

“Further risk assessment methods” for Hazardous Manual Tasks

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Abstract

Risk assessment requires both risk analysis and risk evaluation ie, comparing the results of risk analysis with risk criteria to determine acceptability. The Safework Australia Hazardous Manual Tasks Code of Practice, Appendix F, provides a list of “Further risk assessment methods” including methods developed during a research project which evaluated a participative ergonomics program. This commentary provides more appropriate citations for the methods referred to, as well as a brief discussion of more recent methods appropriate for routine workplace use which provide risk evaluation in addition to risk analysis.

Background

In August 2004, it was my great privilege to provide the Cumming memorial lecture at the 40th Annual Conference of the Human Factors and Ergonomics Society of Australia Inc. For the most part the lecture described the outcomes of a workplace based randomised controlled trial of a participative ergonomics intervention [1]. The project was conducted from 1999-2004 in collaboration with Prof Leon Straker, Prof Clare Pollock (both Curtin University of Technology) and Roxanne Egeskov (then Workplace Health and Safety Queensland) with funding from the National Health and Medical Research Council and Workcover Queensland (QComp). At the request of the editor of Ergonomics Australia of the day, I provided an accompanying paper titled “A tale of two acronyms: PERforM and ManTRA” which was published in the December 2004 issue [2].

I was somewhat surprised to see this paper, and a related unpublished manuscript [3, attached] cited seven years later in the December 2011 Hazardous Manual Tasks Code of Practice [4]. (Such is the power of the internet for giving longevity to documents otherwise bound for obscurity). However, in addition to providing an abbreviated title for the journal paper, the citation is not the most useful to readers seeking information about alternative methods for assessing injury risks associated with manual tasks. In this paper I wish to bring readers’ attention to more detailed sources of information about the methods referenced, as well as providing information about more recently published methods.

ManTRA & PERforM

ManTRA (Manual Task Risk Assessment) was the tool devised by Profs Straker & Pollock, Ms Egeskov, and myself in 2000. Conceptually based on the upper limb Strain Index [5], ManTRA was devised as a measurement tool to be employed by Workplace Health and Safety Inspectors auditing the workplaces involved in the randomised controlled trial. (The logic underlying the tool is described in the 2004 Ergonomics Australia paper, and in an issues paper [6] prepared for the the Worksafe Australia review of the 1990 National Code). The inspectors using the ManTRA tool as part of the research project were requested to gather information about the total time for which a task was undertaken and the typical duration the task was performed, and then make semi-quantitative judgements using a five point scale of five task characteristics (cycle time, force, speed, awkwardness and vibration) for different body regions. The scores for duration and cycle time were combined to derive a rating of “repetition” risk, and force and speed rating were similarly combined to provide an “exertion” risk rating. The ratings were summed with those for total time, awkwardness and vibration” assuming a linear scale, and with equal weight for each risk factor. The method included risk evaluation in that inspectors were provided with guidance regarding the scores which should be considered as indicating risk levels which required action - in this case the provision of formal advice or issuing an improvement notice. A revised version of the tool was subsequently made available [3].

PERforM (Participative Ergonomics for Manual Tasks) was the acronym Prof Pollock devised to refer to the intervention program which was implemented with the workplaces participating in the randomised controlled trial. ManTRA was judged to be unnecessarily complex for routine workplace use, and the PERforM program utilised a much simpler method of analysing the risks associated with a manual task. The methods employed in the intervention involved semi-quantitative ratings of five characteristics (duration, exertion, posture, vibration, repetition) for different body regions. Detailed descriptions of the intervention, and examples of the use of the method are provided in papers describing the outcome of the randomised controlled trial [1], and subsequent case studies in surface and underground coal mines [7,8] and civil construction [9] conducted in collaboration with Dr. Gary Dennis. (A handbook aimed at general industry based on these materials was subsequently published by Workplace Health and Safety Queensland [10]). Importantly, the method utilised within the PERforM program described the degree of exposure to the different risk factors in a “risk profile”, and can be considered to be a risk analysis tool, however no method of combining the scores was provided and guidance was provided regarding evaluation of the risk profiles. Risk evaluation is an essential component of risk assessment as defined by AS/NZS ISO31000:2009, and consequently this method should not be considered to be a risk assessment tool.

This short-coming was highlighted during the evaluation of the program in the mining industry [7,8]. While the tool was able to be utilised to devise potential control measures (as it had with the small businesses involved in the original evaluation), the safety management systems utilised within the large mining organisations required an evaluation of the risk against risk criteria to allow incorporation of the information within the wider safety management systems - an essential part of facilitating resource allocation for the control measures.

More recent developments

In 2005/2006, I was able to spend 6 months at the National Institute of Occupational Safety and Health (NIOSH), Office of Mine Safety and Health Research, Pittsburgh. One of the projects undertaken was the implementation and evaluation of a participative ergonomics program in collaboration with Vulcan Materials, the largest manufacturer of aggregates in the USA [11]. A number of different tools for implementing the program were identified and developed. One of the tools provided (and described in the re-

sulting NIOSH publication [12]) was an unimaginatively named “Manual Task Risk Assessment” tool which attempted to achieve the simplicity of PERforM while providing an evaluation of manual task injury risk compatible with wider safety management systems. This assessment tool provided an exponential rather than linear scale, and unequal weightings for different risk factors. The latter decision reflects an understanding that “exertion” and “exposure” task characteristics are more strongly implicated in the causation of injury than posture and movement characteristics.

At the same time, I was conducting a project for the Australian Coal Association Research Program focussed on reducing injury risks associated with underground coal mining equipment. The outcomes of the project included a handbook [13] aimed at assisting mine sites to assess and control such risks, including manual tasks risks. The handbook included a tool titled, a “Simplified matrix for assessment of manual tasks risks” which was a modified version of the risk assessment tool published in the NIOSH Information Circular. In this version, vibration is assessed as an “environmental” characteristic rather than a task characteristic. The logic behind this decision is that if vibration, whether whole body or peripheral, is the primary cause of injury risk associated with a task, then an assessment of the vibration characteristics via accelerometer with respect to the relevant standards is indicated, rather than using a semi-quantitative Manual Task Risk Assessment tool.

In 2008 I was engaged by Xstrata Copper at Mt Isa to provide a “Procedure for Managing Injury Risks Associated with Manual Tasks”. The resulting document [14] outlines the requirements for a participative ergonomics process and included a reformatted and slightly modified version of the “simplified matrix” in Appendix B, as well as additional guidance materials. This procedure was made freely available under a Creative Commons Attribution-Noncommercial-No Derivative Works license, and has been subsequently adopted, or adapted with permission, by a number of large organisation in a range of industries; and is cited in guidance materials prepared by NSW and WA mining safety authorities [15, 16]. The version of the tool in Appendix B of this procedure forms the basis of the risk assessment method utilised within an on-line database provided for the management of hazardous manual tasks risks [17].

Conclusion

Implementation of a participative ergonomics program remains the only evidence based method for the reduction of injuries associated with manual tasks [18, 19]. Analysing and evaluating the risks of injury associated with manual tasks is a key step in this process. A range of semi-quantitative tools are available which are both simple enough for routine workplace use and provide useful information to guide the participative identification, development and implementation of design controls. In some organisational contexts it will be critical to choose a tool which allows risk evaluation, in addition to risk analysis.

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Manual Tasks Risk Assessment Tool (ManTRA) V 2.0

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Manual Tasks Risk Assessment (ManTRA) V 2.0

This document describes the revised version of an audit tool developed by Robin Burgess-Limerick PhD CPE, School of Human Movement Studies, The University of Queensland; Roxanne Egeskov CPE, Senior Principal Advisor Ergonomics, Workplace Health and Safety Queensland; Leon Straker, PhD, School of Physiotherapy, Curtin University of Technology, and Clare Pollock, PhD, School of Psychology, Curtin University of Technology. The development of the tool was undertaken as part of a research project funded by Workcover Queensland (QComp) and the National Health and Medical Research Council through a Translational Grant in Injury.

One aim of ManTRA, as originally developed, was to assist DWHS inspectors in auditing workplaces across all industries for compliance with the Queensland Manual Tasks Advisory Standard. A second aim was to make an assessment of the exposure to musculoskeletal risk factors associated with manual tasks in the workplace. For workplace use the assessment should be undertaken by a team including employees who perform the task and staff responsible for manual task risk management.

The physical risk component of the revised tool combines information about the total time for which a person performs the task in a typical day (exposure) and the typical time for which the task is performed without break (duration) with an assessment, for each of four body regions, of five characteristics of the task (cycle time, force, speed, awkwardness and vibration). The assessment of each characteristic is for the task *as a whole*, rather than individual task elements. The assessment is for a specific person performing a task, rather than people generally. The aim is for the assessor to make a judgement regarding the severity of each characteristic of the task at each region for the task as a whole. The text which corresponds to the numeric codes is provided as a guide only.

The codes for each characteristic describing the task are then combined to assess the extent of exposure to each of the direct risk factors identified in the Queensland Manual Tasks Advisory Standard. The risk factors are assessed independently for each region because a task only needs to overload one body structure to cause injury. A maximum score for exertion for any body region, or a high combined exertion and awkwardness score, indicates a high risk of acute injury; while a high risk of cumulative injury is indicated by the presence of multiple risk factors for a particular body region. Suggested thresholds are provided to aid the user in making judgements about the need for action.

Explanations for each of the codes are provided below.

Total time

Total time refers to the total time which would be spent performing the task on a typical day. The code will be the same for each body region.

Total time

| 1 | 2 | 3 | 4 | 5 |
|---------------|---------------|---------------|---------------|----------------|
| 0-2 hours/day | 2-4 hours/day | 4-6 hours/day | 6-8 hours/day | 8-10 hours/day |

Repetition

Tasks which involve short cycle time and prolonged duration are considered to be a risk factor because of the inevitable loading of the same tissues during the task. Tasks performed for a very long duration without interruption (> 2 hr) are similarly a risk, regardless of the cycle duration. Reduced risk is associated with tasks involving longer cycle times and shorter task duration. Cycle time and task duration are first assessed independently, and then a combined score for repetition is allocated.

Cycle time refers to the duration of task which is performed more than once without interruption. The cycle time code may vary between body regions. If a task is performed once only at any time without repetition then the code for cycle time is minimum (1). *Duration is defined as the typical length of time for which repetitions of the task are performed without any rest break or substantial interruption by any other task.* The duration code will be the same for all regions for any particular task. Cycle time and duration codes are combined to give an overall score for repetition using the key below.

Duration

| 1 | 2 | 3 | 4 | 5 |
|--------------|-----------------|---------------|-------------|--------|
| < 10 minutes | 10 min - 30 min | 30 min - 1 hr | 1 hr - 2 hr | > 2 hr |

Cycle time

| 1 | 2 | 3 | 4 | 5 |
|-------------|--------------|--------------|-------------|--------|
| > 5 minutes | 1 – 5 minute | 30 s - 1 min | 10 s - 30 s | < 10 s |

Repetition Risk Factor

| | Duration | | | | |
|------------|----------|---|---|---|---|
| Cycle Time | 1 | 2 | 3 | 4 | 5 |
| 1 | 1 | 1 | 2 | 3 | 4 |
| 2 | 1 | 2 | 3 | 4 | 4 |
| 3 | 2 | 3 | 4 | 4 | 5 |
| 4 | 2 | 3 | 4 | 5 | 5 |
| 5 | 3 | 4 | 5 | 5 | 5 |

Force

The exertion risk factor identified in the advisory standard has been expanded in ManTRA to separate force *per se*, from the speed of movement. Exertion in this audit tool requires an assessment of the force exerted within each region during the task relative to the maximal force which can be exerted. Note that the assessment should be made relative to the strength capability of the region rather than absolute force ie, a relatively small force may still require a “maximal” rating if exerted by a small muscle group (eg., fingers) but not if exerted by the lower limbs. The assessment of force is relative to the capability of the person performing the task. The force required should be rated independently of the duration of the exertion, that is, a short task which involves moderate force in the region is rated the same as a longer task. (Duration is a separate risk factor). *A maximum force score corresponds to the maximum force possible*, if greater force could have been exerted, the score should be reduced accordingly.

| Force | | | | |
|---------------|---|----------------|---|---------------|
| 1 | 2 | 3 | 4 | 5 |
| Minimal force | | Moderate force | | Maximal force |

Speed

The speed of movement has been identified as a separate risk factor. The least risk arises when a task involves slow to moderately paced movements. Tasks which involve primarily static application of force in the region contribute to the risk of musculoskeletal injury. Tasks involving fast movements, and especially those involving rapid accelerations and decelerations constitute higher risks again. The assessment should be of the overall task eg., a tasks which involves mostly slow movements with some fast elements should be rated as moderately paced. However, *the code “3” is reserved for predominantly static tasks only*.

Speed

| 1 | 2 | 3 | 4 | 5 |
|----------------|------------------|--------------------------------------|---------------------------|-----------------------|
| Slow movements | Moderately paced | Little or no movement—static posture | Fast and smooth movements | Fast, jerky movements |

Exertion Risk Factor

Codes for force and speed are combined to give an overall score for exertion using the following key.

| | | | Force | | |
|-------|---|---|-------|---|---|
| Speed | 1 | 2 | 3 | 4 | 5 |
| 1 | 1 | 1 | 2 | 3 | 4 |
| 2 | 1 | 2 | 3 | 4 | 4 |
| 3 | 2 | 3 | 4 | 4 | 5 |
| 4 | 2 | 3 | 4 | 5 | 5 |
| 5 | 3 | 4 | 5 | 5 | 5 |

Awkwardness

Awkwardness is difficult to define independently of specific joints, but typically postures which involve significant deviations from the mid range of movement constitute an increased risk of injury. Higher risk occurs when the deviation occurs in combinations, eg, trunk flexion combined with trunk rotation, or wrist extension and ulnar deviation. As before, the rating is for the task as a whole and the rating should be adjusted to reflect the proportion of time spent in postures of varying awkwardness. Here especially, the text is a guide only and judgement is required.

Awkwardness

| 1 | 2 | 3 | 4 | 5 |
|-------------------------------|--|--|---|---|
| All postures close to neutral | Moderate deviations from neutral in one direction only | Moderate deviations in more than one direction | Near end range of motion posture in one direction | Near end range of motion in more than one direction |

Vibration

Exposure to whole body vibration in addition to other risk factors contributes to increased injury, particularly in the back and neck, and lower limbs. Peripheral vibration, on the other hand, is primarily a risk factor implicated in upper limb disorders. Consequently an assessment of the *severity of whole body vibration is requested for lower limbs, back, and neck regions*, while the severity of *peripheral vibration should be indicated for shoulder/arm and wrist/hand regions*. The rating is for the whole task and the score should be adjusted for duration of exposure as a proportion of the task.

Vibration (Whole body or Peripheral)

| 1 | 2 | 3 | 4 | 5 |
|------|---------|--------------------|-----------------|------------------|
| None | Minimal | Moderate amplitude | Large amplitude | Severe amplitude |

Suggested thresholds for further action

After combining the force and speed codes to obtain a rating of the exertion risk factor, and combining the cycle time and duration to obtain a repetition risk, a cumulative risk score for each region should be calculated as the sum of codes for:

Total time + repetition + exertion + awkwardness + vibration

That is, the cumulative risk score is the sum of the scores in the unshaded columns. This yields a possible range of scores between 5 and 25.

One aim of the audit tool was to assist inspectors make a determination regarding compliance of a task with the Manual Tasks Advisory Standard. It was suggested that further action may be indicated if for any body region:

- *the combined risk factor for exertion is 5,*
- *the sum of exertion and awkwardness is 8 or greater; or*
- *the combined cumulative risk scores is 15 or greater*

These threshold values provide guidance in the prioritisation of tasks for control, and the profile of risk factor ratings should be utilised in provided advice regarding aspects of the task to which controls should be targeted.

Manual Tasks Risk Assessment tool (ManTRA) V 2.0 Scoring Matrix

| | | | Task Codes | | | | | | | CumulativeRisk |
|-------------------|------------|----------|------------|-----------------|-------|-------|---------------|-------------|-----------|----------------|
| Body Region | Total time | Duration | Cycle time | Repetition Risk | Force | Speed | Exertion Risk | Awkwardness | Vibration | |
| Lower Limbs | | | | | | | | | | |
| Back | | | | | | | | | | |
| Neck/ Shoulder | | | | | | | | | | |
| Arm/ Wrist / Hand | | | | | | | | | | |

Cumulative risk is the sum of unshaded cells.

Codes

| | | | | |
|--------------------------------------|--|--|---|---|
| Total time | | | | |
| 1 | 2 | 3 | 4 | 5 |
| 0-2 hours/day | 2-4 hours/day | 4-6 hours/day | 6-8 hours/day | > 8 hours/day |
| Duration of continuous performance | | | | |
| 1 | 2 | 3 | 4 | 5 |
| < 10 minutes | 10 min - 30 min | 30 min - 1 hr | 1 hr - 2 hr | > 2 hr |
| Cycle time | | | | |
| 1 | 2 | 3 | 4 | 5 |
| > 5 minutes | 1 – 5 minute | 30 s - 1 min | 10 s - 30 s | < 10 s |
| Force | | | | |
| 1 | 2 | 3 | 4 | 5 |
| Minimal force | | Moderate force | | Maximal force |
| Speed | | | | |
| 1 | 2 | 3 | 4 | 5 |
| Slow movements | Moderately paced | Little or no movement – static posture | Fast and smooth movements | Fast, jerky movements |
| Awkwardness | | | | |
| 1 | 2 | 3 | 4 | 5 |
| All postures close to neutral | Moderate deviations from neutral in one direction only | Moderate deviations in more than one direction | Near end range of motion posture in one direction | Near end range of motion in more than one direction |
| Vibration (Whole body or Peripheral) | | | | |
| 1 | 2 | 3 | 4 | 5 |
| None | Minimal | Moderate | Large amplitude | Severe amplitude |

Scoring Keys for Repetition & Exertion

| | | | | | |
|----------------------------|----------|---|---|---|---|
| Scoring key for Repetition | | | | | |
| | Duration | | | | |
| Cycle Time | 1 | 2 | 3 | 4 | 5 |
| 1 | 1 | 1 | 2 | 3 | 4 |
| 2 | 1 | 2 | 3 | 4 | 4 |
| 3 | 2 | 3 | 4 | 4 | 5 |
| 4 | 2 | 3 | 4 | 5 | 5 |
| 5 | 3 | 4 | 5 | 5 | 5 |

| | | | | | |
|--------------------------|-------|---|---|---|---|
| Scoring key for Exertion | | | | | |
| | Force | | | | |
| Speed | 1 | 2 | 3 | 4 | 5 |
| 1 | 1 | 1 | 2 | 3 | 4 |
| 2 | 1 | 2 | 3 | 4 | 4 |
| 3 | 2 | 3 | 4 | 4 | 5 |
| 4 | 2 | 3 | 4 | 5 | 5 |
| 5 | 3 | 4 | 5 | 5 | 5 |

Action may be indicated if, for any region, the Exertion risk factor is 5, the sum of exertion and awkwardness is 8 or greater, or the cumulative risk is 15 or greater