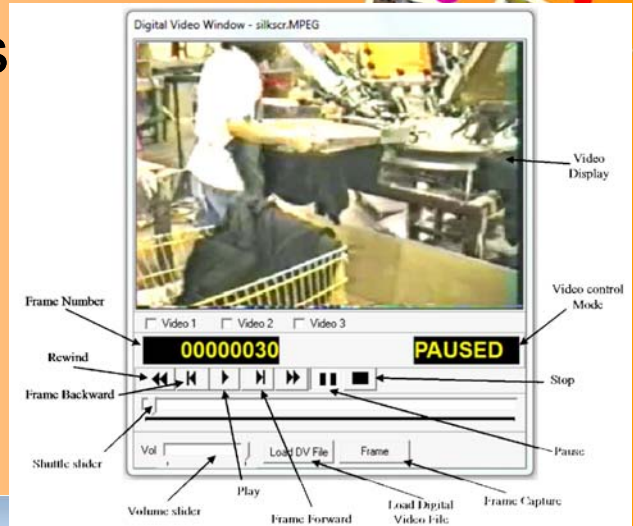
基本動作
：
部位姿勢
：
施力大小



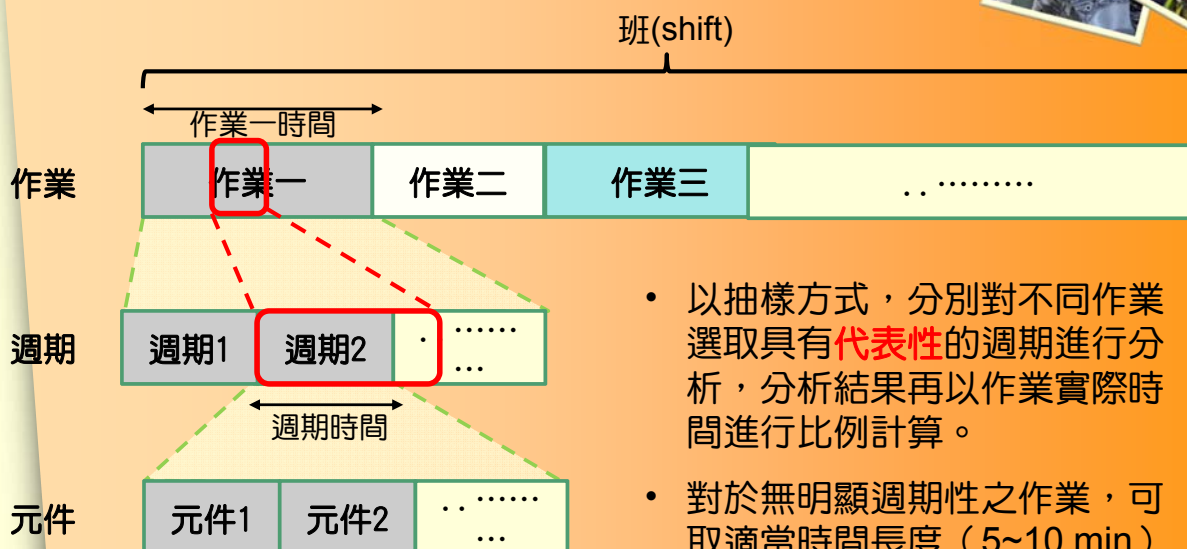
MVTA video analysis software



MVTA video analysis software



Procedure



- 以抽樣方式，分別對不同作業選取具有**代表性**的週期進行分析，分析結果再以作業實際時間進行比例計算。
- 對於無明顯週期性之作業，可取適當時間長度（5~10 min）之具有**代表性**作業進行分析。
- 依據EAWS 各評估表所定義之姿勢、施力方式設定event，逐項進行登錄。

Force Measurement



TAIPEI
TECH



Why measuring force



- Force can't be seen.
- Too many factors can affect hand/finger force:
 - Weight, resistance, reaction force
 - Handles: size, shape, materials
 - Gloves
 - ✓ friction may prevent objects from slipping out of the hand as it opens
 - ✓ stiff or bulky gloves may interfere with closing the fist
 - Mechanical aids: supports, hoists, carts, conveyors, power tools
 - Torque control for threaded fasteners
 - Work pace
 - Quality
 - Maintenance
 - Psychosocial stress



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Force Measurement



Force can't be visualized, therefore, force measurement must be conducted.



Force Measurement



Procedure



- Measure workers' subjective exertions and their maximal exertions, if possible.
- Judge workers' response by your knowledge.
- Validate the magnitude by yourself.



EAWS

Ergonomics Assessment Worksheets



Name of the worksheet



European Assembly Worksheet (V 1.3.2c)			
Plant:	Line	Gender of operator: m <input type="checkbox"/> f <input type="checkbox"/>	Stature:[cm]
Task:		Analyst:	Date:
		Task duration: [sec]	UAS-Analysis:

Ergonomic Assessment Worksheet V1.3.3		
Plant	Gender of operator m <input type="checkbox"/> f <input type="checkbox"/>	Body height
Line	MTM Analysis	Analyst
Task / Workplace	Task duration [sec]	Date



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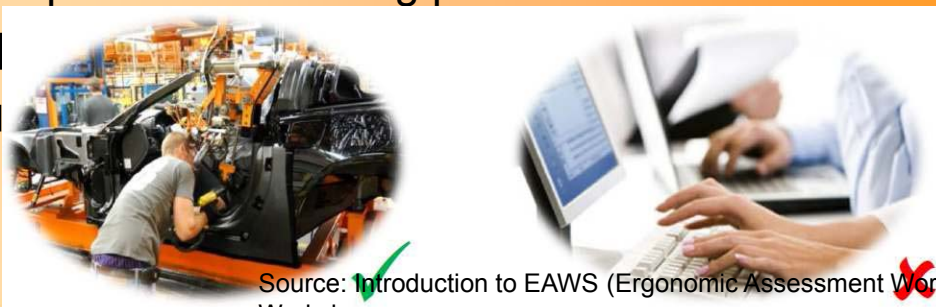
K. Schaub , G. Caragnano, et al. 


Application notes



- Works best for short cycled tasks (cycle time ≤ 5 min)
 - For cycle time above 30 minutes the amount of tasks often exceeds the capabilities of the observer and makes a „pen and paper“-analysis of a certain section impractical
 - No peak loads for long periods

➤ Calli
indu



Source: Introduction to EAWS (Ergonomic Assessment Worksheet) Workshop 
Dipl.-Ing. Torsten Wagner – IAD. 2012



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EAWS Worksheets



header

overall evaluation

additional loads

comments & improvements

time aspects for repetitive loads

European Assembly Worksheet (v1.2.2)

Basic position as well as postures of trunk / arms

Postures	duration of evaluation period for static or high frequency postures (movements of trunk / arms (% seconds, minutes))				posture rating	Postures
	0	1	2	3		
standing	0	0	1	1	2	
1) upright standing & walking slightly bent forward	1	2	4	8	13	
2) slightly bent backward	1	2	4	8	13	
3) leaning the body support for other restrictions see Extra Points	1	2	4	8	13	
4) bent forward (20-30°)	3	7	12	23	43	
5) with torso support	1	2	4	8	13	
6) with torso support	1	2	4	8	13	
7) upright arms at shoulder level	4	10	16	30	55	
8) upright arms above shoulder level	6	14	25	42	75	
9) upright arms above head level	8	19	33	60	100	

Part I

Rating of occupational

Posture = Σ Lines 1 - 13

2D / 3D working postures



EAWS Worksheets



forces

extract from force atlas

manual materials handling

Part II

Part III

Part IV

European Assembly Worksheet (v1.2.2)

Upper limb load in repetitive tasks

Task	static postures (postures)				dynamic postures (postures)				Upper limb
	0	1	2	3	0	1	2	3	
power grip or control grip	1	2	4	8	1	2	4	8	
finger press or shoulder pinch (flat finger or hand)	1	2	4	8	1	2	4	8	
lifting pinch (flat or over the fingers)	1	2	4	8	1	2	4	8	
over 90° flexion of finger or hand	1	2	4	8	1	2	4	8	
light pressure of finger or hand	1	2	4	8	1	2	4	8	
handling of wet loads	1	2	4	8	1	2	4	8	
handling of wet loads with one or more of small muscles (thumb back, thumb to middle with little finger, thumb to middle with index finger)	1	2	4	8	1	2	4	8	
force application on pulling & pushing	1	2	4	8	1	2	4	8	
force application on pulling & pushing (hand / arm posture points)	1	2	4	8	1	2	4	8	

Part IV

Overall evaluation of upper limb loads in repetitive tasks

Posture = Σ Lines 1 - 13

repetitive loads



EAWS lamp system



Whole Body (p1~3)



Upper Limbs (p4)



- Unfavorable posture
- Heavy loads
- Moving heavy loads
- Repetitive tasks

- High frequency (Sorting of goods)
- Strength (Insertion of finger)
- High precision (Using clips)



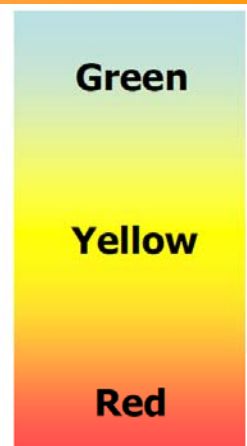
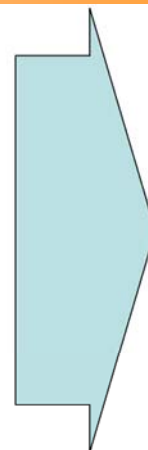
91



Risk Levels



- 1a. Sum up "working postures", "action forces" and "manual materials handling" for total score "WHOLE BODY"
- 1b. Calculate score for "UPPER LIMBS"
2. Assign traffic light color dependent from scores (worst case of "whole body" or "upper limbs")



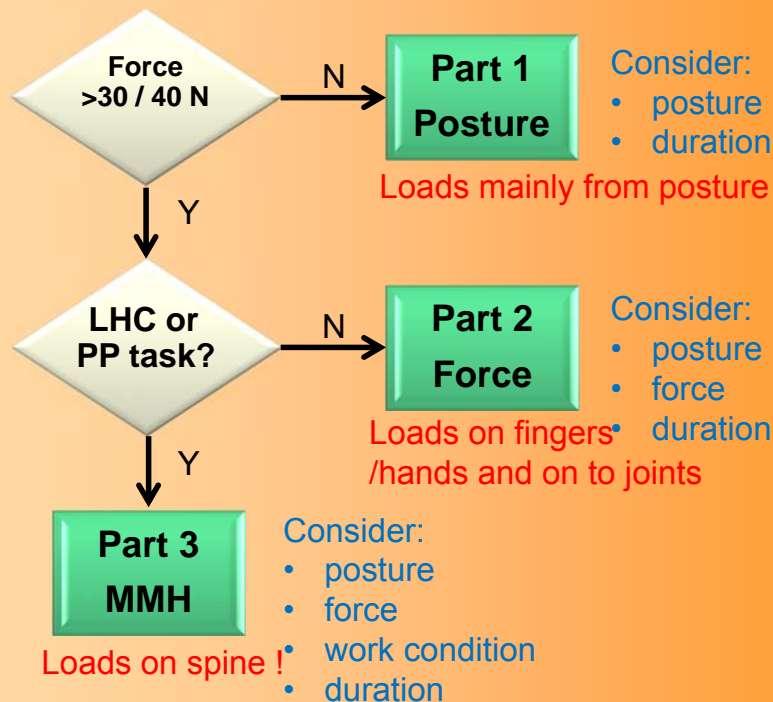
Result of overall evaluation:

	WHOLE BODY	=	Postures	+	Forces	+	Manual handling	+	Extra	UPPER LIMBS
		=		+		+		+		
EAWS evaluation	0-25 Points	green	Low risk: - recommended; no action is needed							
	26-50 Points	yellow	Possible risk: - not recommended; redesign if possible, otherwise take other measures to control the risk							
	>50 Points	red	High risk: - to be avoided; action to lower the risk is necessary							

92



Assessment Procedure



93



Example 1: 油漆作業

A painter's tasks in a work shift:

- **Paint ceiling (2.5 hrs)**
 - standing(6), 1.4 hrs (84 min)
 - standing(2), 1.1 hrs (66 min)
- **Paint wall (3.5 hrs)**
 - standing(2), 1 hr (60 min)
 - standing(3) bend forward, 0.8 hr (48 min)
 - standing(5) elbow at shoulder level, 0.7 hr (42 min)
 - Crouching(12), 0.5 hr (30 min)
 - Crouching(13) bend forward, 0.5 hr
- **Break (sitting, 2 hrs)**



94



Basic Positions / Postures and movements of trunk and arms (per shift)												Postures																	
(incl. loads of <3 kg, forces onto fingers of <30 N and whole body forces of <40 N) Static postures: ≥ 4sec High frequency movements: Trunk bendings (> 60°) ≥ 2/min Kneeling/crouching ≥ 2/min Arm liftings (> 60°) ≥ 10/min												Evaluation of static postures and/or high frequent movements of trunk/arms/legs										Asymmetry effects							
												Duration [sec/min] = $\frac{\text{duration of posture(s)} \times 60}{\text{cycle time}}$										Trunk Rotation 1)		Lateral Bending 1)		Far Reach 2)			
												int 0-5		dur 0-3		int 0-5		dur 0-3		int 0-5		dur 0-2							
												Intensity x Duration		Intensity x Duration		Intensity x Duration		Intensity x Duration		Intensity x Duration									
												[sec/min]		[min/8h]															
												5	7,5	10	15	20	27	33	50	67	83								
												3	4,5	6	9	12	16	20	30	40	50								
												24	36	48	72	96	130	160	240	320	400								
Standing (and walking)																													
1		Standing & walking in alteration, standing with support	0	0	0	0	0,5	1	1	1	1,5	2																	
2		Standing, no body support (for other restrict. see Extra Points)	0,7	1	1,5	2	3	4	6	8	11	13	4																
3		Bent forward (20-60°) with suitable support	2	3	5	7	9,5	12	18	23	32	40	5																
4		Strongly bent forward (>60°) with suitable support	3,3	5	8,5	12	17	21	30	38	51	63																	
5		Upright with elbow at / above shoulder level	3,3	5	8,5	12	17	21	30	38	51	63	7																
6		Upright with hands above head level	5,3	8	14	19	26	33	47	60	80	100	22.5																
Sitting																													
7		Upright with back support slightly bent forward or backward	0	0	0	0	0	0,5	1	1,5	2	0																	
Kneeling or crouching																													
12		Upright	3,3	5	7	9	12	15	21	27	36	45	4.1																
13		Bent forward	4	6	10	14	20	25	35	45	60	75	5																
14		Elbow at / above shoulder level	6	9	16	23	33	43	62	80	108	135																	
Postures = ∑ lines 1 - 16			47.7 (a)										+	(b)	=														

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Example 2: 花園搬土

推斗車、傾倒、耙平、回程

1.5噸/日、5公斤/鏟、10鏟/車、30車/日、2公里



96



Example 2

Manual Material Handling (per shift)												
Weights of loads [kg] for repositioning (lifting / lowering), carrying and holding as well as												
Reposition, carrying & holding	Males	3	10	15	20	25						
	Females	2	5	7	10	12						
Load points		1	1.5	2	3	4						
+ Pushing and pulling	Males	Barrows			<40	75	100	115	135	195		
	Females	Carriage, roller, trolleys			<40	75	100	150	250	350	550	
	Males	No fixed rollers			<40	60	80	115	195	270	425	
	Females	Carts, roller tables, carriages. Fixed rollers			<40	75	150	250	350	500	600	800
Load points				0.5	1	1.5	2	3	4	5	6	8
Posture, position of load (select characteristic posture)												
+ trunk upright and / or not twisted load at the body	little trunk bending or twisting; load at or close to the body			bending trunk deep or far forward; little trunk bending forward and trunk twisting simultaneously; load far from body or above shoulder level			bending trunk far forward and twisting; load far from the body; limited postural stability while standing; crouching or kneeling					
	Posture points	1	2	4	6	8						
Working Conditions (pushing and pulling only)												
(+)	very low rolling resistance	trolley pushing / pulling on (very) slick floor	rough floor and above small gaps / edges	on structured sheet metal, into / out of a track	trolleys have to be teared off when starting on rough and aged floor	very high rolling resistance						
Conditions points	0	1	3	5	8							
Frequency of load manipulations [# / shift], holding time [min] or travel distance [meter / shift]												
x	Frequency of repositionings / pushing & pulling short	5	25	120	300	750	1000	1500	2000	2500	3000	
	Duration (holding time) [min]	2.5	10	37	90	180	≥240					
	Distance (carrying, pushing & pulling long) [m]	300	650	2000	6000	12000	≥16000					
#, duration or distance points	1	2	4	6	8	10	11	13	14	15		
Manual Material Handling (result)												
19	(Load + posture + (condition points)) x (#, duration or distance points)	1.1	6			1	2	3				
	Repositioning	5.6	40			3.5	21					
97	Handling = ∑ line 19	1) Maximal cumulative time points for all tasks of repositioning, holding, carrying as well as pushing & pulling all together = 15						61				

Example 3: 布匹推送作業



- A式推車裝載 > 300kg
- 染布作業一天染8批次，每一批次可染洗4車A，A車布料經過染洗後可產出8台B車
- A車推送距離約15公尺(總距離480 m)，B車約25公尺(總距離1550 m)。
- 推送B式推車時所需施力大小約為A式推車之2.5~3倍

- B式推車裝載約800kg





Example 3 KIM - PP檢核表



KIM 風險等級評估		評級點數	
		A	B
負載重量	定向輪軌道車300 / 800 kg	3	5
定位準確度與速度	低、慢 (<0.8 m/s) 受限制 (地面濕滑)	1	1
姿勢	軀幹前彎或彎腰	3	3
工作狀況	地面濕滑	1	1
時間評級	總距離480 / 1550 m	2	4
A風險值：(3 + 1 + 3 + 1) x 2 = 16		➡ ?	
B風險值：(5 + 1 + 3 + 1) x 4 = 40			

- B式推車約800kg，推送距離約25公尺
- 染布作業一天染8批次，每一批次可染洗4車A，A車布料經過染洗後可產出8台B車

Example 3



Manual Material Handling (per shift)											Loads				
Weights of loads [kg] for repositioning (lifting / lowering), carrying and holding as well as pushing and pulling															
+	Reposition, carrying & holding	Males	3	10	15	20	25	30	35	40	>40				
	Females	2	5	7	10	12	15	20	25	>25					
+	Load points		1	1.5	2	3	4	5.5	7	8.5	25				
	Pushing and pulling	Males	Barrows		<50	75	100	150	200	250					
		Females	Barrows		<40	60	80	115	155	195					
	Males	Carriage, roller, trolleys		<50	75	100	150	250	350	550					
	Females	No fixed rollers		<40	60	80	115	195	270	425					
	Males	Carts, roller tables, carriages. Fixed rollers		<50	75	150	250	350	500	600	800	1250			
Females	Carts, roller tables, carriages. Fixed rollers		<40	60	115	195	270	385	460	615	960				
+	Load points	Means of transport		0.5	1	1.5	2	2.5	3	4	5	6	8		
Posture, position of load (select characteristic posture)															
+															
	trunk upright and / or not twisted load at the body	little trunk bending or twisting; load at or close to the body			bending trunk deep or far forward; little trunk bending forward and trunk twisting simultaneously; load far from body or above shoulder level				bending trunk far forward and twisting; load far from the body; limited postural stability while standing; crouching or kneeling						
+	Posture points	1	2	3	4	5	6	7	8						
Working Conditions (pushing and pulling only)															
(+)	very low rolling resistance	trolley pushing / pulling on (very) slick floor	rough floor and above small gaps / edges	on structured sheet metal, into / out of a track	trolleys have to be teared off when starting, strongly damaged floor	very high rolling resistance									
+	Conditions points	1	2	3	4	5	6	7	8						
Frequency of load manipulations [# / shift], holding time [min] or travel distance [meter / shift]															
x	Frequency of repositionings / pushing & pulling short	5	25	120	350	750	1000	1500	2000	2500	3000				
	Duration (holding time) [min]	2.5	10	37	90	180	≥240								
	Distance (carrying, pushing & pulling long) [m]	300	1500	2500	6000	12000	≥16000								
+	#, duration or distance points	1	2	3	4	6	8	10	11	13	14	15			
Manual Material Handling (result)															
19	(Load + posture + condition points) x (#, duration or distance points)	Repositioning (1)	() + ()	Holding (1)	() + ()	Carrying (1)	() + ()	Pushing & Pulling short (1)	(2.5 + 3 + 1)	Pushing & Pulling long (1)	(6 + 3 + 1)				
		x	=	x	=	x	=	x	1.5	=	10	x	3	=	30
10	Handling = ∑ line 19	1) Maximal cumulative time points for all tasks of repositioning, holding, carrying as well as pushing & pulling all together = 15							=	40					

Example 4: Coil Packing



Push / Pull



- 推動鋼捲，將鋼捲安置於打包機，並將打包完畢之鋼捲推至定位以便進行固定及網綁。
- 彎腰行走，推動距離平均約7m/次，每日約500~700 m。8% (0.7 hr)
- 鋼捲重量300~1000 kg，平均約570 kg。

Posture (<40N)



- 從事吊掛、理貨、取物、設備控制等作業。47% (4 hr)
- 直立站姿，低施力
- 用餐休息，坐姿，12% (1 hr)

- 彎腰站姿/蹲跪姿，進行鋼捲固定及網綁。33% (2.8hr/168min)
- 彎腰站姿：96 min
- 蹲跪姿：72 min

10
1

TAIPEI
TECH

Example 4



Force (>40N)



- 彎腰站姿，使用工具及鉗子進行鋼捲固定及網綁作業。
- 高施力，彎腰站姿。
- 估計每日操作>60次，每次操作網綁工具單手及雙手需分別反覆拉/壓10次，手部所需最大下壓/拉力達300N。

10
2

TAIPEI
TECH

Ergonomic Assessment Worksheet V1.3.4

Basic Positions / Postures and movements of trunk and arms (per shift)										Postures																			
(incl. loads of <3 kg, forces onto fingers of <30 N and whole body forces of <40 N) Static postures: ≥ 4sec High frequency movements: Trunk bendings (> 60°) ≥ 2/min Kneeling/crouching ≥ 2/min Arm liftings (> 80°) ≥ 10/min										Evaluation of static postures and/or high frequent movements of trunk/arms/legs										Asymmetry effects									
										Duration (sec/min) = duration of posture(s) × 60 / cycle time										Sum of lines									
Standing (and walking)										Kneeling or crouching										Sitting									
Lying or climbing										Trunk										Far Reach									
1 Standing & walking in alteration, standing with support										12 Upright										7 Upright									
2 Standing, no body support (for other restrict. see Extra Points)										13 Bent forward										8 Bent forward									
3 Bent forward (20-60°) with suitable support										14 Elbow at / above shoulder level										9 Elbow at / above shoulder level									
4 Strongly bent forward (>60°) with suitable support										15 (Lying on back, breast or side) arms above head										10 Climbing									
5 Upright with elbow at / above shoulder level										16 Climbing										11 Climbing									
6 Upright with hands above head level										17 Climbing										12 Climbing									
7 Upright with back support slightly bent forward or backward										18 Climbing										13 Climbing									
8 Upright no back support (for other restrict. see Extra Points)										19 Climbing										14 Climbing									
9 Bent forward										20 Climbing										15 Climbing									
10 Elbow at / above shoulder level										21 Climbing										16 Climbing									
11 Hands above head level										22 Climbing										17 Climbing									
1) slightly $\le 10^\circ$ 2) medium 15° 3) strongly 25° 4) extreme >30°										1) never 2) 4 sec 3) 10 sec 4) 13 sec										1) never 2) 4 sec 3) 10 sec 4) 13 sec									
Attention: Max. duration of evaluation = duration of task or 100%! Attention: correct evaluation, if duration of evaluation ≠ 60s										Attention: Max. duration of evaluation = duration of task or 100%! Attention: correct evaluation, if duration of evaluation ≠ 60s										Attention: Max. duration of evaluation = duration of task or 100%! Attention: correct evaluation, if duration of evaluation ≠ 60s									
Postures = Σ lines 1 - 16										31.5 (a)										0 (b)									
Total										31.5										0									

- 從事吊掛、理貨、取物、設備控制等作業。47% (4 hr)
- 彎腰站姿/蹲跪姿，進行鋼捲固定及網綁。33% (2.8hr/168min)
- 彎腰站姿：96 min
- 蹲跪姿：72 min

10
3

若以每日網綁80次(條)估計，每次操作固定器及固定鉗各有1次>300N之施力，故平均高施力之頻率為每分鐘1/3次(80*2次/480 min = 1/3)，時間乘數以內差法為0.33。

Assessment Worksheet V1.3.4

Forces									
Intensity x time									
18 Forces onto arms / whole body forces									
P15 for planning & P40 for analysis P15 P40 P15 P40 P15 P40 P15 P40									
Finger forces F _{max} (neutral to gender) Posture A1 (power grip, pliers: ow 70%) Posture A2 (ball of the thumb) Posture B1 (thumb or thumb to 4 fingers) Posture B2 (index or wide pinch) Posture C (hook, palmar, strong pinch)									
Action forces = Σ lines 17 - 18 Attention: correct evaluation, if duration of evaluation ≠ 60s									
17									

10
4



- 推動鋼捲，將鋼捲安置於打包機，並將打包完畢之鋼捲推至定位以便進行固定及網綁。
- 彎腰行走，推動距離平均約7m/次，每日約500~700 m。8% (0.7 hr)
- 鋼捲重量 300~1000 kg，平均約570 kg。



Per shift)										Loads		
ing (lifting / lowering), carrying and holding as well as pushing and pulling												
3	10	15	20	25	30	35	40	>40				
2	5	7	10	12	15	20	25	>25				
1	1,5	2	3	4	5,5	7	8,5	25				
	Barrows	<50	75	100	150	200	250					
	Carrriage, roller, trolleys	<40	60	80	115	155	195					
	No fixed rollers	<40	60	80	115	195	270	425				
	Carts, roller tables, carriages, Fixed rollers	<50	75	150	250	350	500	600	800	1250		
	Means of transport	<40	60	115	195	270	385	460	615	960		
		0,5	1	1,5	2	3	4	5	6	8		
Characteristic posture)												
	trunk upright and / or not twisted load at the body	little trunk bending or twisting; load at or close to the body	bending trunk deep or far forward; little trunk bending forward and trunk twisting simultaneously; load far from body or above shoulder level	bending trunk far forward and twisting; load far from the body; limited postural stability while standing; crouching or kneeling								
	Posture points	1	2	4	8							
Working Conditions (pushing and pulling only)												
(+)	very low rolling resistance	trolley pushing / pulling on (very) slick floor	rough floor and above small gaps / edges	on structured sheet metal, into / out of a track	trolleys have to be teared off when starting, strongly damaged floor					very high rolling resistance		
	Conditions points	0	1	2	3	5	6	8				
Frequency of load manipulations [# / shift], holding time [min] or travel distance [meter/shift]												
	Frequency of repositionings / pushing & pulling short	5	25	120	350	750	1000	1500	2000	2500	3000	
	Duration (holding time) [min]	2,5	10	37	90	180	>240					
x	Distance (carrying, pushing & pulling long) [m]	300	650	2500	6000	12000	>16000					
	#, duration or distance points	1	2	4	6	8	10	11	13	14	15	
Manual Material Handling (result)												
19	(Load + posture + (condition points)) x (#, duration or distance points)	()	()	()	()	()	()	()	()	()	()	
	Repositioning (1)											
	Holding (1)											
	Carrying (1)											
	Pushing & Pulling short (1)											
	Pushing & Pulling long (1)											
								5	2	2		
								2		18		
	Handling = Σ line 19	1) Maximal cumulative time points for all tasks of repositioning, holding, carrying as well as pushing & pulling all together = 15									18	

10
5



Example 4: Coil Packaging



Result of overall evaluation:

Calculate the total score of the whole body sections and compare it to the upper limbs score. The overall result is determined by the higher value but interpretation should also take into account the second value.

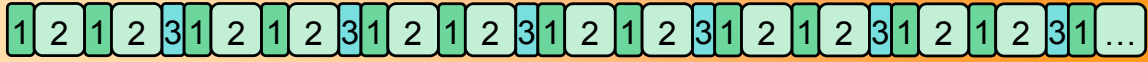
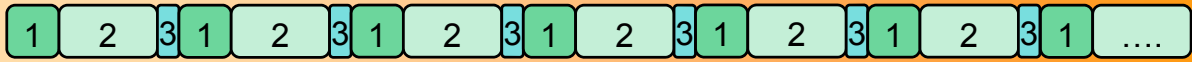
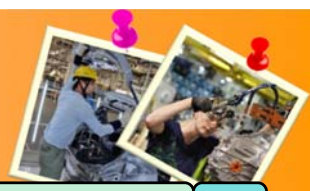
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<input type="checkbox"/> Yellow	66.5	=	31.5	+	17	+	18	+	0	
<input type="checkbox"/> Red										

EAWS evaluation	0-25 Points	Green	Low risk: recommended; no action is needed
	>25-50 Points	Yellow	Possible risk: not recommended; redesign if possible, otherwise take other measures to control the risk
	>50 Points	Red	High risk: to be avoided; action to lower the risk is necessary

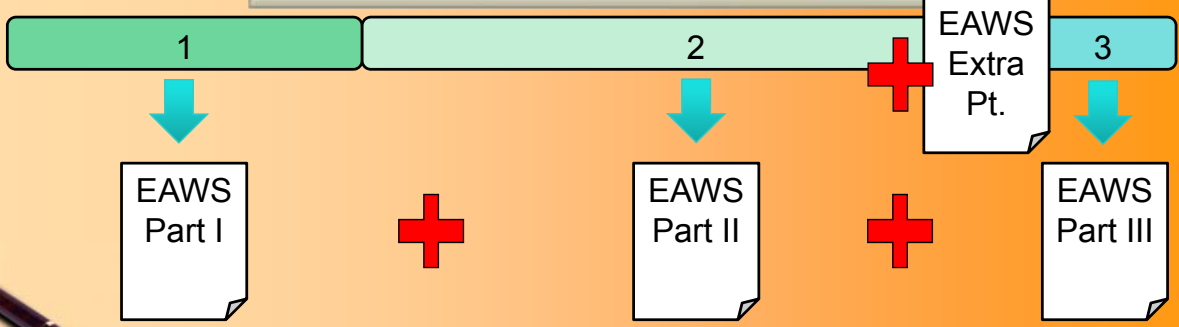
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Summary (Part 1~3)



Question: Can each part be applied individually?



10
7



Thank you!

