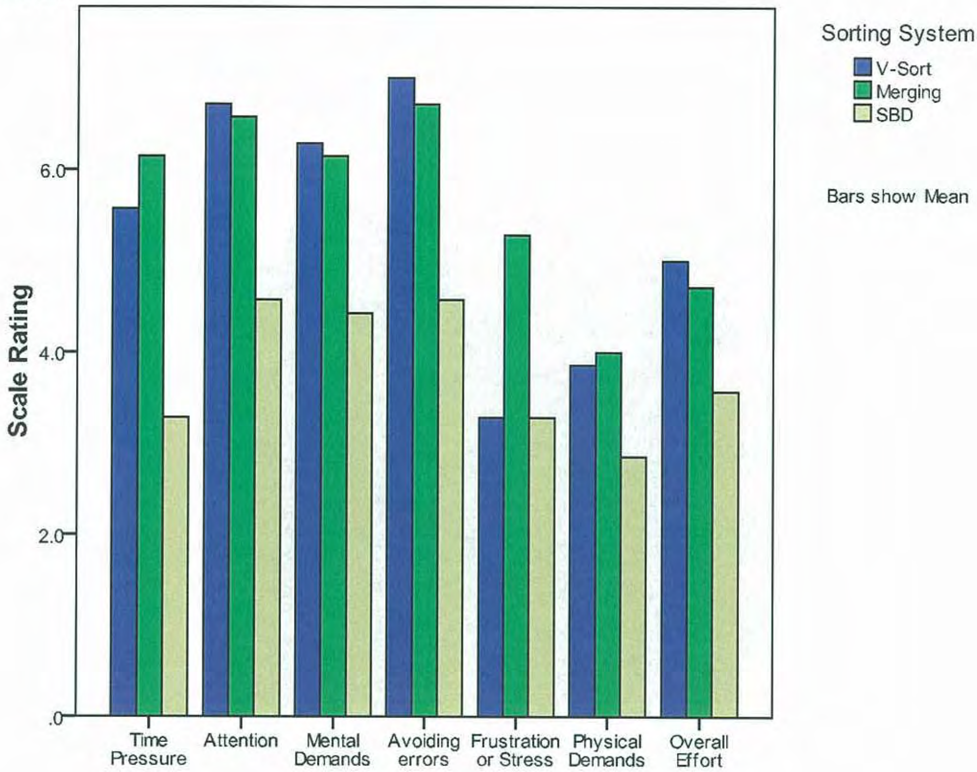
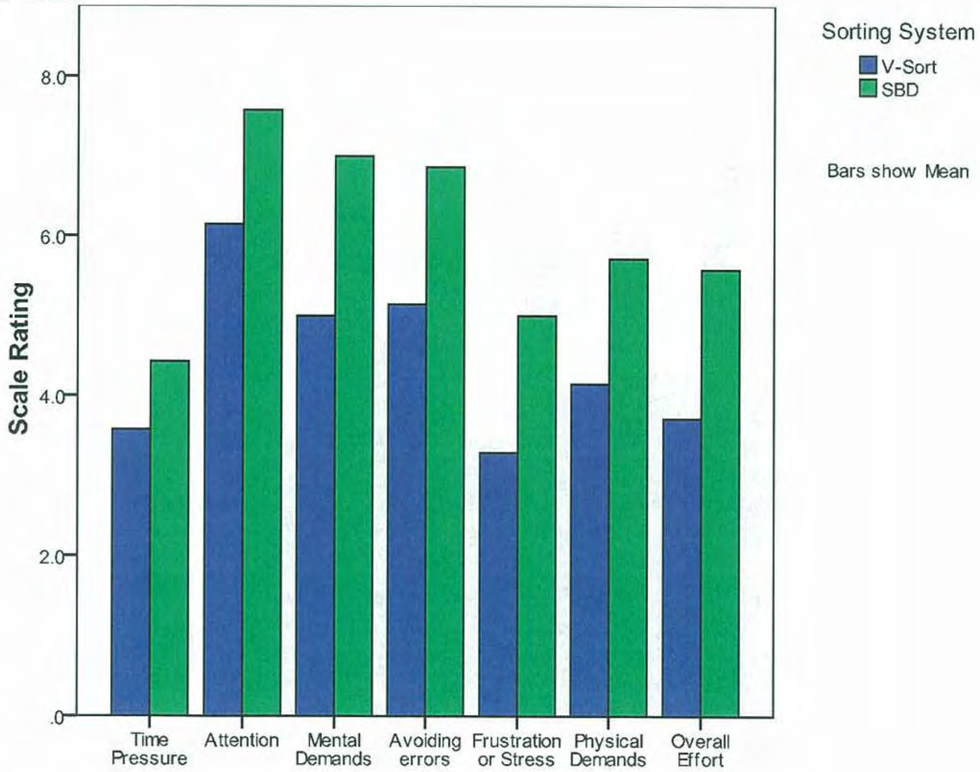
SEVEN HILLS

Indoor work

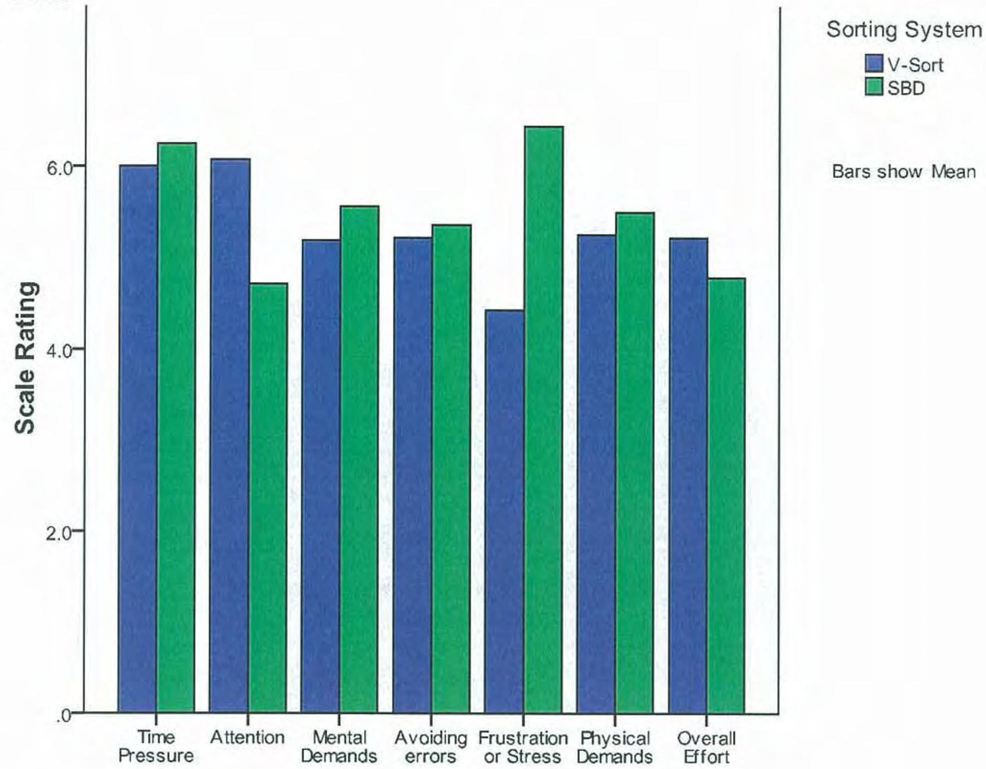


Outdoor work

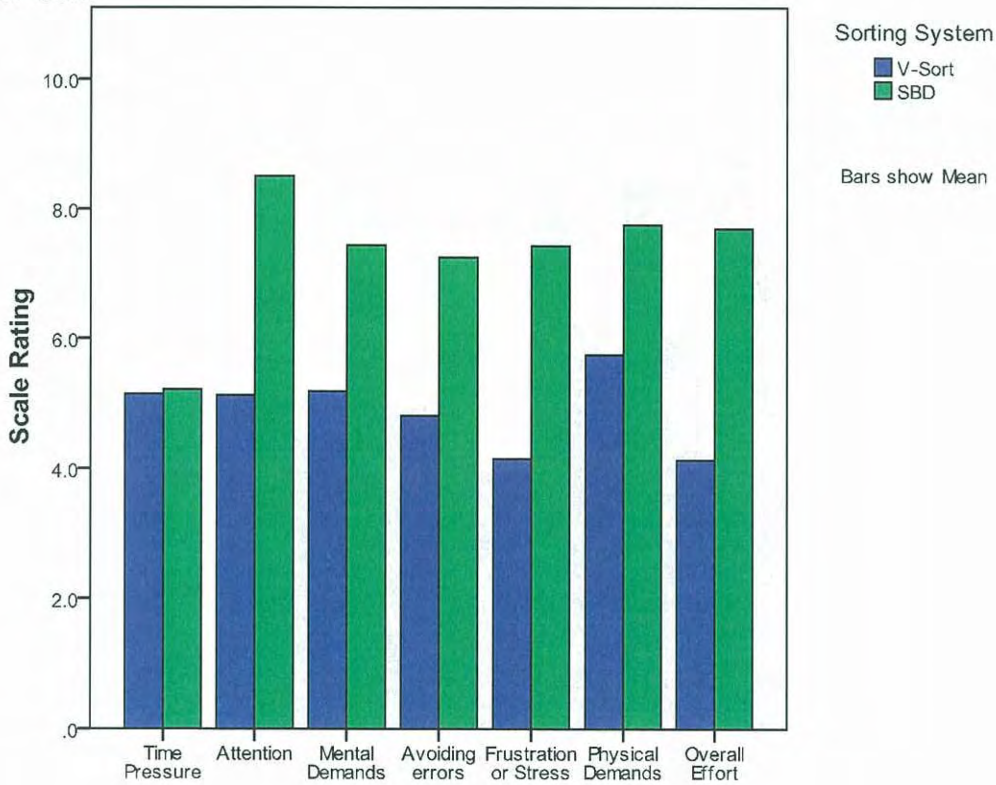


LAKEMBA

Indoor work

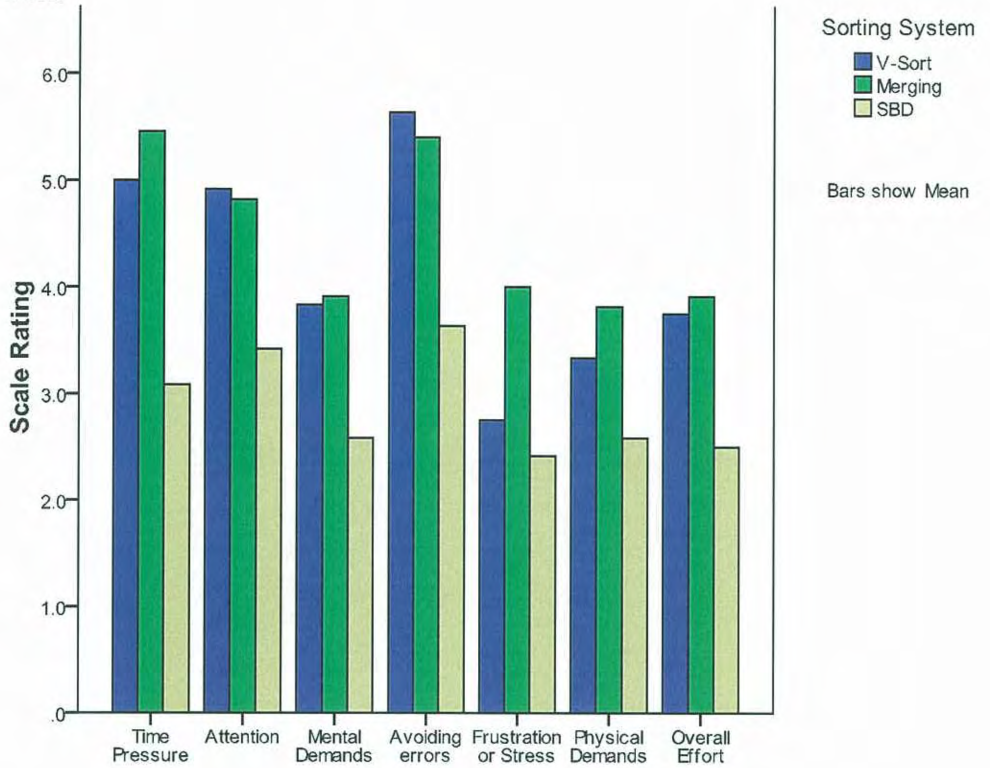


Outdoor work

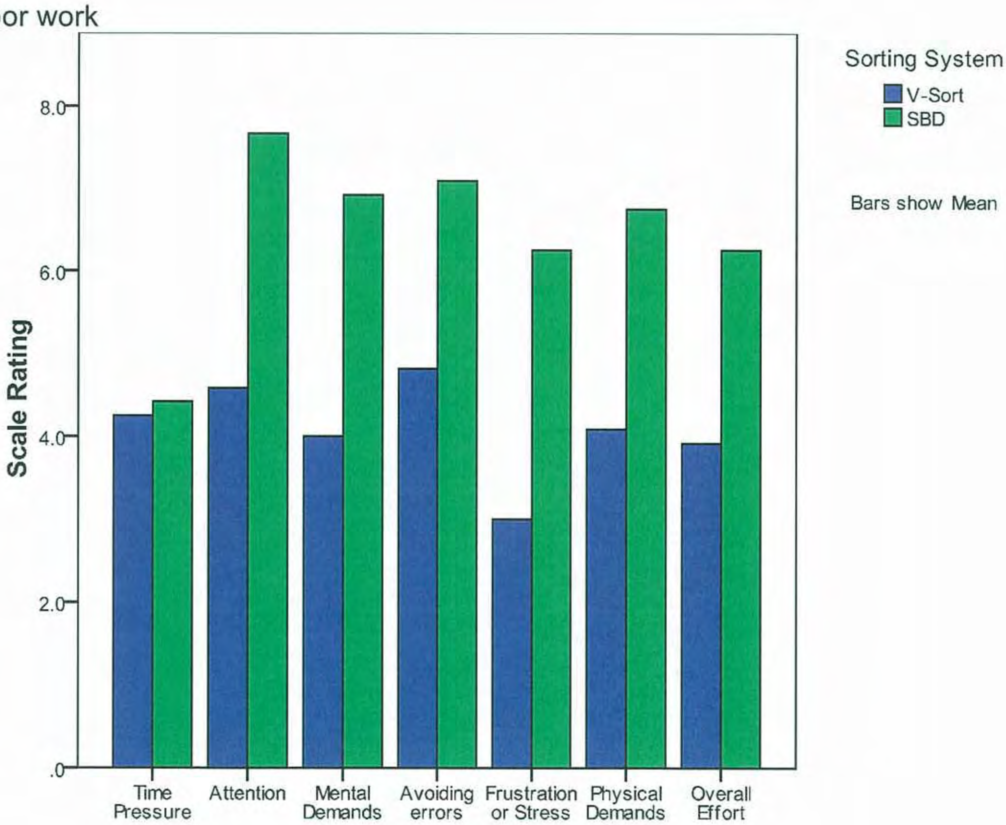


MOUNT WAVERLEY

Indoor work

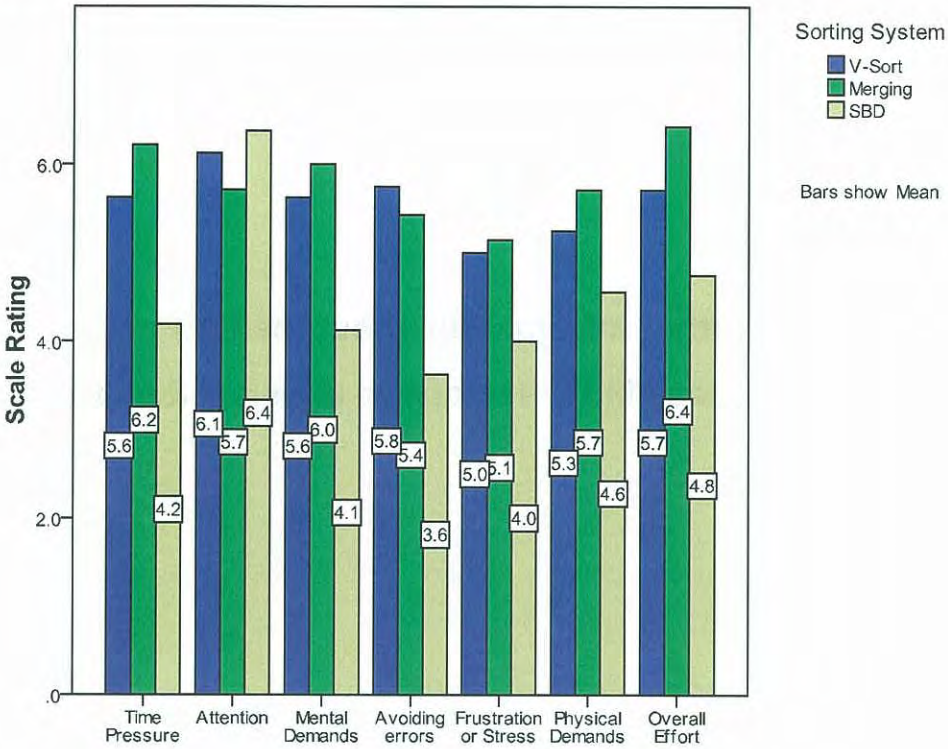


Outdoor work

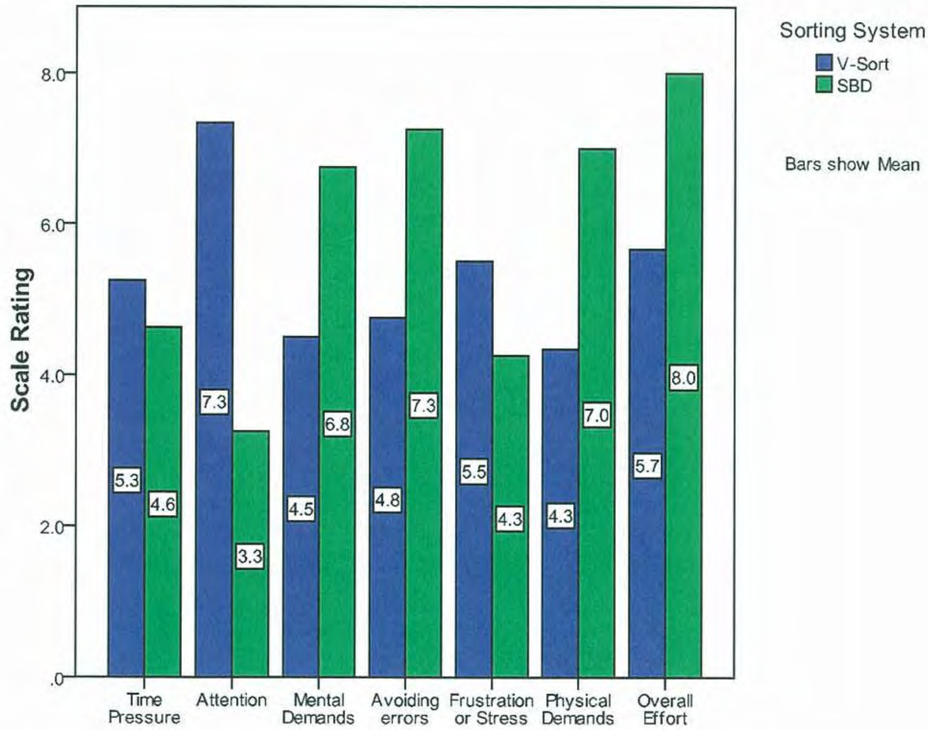


HEATHWOOD

Indoor work



Outdoor work



APPENDIX D. Further information about the four main methods used to assess MSD risk due to physical demands

RULA (Rapid Upper Limb Assessment)

RULA is a screening tool designed to identify postures at workstations that may present risk to the worker. The analysis process involves coding and giving various weights to postures of the upper arm, lower arm, wrist, neck, trunk and legs. Additional factors (force and muscle use) are then added. A consolidated score is arrived at from a cross-tabulation of these sub-scores.

RULA requires the analyst to first identify either the most extreme posture adopted, or the posture adopted for the longest duration. Because the activities of delivery (to a single point) and replenishment of the FLC are of short duration, the extreme postures were adopted in this analysis. The three postures analysed were selecting mail for delivery, placing mail in the letterbox, and, reaching into the pannier for a new mail bundle.

Selecting – Selecting mail for delivery

Placing – Placing mail in letterbox

Reaching – Reaching into pannier for a bundle of mail

RULA analyses were undertaken based on observations of three subjects for these three activities.

Number of Analyses

	Subject 1	Subject 2	Subject 3
Selecting	1	1	1
Placing See Note	3	2	3
Reaching	1	1	1

Note: While Selecting and Reaching postures were very consistent, Placing postures varied with location of letterbox.

RULA rates postures on the following scale:

Score	Interpretation
1-2	Acceptable
3-4	Investigate further
5-6	Investigate further and change soon
7+	Investigate and change immediately

Action Categories of Observed Postures

Posture	**Score** (range)	**Interpretation**
Selecting	3-4	Investigate further
Placing	4-6	Investigate further and change soon (mostly)
Reaching	5-6	Investigate further and change soon

Note:

1. High scores for Delivery were associated with very high or low letterboxes, and letterboxes not on the boundary requiring extended reach. Optimally placed letterboxes resulted in lowest scores.

The situations giving rise to the highest scores for delivery are infrequent (though it would be desirable to reduce these by encouragement of PDO-friendly placement of letterboxes). The postures associated with replenishments are a product of the design of the workstation (cycle and panniers) and stature of the PDO.

OCRA Checklist

OCRA is used for rating the hazardousness of tasks involving repetitive actions of the hands and arms.

OCRA Checklist is a composite score incorporating sub-scores for work-rest pattern arm activity and working frequency presence of activities involving the use of force, presence of awkward postures in the upper limbs, and presence of other additional factors which influence risk[31]. The final score for an activity is the sum of these sub-scores. The final score for a job, is the time-weighted average of the scores for the activities which comprise the job.

OCRA Checklist analyses were undertaken for

- delivery (at a domestic point, subject remaining on the motorcycle).
- replenishing the FLC from the pannier(s).
- riding (during the delivery round)
- 'dead' riding (to and from the delivery round).

OCRA scores for the individual activities were:

	OCRA checklist score
'Dead' riding	11.5
Riding	13.5
Delivery	8
Replenishment	10

Time-weighted average scores were arrived at using the following data:

	Duration (current)	Duration (SBD)
Total outdoor time	270min	296.5min[c]
Riding to/from round	30min	30min
Riding round	154.8min[a]	154.8min[b]
Delivery	80min	104min
Replenishment	5.15min	7.7min

Notes:

a – 270-30-80-5.15min

b. – same as for "current" delivery

c – 30+154.8+104+7.7

OCRA (TWA) = Sum($OCRA_{Activity\ 1}$ * Time $Proportion_{Activity\ 1}$ + $OCRA_{Activity\ 2}$ * Time $Proportion_{Activity\ 2}$ + …)

The time-weighted averaged OCRA Checklist scores for the two methods of delivery are:

Current (Traditional) delivery	11.58
SBD	11.28

Note - SBD round duration was 296.5min (versus 270 for Current delivery).

[31] Additional factors known to increase musculoskeletal risk include: inadequate gloves, impact force, cold, use of vibrating tools, precision tasks, paced work.

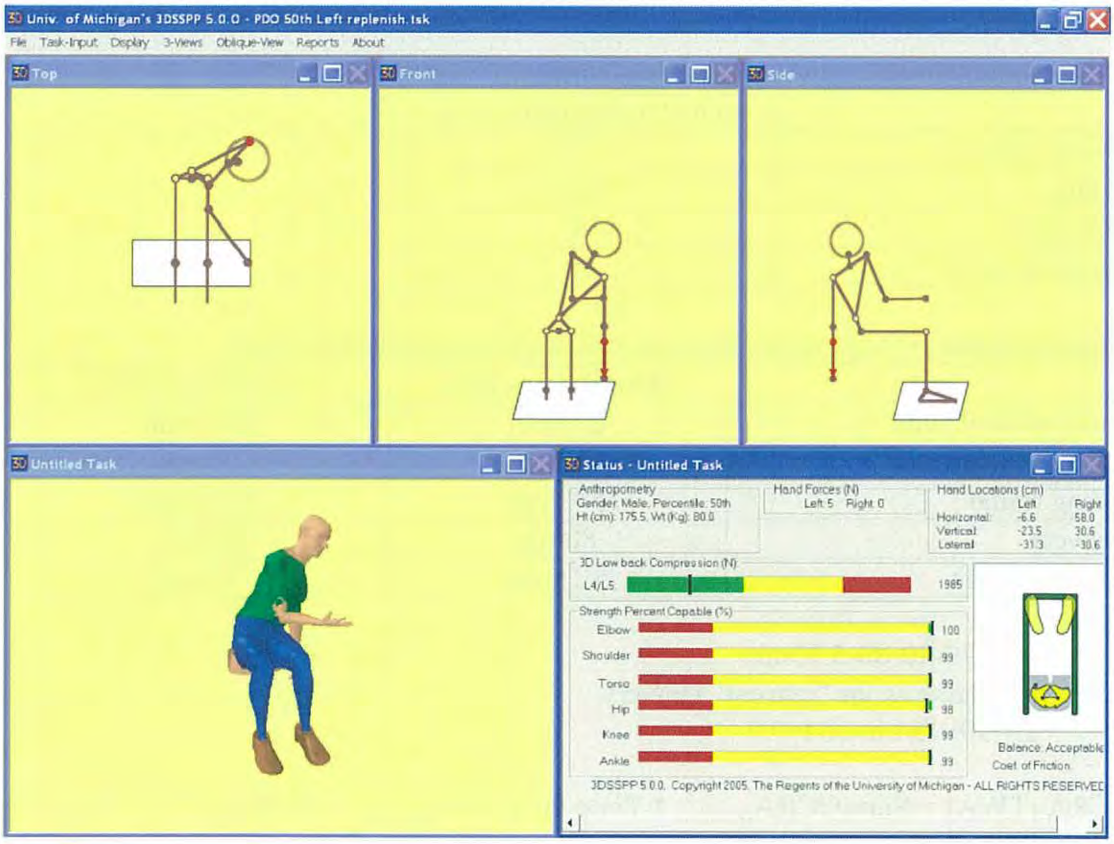
3D Static Strength Prediction Program (3D SSPP)

The 3DSSPP uses a biomechanical model to predict muscle forces required (in terms of the percentage of the population capable of an exertion) and joint forces experienced (in particular in the low-back.

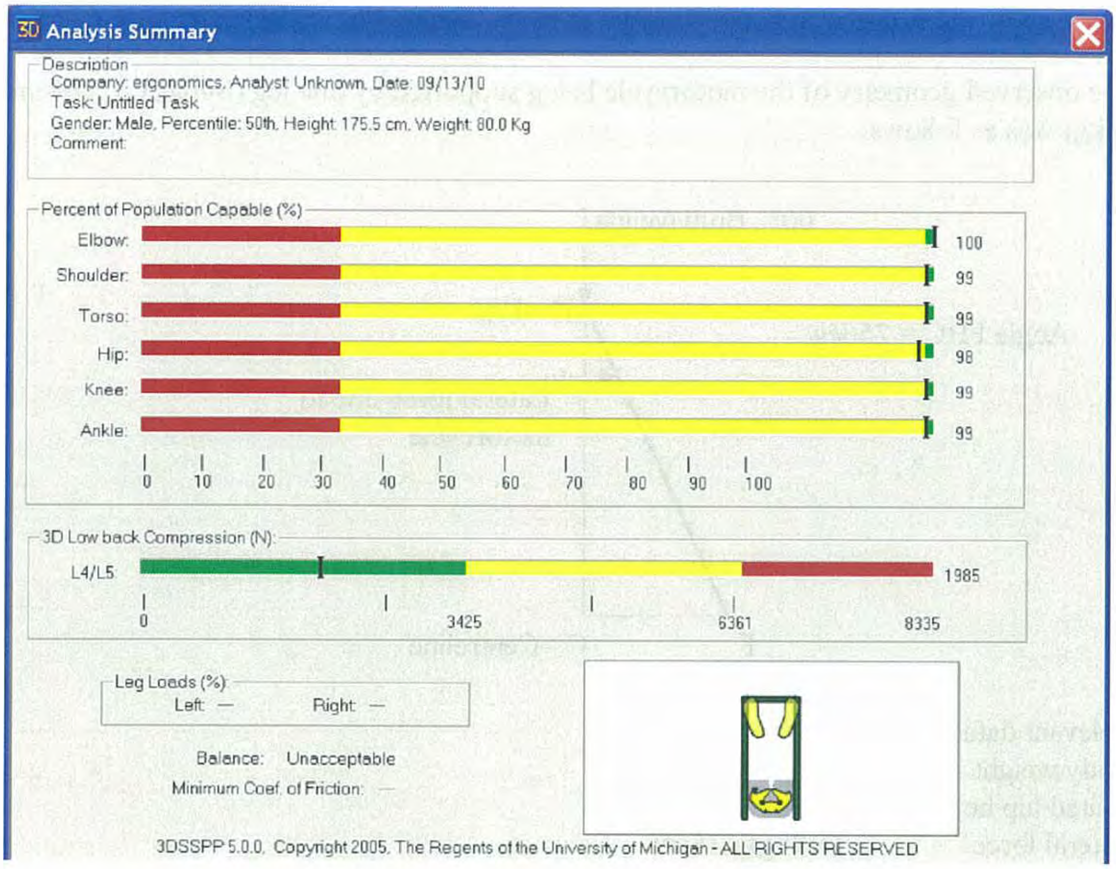
The 3DSSPP was seen as a potentially useful tool to evaluate the extreme posture of reaching into the pannier to retrieve a bundle of mail to replenish the FLC. This is a somewhat different application from those for which it was designed, since, while the posture is unusual, the load is quite small.

Modelling is for a 50%ile male – approximating our Subject 2.

The graphic from the model is shown below with the subject leaning into the left pannier.



The summary report is shown below.

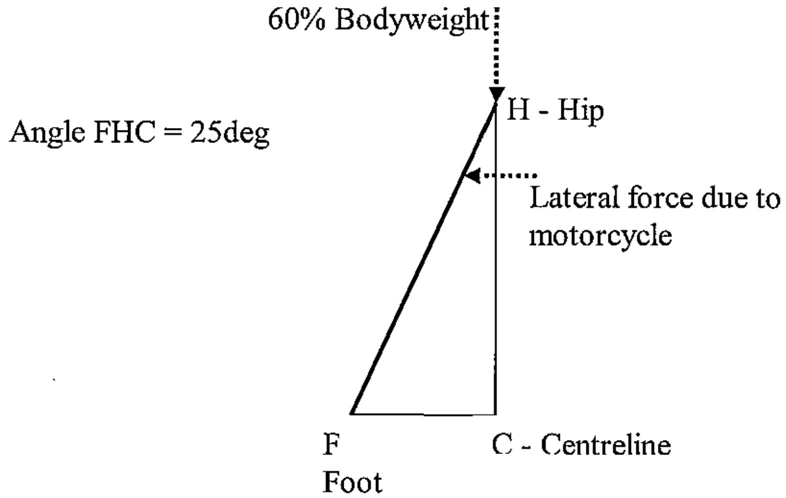


The report summary shows low joint force in the low-back (well within the "green" zone established by the US NIOSH). Muscular forces are shown to be in the range where at least 98% of the (US) male population would be capable.

Because of the origins of this model (it was designed for lifting), it reports the muscle efforts required, and the back compression forces since these are implicated in injuries in that type of activity.

Biomechanical Analysis

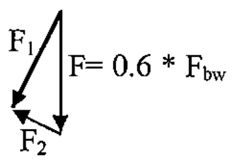
The observed geometry of the motorcycle being supported by one leg (Subject 3, 169cm, 76kg) was as follows:



Relevant data:

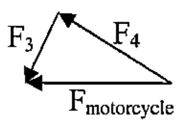
Body weight - F_{bw}	76kg= 745N
Seated hip height	0.85m
Lateral force	15.7kgf= 154N
Lateral force point of application	
	0.10m from hip

Body weight force can be resolved into force along the line of the leg (F_1), and force perpendicular to the leg (F_2):



$F_1 = F_{bw} * 0.6 * \cos(25) = 745 * 0.6 * 0.90 = 405.12N$
$F_2 = F_{bw} * 0.6 * \sin(25) = 745 * 0.6 * 0.42 = 188.91N$

Similarly, the lateral force of the motorcycle on the leg may be resolved into two components, one along the line of the leg (F_3), and one perpendicular to the leg (F_4):



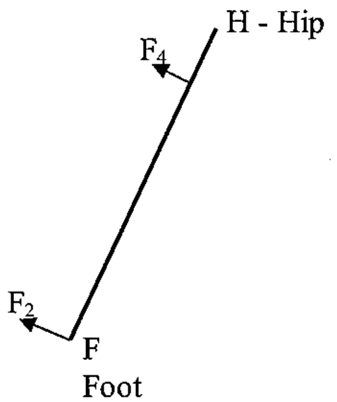
$F_3 = F_{motorcycle} * \sin(25) = 154 * 0.42 = 64.7N$

$F_4 = F_{motorcycle} * \cos(25) = 154 * 0.90 = 135.9N$

So, load carried through the leg = $F_1 + F_3 = 405.12 + 64.7 = 469.8N$ By comparison, half the body weight carried through one leg in normal upright two-legged stance is 745/2 = 372.5N The increase over the force supported by the leg in normal two-legged stance is 26%

In addition, the force component acting perpendicularly to the leg (equations ii and iv above) tends to force the leg outwards, away from the body's vertical centreline. This results in the PDO having to exert a corresponding torque to maintain stability.

We may calculate the torque (rotating force) at the hip of the two forces acting perpendicular to the leg:



The torque (moment) about the hip is:

$M_{hip} = F_2 * 0.85 + F_4 * 0.10$
$= 188.91 * 0.85 + 135.9 * 0.10$
$= 160.6 + 13.6 = 174.2Nm$

Exertion of the lateral force necessary to support the motorcycle results in an additional 8.5% of that required in this posture (legs at 25deg from the vertical) without supporting the motorcycle.

APPENDIX E. A composite, ergonomics model of work-related hazards for musculoskeletal disorders

(modified from Macdonald & Evans, 2006, p.24)