Further development of the usability and validity of the Quick Exposure Check (QEC)

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The Quick Exposure Check (QEC) was developed to enable health and safety practitioners to undertake assessments of the exposure of workers to musculoskeletal risk factors (Li and Buckle, 1999). QEC focuses on exposure assessment and change in exposure, thus allowing the benefits of workplace interventions to be assessed rapidly. The method has been published and is freely available in electronic form. Further improvements to the usability and validity of QEC have been made using a participatory approach, with input from health and safety practitioners and ergonomics experts (n=57).

Four facets of usability have been investigated: attitude; learnability; flexibility; and effectiveness (Shackel, 1991). Experienced users were interviewed to identify the strengths and weaknesses of the assessment tool. These data provided the basis for an improved version of QEC. Modifications were also made to the QEC forms and Reference Guide, in accordance with good practice on the presentation of graphic information.

The improved versions of the tool have been trialled by practitioners and the reliability and validity determined with both practitioners and experts in the workplace. Revisions based on these trials have provided an improved QEC, Reference Guide and on-line resource. Awareness of QEC and its use has been increased through presentations, and workshops, including one specifically for practitioners on ‘Assessing musculoskeletal disorders at work: which tools to use when’.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.
Executive Summary

What were the aims of the study?

- Improve the usability of the Quick Exposure Check (QEC) based upon feedback from practitioners
- Confirm the reliability and validity of the revised version of QEC
- Develop an improved and transparent scoring method
- Provide user-friendly information about how to use QEC

How was the study conducted?

- A participatory approach was used throughout the study with input from health and safety practitioners and ergonomics experts (n=57)
- Experienced users were interviewed to explore the usability, strengths and weaknesses of QEC
- These data provided the basis for an improved version of QEC and Reference Guide which was tested with practitioners
- A graphics designer then modified the QEC forms and Reference Guide, in accordance with good practice on the presentation of graphic information
- Further user testing and redesign continued throughout the study
- The reliability and validity of the improved versions of QEC were determined by both practitioners and experts undertaking assessments in the workplace

How was QEC improved?

- The presentation of both observer and worker questions on a single page in portrait format
- Rewording observer and worker questions to improve precision of terminology used, and thereby their clarity
- The format and transparency of the scoring sheet
- The extension of the Reference Guide to cover
  - defining the nature and purpose of exposure assessment
  - advice on how to establish priorities for assessment,
  - basic methods to define the range of tasks that are undertaken during a working day in the performance of the overall job, and
  - the need to adopt a systems approach when making interventions

What is the output?

- An improved Quick Exposure Check and Reference Guide.
- Increased awareness of QEC and its use through presentations, papers and workshops, including one specifically for practitioners on ‘Assessing musculoskeletal disorders at work: Which tools to use when’
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### Acknowledgements

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Introduction

The Quick Exposure Check (QEC) was developed to enable health and safety practitioners to undertake assessments of the exposure of workers to work-related musculoskeletal risk factors (WMSDs). The primary development of the tool is documented as a HSE Contract Research Report (Li and Buckle, 1999). This initially involved a detailed review of the scientific literature concerning risk factors for musculoskeletal disorders and an investigation of user needs. These provided the basis for the construction of QEC using a participatory approach with input from approximately 150 health and safety practitioners. The tool was then evaluated in both the laboratory and workplace to determine its reliability and validity. Pragmatic compromises had to be made between scientific validity and usability. These have remained a source of potential scientific criticism, but the tool has been well accepted and used by many practitioners. The report is available electronically:

QEC, therefore, is a tool designed for and by practitioners. It assesses exposure and change in exposure to the main risk factors for WMSDs. By assessing exposure as opposed to risk, the effectiveness of workplace interventions can be evaluated without waiting for changes in the prevalence of WMSDs to become evident.

The main benefits of the Quick Exposure Check (QEC) are that it:
• provides health and safety practitioners with a user friendly assessment tool with good validity
• has been shown to be straightforward to use
• helps persuade organisations to make ergonomic changes
• is compatible with HSE risk assessment methods
• involves both the practitioner and the worker in the assessment, thereby providing a fuller understanding of working practices

Since its launch, feedback from both researchers and practitioners identified that a number of improvements to QEC would be advantageous. Further development work on the QEC has been carried out. The aims of this study were to:
• Improve the usability of the QEC based upon feedback from practitioners
• Confirm the reliability and validity of the revised version of QEC
• Develop an improved and transparent scoring method
• Provide user-friendly information about how to use QEC

Part 1 of this report summarises the various phases undertaken, the approaches adopted, and the main findings from the study based upon a participatory approach that involved a further fifty-seven health & safety practitioners and ergonomists. It provides an outline of the process underlying the further development of QEC. These further developments of QEC are underpinned by the construction and evaluation evidence provided in the earlier QEC report (Li and Buckle 1999). Part 2 shows the new version of QEC, its accompanying Reference Guide and further resources. Major changes have been made to the format and presentation of the QEC form and scoring sheet. In addition, essential information has been provided in the Reference Guide to enable practitioners to apply QEC effectively. These improvements are in line with the original design philosophy and enhance the earlier version of QEC.
Part 1: Further Development

Phase 1: Review of Use

Usability issues were addressed extensively in the original development of QEC [Li & Buckle 1999, Chapters 2 and 5; Buckle & Li 1998], and continued to be the focus of this study. Four facets of usability were investigated in detail i.e. attitude; learnability; flexibility; and effectiveness (Shackel, 1991) based on the experiences of current users.

Seven current QEC users (predominantly health and safety practitioners) were interviewed by telephone. This structured interview explored their experiences in the use of QEC and in particular: ambiguity in terminology; how the assessment was used; the usefulness of the scoring system; speed of learning, training and problems of intermittent use; understanding the function of the tool; adaptations made to QEC; the scope of factors assessed; and the problem of task and job definition. A number of QEC assessments were completed by eight ergonomists. The questions from the interviews were then used to direct discussion within this group to identify areas for improvement in QEC. The many points and issues raised in the course of the interviews, focus group and research team meetings are detailed in Appendix 1. These are summarised below:

- Changes to the layout of the tool
  - to increase ease of use at the workplace

- Alteration to the questions asked of the worker
  - more detail about work organisational issues
  - clarification of meaning of certain questions

- Possible addition of other risk factors
  - e.g. whole body and hand/arm vibration,

- Changes to the scoring system
  - to make it more transparent and easier to use
  - to help to prioritise issues for change

- Provision of improved guidance on
  - the function of QEC and how it can be used in the organisation
  - how to conduct assessments, e.g. how long to observe the worker
  - advice on simple procedures to break down jobs into tasks to be assessed
  - stress the importance of a participatory approach
  - advice on interventions
  - the meaning of each QEC question
  - training/practise required

This information was used to inform the refinement and improvement of the tool in Phase 2 and to provide useful input for the format of the final deliverables.
Phase 2: Refining and Improving QEC

The feedback data from the review of use by practitioners and experts formed the basis for identifying specific issues where improvements were necessary. Each issue was reviewed during a series of development meetings of the four members of the project team, two of whom were responsible for the original development of QEC [Li & Buckle 1999]. Individual members were tasked with consulting the relevant scientific literature, researching specific topics and proposing appropriate improvements where possible. These were then considered at subsequent team meetings and agreed changes incorporated into the revised QEC form, scoring sheet and Reference Guide. This led to enhancements of the usability of the original version of the QEC tool and Reference Guide where appropriate.

The issues considered and improved included:

- The presentation of both the observer and worker questions on a single page in portrait, as opposed to landscape format. This is more suitable for use in the workplace and helps with the transcription of the recorded data to the scoring sheet.
- Both the observer’s questions and those completed in discussion with the worker were reformatted under column titles. Upper case designations were used for both observer and worker questions as opposed to a combination of upper and lower case that appeared confounding.
- The observer and worker questions were reworded to improve the precision of the terminology used and thereby their clarity. For example,
  - the question on the shoulder/arm posture adopted was referenced to the position of the hands during the performance of the task.
  - clarification was provided about the load handled by the worker by the addition of the phrase ‘manually by you’.
  - the question on vibration was split to cover both whole body vibration and hand/arm vibration as both may occur independently of each other.
  - the question on stress was revised in line with the recent scientific advances.
- The provision of space at the base of the revised form for written assessment details and additional comments if workers reported problems about visual demands, pace of work or stress.
- The improvement of the format and transparency of the scoring tables. The use of red, amber and green colour coded zones was considered to indicate levels of exposure. However, they were not used, as the epidemiological evidence did not indicate that any exposure level could necessarily be considered ‘safe’.
- The provision of improved guidance. For example
  - defining the nature and purpose of exposure assessment
  - advice on how to establish priorities for assessment
  - basic methods to define the range of tasks that are undertaken during a working day in the performance of the overall job, and
  - the need to adopt a systems approach when making interventions

A number of different formats and representations for both the assessment form and the scoring sheet were devised and considered during this phase of the study. The final versions were then evaluated by practitioners during user trials, as described in Phase 3. The need for graphic design input at subsequent development phases of the project was identified, once the initial evaluation of the above changes had been completed.
Phase 3: Usability Re-assessment

This phase addressed the usability of QEC and encompassed user testing, development work on the Reference Guide, and improvements to the format and presentation of the assessment forms.

Ten practitioners observed and assessed a simulated manual task using the amended QEC form and scoring sheet. Individually completed questionnaires followed by group discussion provided feedback on the usability of the assessment form, scoring sheet and the Reference Guide. The points and issues raised in the course of these trials are detailed in Appendix 2. These are summarised below:

- **Assessment form**
  - **General**, e.g. observer and worker participation in assessment process liked; is QEC more suitable for the assessment of non-repetitive rather than manual handling tasks?
  - **Layout**, e.g. the colour coding was found to be useful for prioritising problems; too much information on the QEC form
  - **Assessing posture and movement**, e.g. discussion regarding selecting the worst case, the guide seems to suggest that the magnitude of the posture is more important than duration or frequency
  - **Exclusions**, e.g. what about assessing the lower limbs, why are these not included in QEC?
  - **Difficulty with assessment**: e.g. the worker wore gloves and this made it difficult to assess wrist posture
  - **Specific questions**, e.g. discussion regarding the differences between categories for back assessment; difficulty making decision about what type of task (manual handling or static) was being assessed.

- **Scoring sheet**
  - **Layout**, e.g. scoring sections for each body part were poorly delineated; the sheet had too much information and looked ‘busy’; would prefer a portrait layout
  - **Scoring**, e.g. difficulty found with totalling summary scores, more explanation required about interactions; some thought they would require training to use QEC
  - **Exclusions**, e.g. discussion regarding the scoring of the right and left side of the body, other tools allow this but QEC does not

- **Reference Guide**
  - **Layout**, e.g. considered ‘quite wordy’
  - **Expansion of guidance required**, e.g. need more information on the definition of a task and how to break the job into tasks for assessment; example needed for scoring but excellent on posture; more guidance required to assess movement of body parts

Following the evaluation of the usability data from Phases 1, 2 and 3 of the study, the revised format was discussed with four graphic designers to identify potential improvements in the presentation of the assessment and scoring forms. Based upon these discussions, one designer was given the task of improving the forms to enhance their usability by practitioners.

Following further discussion and the production of prototypes, an interim version of QEC was produced for testing. The new forms:

- incorporated a front sheet for recording subject information
- increased the clarity of information presentation and formatting
• included a redesigned layout for the scoring sheet that made it easier to use and to provided greater transparency when scoring. 
A noticeable feature of the new form and the scoring sheet was the use of colour density to indicate increasing level of exposure to risk.

Additions were also made by the research team to the Reference Guide to meet the requirements identified during the trials. The new Reference Guide included information on:
• the introduction and background to QEC and the role of the guide
• establishing priorities: deciding on tasks to assess
• completing an exposure assessment
• interpreting each QEC question
• scoring the assessment
• interpreting the scores
• interventions and re-assessment
• useful resources list including text and web links to specific topics e.g. vibration, stress

Following the above changes, the usability of the improved versions of QEC and the Reference Guide were tested by twelve practitioners and seven ergonomists. The points and issues raised in the course of these trials are detailed in Appendix 2. These are summarised below:

• **Assessment form**
  - **Layout**, e.g. good layout and the correct amount of information on one sheet; choice between optional questions and the instruction to give details should be more evident
  - **Assessing posture and movement**, e.g. the role of the increasing colour density was not immediately apparent
  - **Exclusions**, e.g. extra information on the form would be useful i.e. job information, actions, recommendations
  - **Difficulty with assessment**, e.g. could be difficult to conduct a QEC assessment in loud environments or if there is a great variety in nature of tasks within an activity
  - **Specific questions**, some amendments required to QEC items, e.g. categories for driving do not cover all possible scenarios, what if the person drives for 2 hours?; need more guidance about assessing repeated posture

• **Scoring sheet**
  - **General**, e.g. discussed computer scoring and the importance of keeping scoring transparent
  - **Layout**, easy to follow sheet but some repositioning and clarification needed; difficult to cross reference scores but thought this would get easier with practise
  - **Scoring**, e.g. transparent scoring enables the user to see where action could be taken; some clarifications required i.e. do not complete both B1-3 and B4-B5.
• **Reference Guide**
  - **General:** clear and concise
  - **Layout,** e.g. liked pictures of postures but more labelling required
  - **Expansion of guidance required,** e.g. need indication of what the scores mean;
    **When to intervene?** Clarification required i.e. role of shading.

Once again feedback was collated and fed back to the designer and further refinements were made to the tool and Reference Guide in this iterative process.

**Phase 4: Inter-User Reliability**

The inter- and intra-user reliability of the original version of QEC were established in the original study to develop QEC which showed that the tool had an acceptable or moderate levels of agreement for inter-observer reliability and higher intra-observer reliability [Li & Buckle 1999, Chapters 5 and 6]. Phase 4 of this study investigated the inter-user reliability when using the revised versions of QEC and the Reference Guide, to carry out exposure assessments on three tasks.

Six individuals, who normally undertake risk assessments in the course of their work, acted as subjects. Each subject received information about the trial and QEC before agreeing to participate. They were given a brief period of training to ensure that they understood how to carry out a QEC assessment.

A simulation trial was considered to be preferable to evaluating video footage, as the assessor could interact with the worker and move position to conduct the postural assessment. The tasks chosen for assessment were

- heavy physical work - cleaning a floor using a buffing machine
- light physical work - pipetting whilst standing at a laboratory bench
- routine DSE keyboard work - word processing

All three workers selected to perform the tasks normally carried out similar work in the course of their job. They each confirmed that they had been free from any musculoskeletal pain or discomfort for seven days prior to the trials. They performed the tasks on six occasions over a three-day period to enable each subject to make their assessment. Each task was performed in the normal manner and at the typical pace for approximately ten minutes. Video-film records of the workers’ performances were made during the assessments. The consistency of the worker’s performances were confirmed by the research team throughout the assessment period, as this ensured that the same, standardised, controlled tasks were performed for each subject to assess.

The subjects assessed each task independently and no other subject was present when the assessment was being made. The assessments were carried out over a period of three days, with a gap of approximately 24 hours between each one. The presentation order of the tasks was varied randomly between subjects to counteract learning effects. Following each assessment the subject completed a questionnaire on their use of QEC.

Inter-reliability scores were determined from the completed QEC forms. Kendall’s coefficient of concordance was used to assess the level of agreement between the assessors and good to moderate levels of agreement were found. The results are shown in Table 1.
Table 1: Inter-reliability scores

<table>
<thead>
<tr>
<th>Task</th>
<th>Back posture</th>
<th>Shoulder/arm posture</th>
<th>Wrist/hand posture</th>
<th>Neck posture</th>
<th>Back motion</th>
<th>Shoulder/arm motion</th>
<th>Wrist/hand motion</th>
<th>Neck motion</th>
<th>Kendall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buff</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>83</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>67</td>
<td>.79</td>
</tr>
<tr>
<td>Pipette</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>83</td>
<td>100</td>
<td>83</td>
<td>50</td>
<td>83</td>
<td>.7</td>
</tr>
<tr>
<td>DSE</td>
<td>100</td>
<td>83</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>.6</td>
</tr>
<tr>
<td>Overall</td>
<td>83</td>
<td>83</td>
<td>94</td>
<td>61</td>
<td>100</td>
<td>67</td>
<td>67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The subjects’ ratings indicated that they found QEC a straightforward and useful assessment tool; however, their specific suggestions informed further refinements of the QEC and scoring forms and Reference Guide.

**Phase 5: Validation in the Workplace**

The validity of the QEC was established by workplace trials during its original development [Li & Buckle 1999, Chapter 7]. These trials showed an overall level of agreement of 78% between the practitioners’ assessments and corresponding data gathered from video analysis of the postures and frequency of movements for the four body areas.

A strategy was developed for this study to validate the revised version of the QEC. The validity of QEC was investigated with respect to:

- **Face validity**: the extent to which QEC is acceptable to practitioners, workers and other interested parties within the working environment. This was also determined during Phases 3 and 4 of the study.
- **Criterion-related validity**: the extent to which the QEC assessment made by practitioners are in agreement with assessments made by experts; a similar approach to that adopted in the original study (Li and Buckle, 1999).

Initially, validation trials were undertaken at three organisations. The QEC forms and reference guide were sent to the practitioner a few days in advance of the trial and they were asked to read and familiarise themselves with the QEC. They were then given the opportunity to ask for further clarification at the start of the trial. Five tasks were identified, representing a range of activities, at each of these organisations.

- **Printing works**: the tasks assessed were manual handling to feed machines (2), manual collation of book materials, machine stapling of materials, and computer work,
- **Automotive engineering plant**: the tasks assessed were manipulative assembly and manual handling tasks at five stages of the assembly line,
- **Agro-chemical production plant**: the tasks assessed were stacking boxes of product on to a pallet, assembling items on conveyor line, packing items into cartons (2), and pallet moving with mechanical aids.

These tasks were assessed by both the practitioner from the organisation concerned and by experts from the study team using the current version of the QEC. The responses of the worker to the QEC assessment procedures were recorded following each assessment. In addition, video recordings of the tasks performed were made. When the five assessments had been completed, the practitioner scored the assessments using the forms provided. A structured interview then took place to gather the practitioner’s responses to questions about the QEC form, scoring sheet, Reference Guide and more general issues, e.g. any training requirements and the use of QEC to make interventions. Seven point rating scales on `ease of use’, ‘the applicability of QEC
Comparisons were made between the exposure categories ticked by the practitioner and the experts on the assessment form. The findings from the fifteen tasks initially assessed are shown in Table 2 and in Figures 1 - 7. Each chart illustrates graphically the agreement between the practitioner and the expert for each body area assessed.

Figure 1 illustrates that when assessing back posture, there was full agreement for 53% of the tasks assessed and disagreement on the remainder. The difference between the practitioner and the expert, however, was confined to only one exposure category of difference, e.g. if the practitioner chose category A1 when the expert selected A2.

For back motion, illustrated in Figure 2, there was
- full agreement between the practitioner and the expert in 27% of the tasks;
- disagreement to the extent of one exposure category in 20% of the tasks, e.g. if the practitioner chose category B4 when the expert selected B5; and
- disagreement to the extent of two or more categories in the remainder, e.g. if the practitioner chose category B1 when the expert selected B3.

The level and extent of the agreement for the other body areas are shown in Figures 3-7.

<table>
<thead>
<tr>
<th>Assessment of</th>
<th>Full agreement [%]</th>
<th>One category difference [%]</th>
<th>Two category difference [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back posture</td>
<td>53</td>
<td>47</td>
<td>-</td>
</tr>
<tr>
<td>Back motion</td>
<td>27</td>
<td>20</td>
<td>53</td>
</tr>
<tr>
<td>Shoulder/Arm posture</td>
<td>60</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>Shoulder/Arm Motion</td>
<td>27</td>
<td>60</td>
<td>13</td>
</tr>
<tr>
<td>Wrist/Hand posture</td>
<td>47</td>
<td>53</td>
<td>-</td>
</tr>
<tr>
<td>Wrist/Hand motion</td>
<td>73</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Neck posture</td>
<td>53</td>
<td>47</td>
<td>-</td>
</tr>
</tbody>
</table>
Figure 1. Level and extent of agreement for Back Posture

Figure 2. Level and extent of agreement for Back Motion

Figure 3. Level and extent of agreement for Shoulder/Arm Posture

Figure 4. Level and extent of agreement for Shoulder/Arm Motion

Figure 5. Level and extent of agreement for Wrist/Hand Posture

Figure 6. Level and extent of agreement for Wrist/Hand Motion

Figure 7. Level and extent of agreement for Neck Posture

Legend:
- Full agreement
- 1 category difference
- 2 category difference
The workers’ responses indicated that they believed their involvement in the assessment process was vital and that the meanings of the majority of the QEC questions put to the worker were clear. Some difficulty was reported, however, with the hand force question where greater explanation was required.

The practitioners’ ratings for the new version of QEC indicated that they found QEC a straightforward and useful assessment tool.

The findings from these three initial trials indicated, however, that further refinements of the QEC were required before conducting the remaining validation trials. Revisions were made, therefore,

- to clarify the section of the form and supporting reference guide on back motion,
- to provide more explanation of the workers questions in the reference guide,
- to improve the layout of the scoring sheet: i.e. re-locating the sections on back motion, neck posture and worker questions,
- to improve the terminology used to increase the precision of the questions on the motion of the shoulder/arm and wrist/hand.

Further, validation trials were undertaken at another three organisations using the revised form and following the same protocol as used previously, with respect to familiarisation with the QEC forms and reference guide. Representative tasks were identified at each of these organisations.

- Retail service outlet: the tasks assessed were cleaning and refurbishing a drinks product display, customer sales till operation, cleaning and refurbishing a CD/Video product display, shelf stacking, sandwich preparation and computer work,
- Engine manufacturing plant: the tasks assessed were manipulative assembly and manual handling tasks at six stages of the assembly line,
- University Library: the tasks assessed were returning books to the shelves, handling incoming or outgoing books at the loans check-in/out desk, manually removing boxes of supplies from a pallet and placing in storage.

In similar manner to the previous trials, these tasks were assessed by both a practitioner from the organisation concerned and by experts from the study team using the revised version of the QEC. The responses of the worker to the QEC assessment procedures were recorded following each assessment, and video recordings of the tasks performed were made. The practitioner scored the assessments using the revised forms, and this was followed by the structured interview to gather the practitioner’s responses to questions about the QEC form, scoring sheet, Reference Guide and more general issues, e.g. training requirements and making interventions. Seven point rating scales on ‘ease of use’, ‘the applicability of QEC to the workplace’ and ‘its value in conducting workplace assessments’ were also completed by the practitioner at this stage.

The comparisons made between the practitioner and expert assessments for the fifteen tasks assessed are shown in Table 3 and in Figures 8 - 14. Each chart illustrates graphically the agreement between the practitioner and the expert for each body area assessed. In comparison to Figures 1-7, it is apparent that the level and extent of agreement between the practitioners’ and expert assessments has increased as shown in Figures 8-14. The level of full agreement has increased for all body areas, and disagreement to the extent of two or more categories was found only for wrist/hand motion, as shown in Figure 13. For all other comparisons made the difference between the practitioner and the expert arose from the choice between adjoining categories on the assessment form.
Table 3: Level and extent of agreement between practitioners and experts

<table>
<thead>
<tr>
<th>Assessment of</th>
<th>Full agreement [%]</th>
<th>One category difference [%]</th>
<th>Two category difference [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back posture</td>
<td>67</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Back motion</td>
<td>67</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Shoulder/Arm posture</td>
<td>73</td>
<td>27</td>
<td>-</td>
</tr>
<tr>
<td>Shoulder/Arm Motion</td>
<td>67</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Wrist/Hand posture</td>
<td>80</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Wrist/Hand motion</td>
<td>66</td>
<td>27</td>
<td>7</td>
</tr>
<tr>
<td>Neck posture</td>
<td>80</td>
<td>20</td>
<td>-</td>
</tr>
</tbody>
</table>

The level of agreement between the practitioners’ and experts’ scores were investigated by determining correlation coefficients (Spearman’s rho) for each of the four body areas. The data plots, correlation coefficients and significance levels found are shown in Figures 15 –18.
Figure 8. Level and extent of agreement for 
Back Posture

Figure 9. Level and extent of agreement for 
Back Motion

Figure 10. Level and extent of agreement for 
Shoulder/Arm Posture

Figure 11. Level and extent of agreement for 
Shoulder/Arm Motion

Figure 12. Level and extent of agreement for 
Wrist/Hand Posture

Figure 13. Level and extent of agreement for 
Wrist/Hand Motion

Figure 14. Level and extent of agreement for 
Neck Posture

Legend:
- Full agreement
- 1 category difference
- 2 category difference
Figure 15. Comparison of QEC Back scores between Expert and Practitioners

$r_s = 0.87$, at 0.01 level of significance

Figure 16. Comparison of QEC Shoulder/Arm scores between Expert and Practitioners

$r_s = 0.86$, at 0.01 level of significance
Figure 17. Comparison of QEC Wrist/Hand scores between Expert and Practitioners

\[ r_s = 0.79, \text{ at 0.01 level of significance} \]

Figure 18. Comparison of QEC Neck scores between Expert and Practitioners

\[ r_s = 0.98, \text{ at 0.01 level of significance} \]
Figures 15-18 show that the tasks selected for the trial covered a variety of exposure levels, as evident from the wide range of scores determined for the tasks. Very high levels of agreement were found between the practitioners’ and experts’ scores for the four body areas ($r_s$ range 0.79 – 0.98, level of significance 0.01).

The workers’ responses from the second trial confirmed that in general, the meanings of the QEC worker questions were clear. They considered worker involvement in the assessment process to be invaluable because of the unique insight that they could provide about the performance of the task and any individual problems they might have. No worker believed that they would have any concerns about answering these questions as part of a workplace assessment.

The interviews with practitioners elicited comments and suggestions that were used to amend the QEC forms and Guide (see Appendix 2 for details).

- The time required to conduct the assessments varied from 5-15 minutes. The practitioners recognised that this would vary dependent upon the need to observe a representative series of activities. Tasks that are more complex may take longer to assess and will need to be sub-divided.
- The QEC assessment process was seen to be of value in prompting improvements because it provides a structured process with scores that help prioritise the need for change. It was also considered to be a basis for communications with management and to persuade them to make adequate resources to fund improvements.
- Practitioners believed that QEC could be used in most situations within their organisations, apart from those locations where it would be difficult to observe workers, or where tasks are highly varied and not repetitive.
- QEC could not be considered by itself to be a suitable and sufficient risk assessment, but there was general agreement that it would support and compliment the general risk assessment process within organisations and could form part of their tool box of techniques.
- Practitioners said that they would find web based case studies, including video example of assessments, helpful. Some said that they would also like short structured training programmes, including practical examples to increase their confidence to undertake the QEC and any subsequent interventions.
- Practitioners indicated that their initial selection of tasks or activities for assessment could be reactive (e.g. responding to injury report). Following this, a proactive approach would be adopted informed by staff with local knowledge or based on screening programmes to identify problem tasks. They appreciated the need to look at a range of workers and task on different occasions to ensure the sample was representative.

The practitioners’ ratings for the new version of QEC from Phase 4 and 5 ($n = 13$) were combined, and indicated that they found the QEC to be a straightforward and useful assessment tool. The mean and standard deviations for the three scales (seven points, 1 = Very low, 7 = Very High) and are shown in Table 4.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>6.2</td>
<td>0.73</td>
</tr>
<tr>
<td>Applicability to workplace assessments</td>
<td>5.8</td>
<td>0.99</td>
</tr>
<tr>
<td>Value at work</td>
<td>6.0</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Part 2: QEC & Reference Guide

Introduction

The output from the five phases of the study, described previously have culminated in the development of the revised versions of the Quick Exposure Check and Reference Guide, that are provided in this section of the report.

The Quick Exposure Check is presented in the following section. It comprises

- a front sheet for recording subject information
- a one page assessment form
- a scoring sheet.

The QEC Reference Guide is also presented. This provides information on

- Context for tool use and the introduction to a holistic approach to an assessment of all elements of the work system
- Establishing priorities for assessment and how to break down a job into tasks to assess
- Step-by-step instructions to undertake an assessment
- Interpreting each of the observer’s questions on QEC with pictures from real work settings
- Interpreting each of the worker’s questions on QEC
- Guidance on how to score the assessment
- Advice regarding the interpretation of exposure scores
- Advice on ergonomic action/interventions that might follow from QEC evaluations
Quick Exposure Check (QEC)
Reference Guide
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Getting started and using QEC effectively</td>
<td>4</td>
</tr>
<tr>
<td>Establishing priorities</td>
<td>5</td>
</tr>
<tr>
<td>Completing an exposure assessment</td>
<td>7</td>
</tr>
<tr>
<td>Interpreting QEC questions</td>
<td>8</td>
</tr>
<tr>
<td>Scoring the assessment</td>
<td>11</td>
</tr>
<tr>
<td>Interpreting the scores</td>
<td>12</td>
</tr>
<tr>
<td>Interventions &amp; re-assessment</td>
<td>13</td>
</tr>
<tr>
<td>Appendix</td>
<td>14</td>
</tr>
<tr>
<td>QEC Forms</td>
<td>16</td>
</tr>
</tbody>
</table>
Work related musculoskeletal disorders

Work related musculoskeletal disorders (WMSDs) are a common health problem throughout the industrialised world and a major cause of disability. WMSDs are conditions of the nerves, tendons, muscles, and supporting structures of the musculoskeletal system that can result in fatigue, discomfort, pain, local swelling, or numbness and tingling. WMSDs usually develop from cumulative damage resulting from months or years of exposure to excessive levels of physical and psychosocial stressors at work.

Scientific evidence has shown that physical and psychosocial factors are critical in the development of WMSDs.

The major risk factors for WMSDs in the workplace include:
- heavy manual handling
- repetitive and forceful actions
- vibration
- awkward static postures that arise from badly designed workstations, tools, equipment, working methods
- poor work organisation.

Exposure to such factors produces effects within the worker’s body (e.g. decreased blood flow or local muscle fatigue). If adequate recovery does not take place, it can lead to the development of WMSDs.

The ergonomics approach

The ergonomics approach to reducing musculoskeletal disorders requires the holistic assessment of all elements of the work system so that optimal solutions can be achieved (see diagram below). This requires the full range of generic issues to be considered, such as task design, worker/equipment interface, individual variation (including motivation) and organisational culture, training needs, work organisation and legal requirements. This approach ensures that the needs of all relevant user groups within the organisation are addressed.

The Quick Exposure Check fits within this approach at the level of the individual(s) in the work system and enables their exposure to a range of risk factors for WMSD to be assessed. It is important that the issues depicted in the outer levels of the diagram are also addressed using appropriate ergonomic techniques and that interventions should be considered at all levels.
Quick Exposure Check (QEC)

QEC assesses the exposure of the four body areas at greatest risk to the most important risk factors for WMSDs. QEC has been developed for use by Occupational Safety and Health practitioners, safety representatives or those responsible for health and safety in Small and Medium Enterprises (SMEs) to:

• assess the change in exposure to musculoskeletal risk factors before and after an ergonomic intervention
• involve both the practitioner (observer) and the workers (who have direct experience of performing the job) in conducting the assessment and identifying possibilities for change
• encourage improvement of workplaces and allow consideration of the comparative impact and potential cost benefits of a number of alternative interventions
• increase awareness among managers, engineers, designers, health and safety practitioners and workers about musculoskeletal risk factors in the workplace
• compare exposures between two or more people performing the same task, or between people performing different tasks.

The QEC assessment encourages consideration of changes to workstations, tools, equipment and working methods to eliminate, or at least minimise, levels of exposure. This should be done in discussion with the worker(s). Those who have regular involvement in performing the task may have good suggestions for improvement. Consultation at this stage will assist with the introduction of change in the workplace.

When a change has been made, exposure should be re-assessed to confirm the efficacy of the intervention in reducing the risk factors for WMSDs. This can be done immediately following the change rather than waiting for changes in the prevalence of reported WMSDs to become evident which may take many months.
## Getting started and using QEC effectively

### Role of this guide

QEC allows physical work activities to be assessed in collaboration with the worker. It has been designed to be quick, easy to use and not require extensive training before use.

A one-page assessment sheet includes questions for both the practitioner (observer) and the worker to quantify exposure to risk for WMSDs. The exposure levels for four main areas of the body can be scored and these can form a basis for intervention and re-assessment. See sample QEC Assessment Form at the end of this Guide.

The guide aims to:
- provide background to QEC
- present information on how to prioritise tasks for assessment and conduct basic task analysis
- explain each question and describe the range of answers
- show how to score assessments
- encourage a systems approach to making interventions.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decide on task to be assessed</td>
<td>(Establishing priorities pg 5)</td>
</tr>
<tr>
<td>Conduct the assessment</td>
<td>(Completing an exposure assessment pg 7 and Interpreting QEC questions pg 8)</td>
</tr>
<tr>
<td>Score</td>
<td>(Scoring the assessment pg 11)</td>
</tr>
<tr>
<td>Interpret and prioritise</td>
<td>(Interpreting the scores pg 12)</td>
</tr>
<tr>
<td>Re-assess the change</td>
<td>(Interventions and re-assessment pg 13)</td>
</tr>
</tbody>
</table>
Establishing priorities

Initially, it is necessary to set priorities for assessment. You may be asked by a worker, a supervisor or a manager to carry out an assessment because of the problems reported by or to them about pain, sickness absence or low productivity for one specific operation. Alternatively, you may be required to carry out assessments as part of your responsibilities to survey a range of jobs and tasks conducted by workers at different locations within your organisation.

If you are directed to a specific task, then begin there and carry out assessments of additional tasks within that job if time allows. If a more general survey has been requested then it may be difficult to decide where and how to start. It is important to set priorities and use resources effectively and the following approaches are suggested:

(a) It may be possible to conduct a workplace survey about pain and discomfort, and focus on those situations where the prevalence of problems is highest (you could use checklists and body maps for this, for example go to the following websites:

   http://ergo.human.cornell.edu/ or
   http://www.hazards.org/tools/index.htm

(b) Organise a representative group of workers to review the work performed and identify five tasks with the highest priority.

(c) Alternatively, if time permits, begin your survey by talking with workers individually and asking them to describe what they do.

- Ask the worker to describe the organisation of their day by hours with breaks.
- Ask them to list the tasks performed and map them onto a plan. Record the task duration.
- Define repetitive and non-repetitive activities within each task.
- Identify actions performed in each task.
- Define cycles and the frequency of repetitive tasks.
- Confirm the information with more than one worker and ask about:
  - a typical day and variations from the norm
  - downtime and stoppages
  - non scheduled breaks
  - any additional/unusual tasks performed at different times in the month/year.
- Carry out assessments for tasks identified.

See over for example >
Example of tasks performed daily by a laboratory technician

For each job ask them to describe the organisation of their day by hours with breaks:

<table>
<thead>
<tr>
<th>Time duration</th>
<th>Hour 1</th>
<th>Hour 2</th>
<th>Hour 3</th>
<th>Hour 4</th>
<th>Hour 5</th>
<th>Hour 6</th>
<th>Hour 7</th>
<th>Hour 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>admin</td>
<td>pipetting</td>
<td>pipetting</td>
<td>rest delivery</td>
<td>Sample</td>
<td>pipetting</td>
<td>pipetting</td>
<td>Lunch</td>
</tr>
</tbody>
</table>

Then look at tasks in more detail:

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Repetitive (R) or not (NR)?</th>
<th>Equipment</th>
<th>Actions performed in task</th>
<th>Cycle length</th>
<th>Frequency of cycle (seconds)</th>
<th>Total duration throughout day (mins)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipetting</td>
<td>R</td>
<td>Pipette</td>
<td>- Place tip in fluid&lt;br&gt;- Depress plunger&lt;br&gt;- Withdraw sample&lt;br&gt;- Transfer/expel sample to well</td>
<td>3</td>
<td>20 per min</td>
<td>240</td>
<td>Delay in sample delivery caused interruption to pipetting task and equipment cleaning task substituted</td>
</tr>
<tr>
<td>Admin</td>
<td>R</td>
<td>Computer</td>
<td>- data entry</td>
<td>10</td>
<td>6</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Sample delivery recording</td>
<td>NR</td>
<td>Date stamp</td>
<td>- record delivery&lt;br&gt;- unpack samples&lt;br&gt;- record classification no.</td>
<td></td>
<td></td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>
Completing an exposure assessment

In order to conduct an exposure assessment, it is necessary to decide what task or part of task you will assess (see page 5). If you observe one repetitive task, it is suggested that you observe the task for 20/30 cycles before completing the form. It should take approximately 10 minutes to make the assessment. Where daily patterns of work and job demands vary, observe workers more than once. For group work, ensure a sufficiently representative number of individual workers are assessed. Re-observation may be necessary to confirm judgements made.

1. Introduce yourself and explain the aims of the exposure assessment.

2. Enter the details on the front sheet: worker's name, job title, task, assessor's name, date and time of assessment in the space provided. Leave 'Action required' blank until you have completed the exposure assessment.

3. Answer each question with respect to the task you have selected to assess.

4. For each question in the Observer's Assessment place a tick in the most appropriate shaded box for questions A-G based on your observation of posture and movement of the back, shoulder/arm, wrist/hand and neck. The graduation in shading for each question indicates an increase of exposure to risk.

5. Assess the 'worst case' for each body area. For example:
   - the assessment for back posture should be made at the moment when the back is most heavily loaded, i.e. when the person leans or reaches forward to pick up the load.
   - the assessment of frequency of motion should be recorded when a production line is at full speed.

6. If you do not have a clear view of the worker, change your position or ask the worker to demonstrate the posture. If the person is crouching or kneeling this may pose additional risks and may need to be investigated in a supplementary assessment.

7. For the Worker's Assessment, ask the worker to answer the questions and then place a tick in the appropriate box. The graduation in shading for each question indicates an increase of exposure to risk.

8. The worker's answer may differ from the actual answer and the observer may want to carry out some measures to inform any intervention that may be introduced e.g. by measuring the weight of the load. However, this measure should be used to supplement the exposure assessment and not to replace the worker's assessment of the load, as workers' opinions are very important.

9. In three questions on the Worker's Assessment (L, P, Q), you should ask the worker for more detail if appropriate as a basis for identifying the nature of the problem and opening a dialogue to seek solutions. This information can be recorded in the box at the bottom of the page. This area can also be used to record other observations made during the assessment.

10. Providing immediate feedback to workers after you have assessed the task can be useful in terms of credibility and also to encourage suggestions for improvements. These could be incorporated into the Action Required section on the front of QEC. The graduation in shading for each question indicates an increase of possible risk and this can helpful in telling the worker where particular problems lie.


12. Enter Actions Required on the front of the form.

13. After an intervention has been made, another exposure assessment should be conducted to assess the change in exposure to risk factors for WMSDs (see pages 12 and 13).
### Observer’s assessment
If in doubt when conducting the assessment, opt for the higher exposure category.

### Assessment of the back

#### Back posture (A1-A3)
- **The back is defined as almost neutral (A1) if it is in less than 20° of flexion/extension, twisting, or side bending.**
- **The back is defined as moderately flexed or twisted or side bent (A2) if it is in more than 20° but less than 60° of flexion/extension, twisting or side bending.**
- **The back is defined as excessively flexed or twisted or side bent (A3) if it is in more than 60° of flexion, twisting or side bending.**

#### Back movement (B1-B5)
Select ONLY one of the two task options:
- If you are assessing a standing or seated stationary task (e.g. sedentary work, repetitive tasks), assess B1-B2 and ignore B3-B5. If the back is static for most of the time, select B2.
- If you are assessing a lifting, pushing/pulling or carrying task (i.e. moving a load by moving the back), assess B3-B5 and ignore B1-B2. This question refers to how often the person needs to bend or rotate the back when performing these types of manual handling tasks. For example, when unloading boxes from a pallet, count the number of times per minute the individual's back moves to lift and lower the load. Then select the most appropriate category B3-B5.
Assessment of the shoulder/arm

**Shoulder/arm position (C1-C3)**
The assessment should be based upon the position of the hands when the shoulder/arms are most heavily loaded during work.

This may not necessarily be at the same time as when the exposure of the back is assessed. For example, the load on the shoulder may not be at the highest level when the person bends down to pick up a box from the floor, but may become greater subsequently when the box is placed at a higher level.

**Shoulder/arm movement (D1-D3)**
The movement of the shoulder/arm is defined as:
- Infrequent (D1) if there is some intermittent movement.
- Frequent (D2) if there is a regular movement with some pauses.
- Very frequent (D3) if there is almost continuous movement.

Assessment of the wrist/hand

**Wrist/hand posture (E1-E2)**
This posture is assessed during the task when the most awkward wrist posture is adopted. This may be wrist flexion/extension, side bending (ulnar/radial deviation).

The wrist is regarded as almost straight (E1) if the movement is limited within a small angular range (e.g. less than 15°) of the neutral wrist posture. Otherwise, if an obvious wrist angle can be observed during the performance of the task, the wrist is considered to be deviated or bent (E2).

**Wrist/hand movement (F1-F3)**
This refers to the movement of the wrist/hand and forearm, excluding the movement of the fingers. One motion is counted every time the same or similar motion pattern is repeated over a set period of time (e.g. 1 minute).

Assessment of the neck (G)

The neck posture is defined as excessively bent or twisted if the angle is greater than 20° relative to the torso. If this angle is exceeded select either G2 or G3 dependent upon the duration. Otherwise select G1.
Worker's assessment of the same task

The worker’s responses are an integral part of the assessment and it is important that they answer each question based on their experience of doing the work. Explain the meaning of the questions and list the response categories. If the worker is in doubt, opt for the higher exposure category.

<table>
<thead>
<tr>
<th>Maximum weight handled (H1-H4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question refers to the weight borne by the worker, and not the maximum weight handled in the task or the load handled with the use of equipment.</td>
</tr>
<tr>
<td>The worker’s perception of the load weight may differ from the actual weight category, e.g. a light load may seem heavy if held at full reach. The actual weight of the load can be measured by the observer if required, to inform any intervention that may be introduced. However, this measure should be used to supplement the exposure assessment and not to replace the worker’s assessment of the load.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time spent on task (J1-J3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question examines the amount of time per day the worker spends conducting the task being assessed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum force level (K1-K3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question refers to the maximum force level exerted by one hand when performing the task. Even if the task is performed with two hands, ask the worker about the force for one hand only.</td>
</tr>
<tr>
<td>Measures of the forces involved can be made by the observer to inform any intervention that may be introduced. However, this measure should be used to supplement the exposure assessment and not to replace the worker’s perception of the force required to perform the task.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visual demand (L1-L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask the worker to specify if the level of visual demand of the task is ‘low’ (almost no need to view fine details) or ‘high’ (need to view some fine details). If the requirement is ‘high’, ask for more information about this aspect of the task. Record this in the space at the bottom of the page.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Driving (M1-M3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question investigates whole-body vibration that may result from driving a vehicle at work. The worker is asked to estimate total time spent driving a vehicle during the working day. If the worker does not drive, do not leave the answer blank, place a tick in M1 ‘Less than one hour per day or Never’. This question only refers to driving at work, do not include driving to and from work.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vibration (N1-N3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question enquires about the hand-arm vibration that may arise from using vibrating tools at work. The worker is asked to estimate the total time spent using vibrating tools during the working day. If the worker does not use vibrating tools, do not leave the answer blank, place a tick in N1 ‘Less than one hour per day or Never’.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work pace (P1-P3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question asks about the difficulties that workers may have keeping up with their work. If the answer is ‘often’, ask for more information about this aspect of the work. Record this in the space at the bottom of the page.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stress (Q1-Q4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This question asks how stressful the worker finds their job. If the answer is ‘moderately’ or ‘very’, ask for more information about this aspect of the job. Record this in the space at the bottom of the page.</td>
</tr>
</tbody>
</table>
The QEC Exposure Scores are based on combinations of risk factors identified by the observer for each body area and by the worker’s subjective responses. These scores represent a hypothetical relationship between the increased level of exposure and potential health outcomes. Current epidemiological evidence is not sufficient to define the actual relationship for different working situations. Nevertheless, the existing scoring system provides a basis for comparing the level of exposure before and after an intervention. In addition, increasing levels of exposure are signified by darker shading in the boxes on both the assessment and the scoring sheets.

The assessment scores should be used to:
• determine the comparative levels of exposure for each body area
• identify where exposures are highest, and consequently, prioritise the issues that interventions should address.

The aim of an intervention is to reduce exposure scores. When changes to a task are planned, an assessment should be done based upon the improvements proposed. This will indicate the potential benefits of the intervention and reveal if the exposure to risk factors for any other body area is increased inadvertently. Re-assessment should always be done following the implementation of any intervention.

**To score the exposure assessment**

1. Use the Exposure Scores sheet to determine the scores for each body area. For example, at the top left hand corner of the sheet for the Back:
   • The first table shows the scores for combinations Posture (A1-3) and Weight (H1-4). Identify the corresponding exposure combination, e.g. the combination A2 and H2 would score 6, for A3 and H3 score 10. Enter this in the ‘Score 1’ box at the bottom right-hand corner.
   • Do this for the correct combination of factors for the back, i.e. by calculating either scores 1 to 5 OR scores 1 to 3 plus score 6.
   • Then sum the total scores for the back.

2. Repeat this procedure for each body area and other factors (i.e. driving, vibration etc).

3. Do this following both the initial assessment and any intervention.
Exposure scores for body areas

The total score for each body area is determined from the interactions between the exposure levels for the relevant risk factors (see table below), and their subsequent addition.

It is important to take note of which interactions contribute most to the overall score for each body area.

The exposure scores for the back, shoulder/arm, wrist/hand and neck have been categorised into 4 exposure categories: Low, Moderate, High or Very High.

Even if the exposure score is Low, it is important to note that one or two interactions may be contributing disproportionately to the score (i.e. a score of 8 or more).

For Moderate, High and Very High scores, there are likely to be several interactions that should be identified and reduced. It is also possible that one or two interactions are at the highest levels (i.e. 10 or 12) of exposure. These should be addressed urgently to reduce the level of exposure for these factors.

These interactions should be monitored and reviewed as injury to the body could occur if exposure continues.

Exposure scores for other factors

The exposure scores for driving, vibration and work pace have been categorised into three exposure categories: Low, Moderate, High. Stress has a fourth category: Very High. Where scores are Moderate or High, or Very High, the level of exposure should be reduced.

<table>
<thead>
<tr>
<th>Important risk factors</th>
<th>Wrist/hand</th>
<th>Neck</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Back</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• load weight</td>
<td>• force</td>
<td></td>
</tr>
<tr>
<td>• duration</td>
<td>• duration</td>
<td></td>
</tr>
<tr>
<td>• frequency of movement</td>
<td>• frequency of movement</td>
<td></td>
</tr>
<tr>
<td>• posture</td>
<td>• posture</td>
<td></td>
</tr>
<tr>
<td><strong>Shoulder/arm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• load weight</td>
<td>• duration</td>
<td></td>
</tr>
<tr>
<td>• duration</td>
<td>• posture</td>
<td></td>
</tr>
<tr>
<td>• task height</td>
<td>• visual demand</td>
<td></td>
</tr>
<tr>
<td>• frequency of movement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is important to take note of which interactions contribute most to the overall score for each body area.

<table>
<thead>
<tr>
<th>Score</th>
<th>Exposure level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Back (static)</td>
<td>8-15</td>
</tr>
<tr>
<td>Back (moving)</td>
<td>10-20</td>
</tr>
<tr>
<td>Shoulder/arm</td>
<td>10-20</td>
</tr>
<tr>
<td>Wrist/hand</td>
<td>10-20</td>
</tr>
<tr>
<td>Neck</td>
<td>4-6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Exposure level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Driving</td>
</tr>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Driving</td>
<td>1</td>
</tr>
<tr>
<td>Vibration</td>
<td>1</td>
</tr>
<tr>
<td>Work pace</td>
<td>1</td>
</tr>
<tr>
<td>Stress</td>
<td>1</td>
</tr>
</tbody>
</table>
Interventions

When seeking to make changes to reduce the exposure of workers to known risk factors for WMSDs, it is essential to consider all aspects of the work system so that optimal solutions can be achieved (see diagram below).

The ergonomics approach seeks to re-design the work system by considering the full range of relevant issues, including:

- Tasks undertaken
- Job demands
- Equipment or work space
- Interactions between sets of equipment and groups of people
- Work organisation
- Environmental factors
- Overall system goals

QEC is helpful in addressing some aspects of the work system but it will be necessary to collect and use additional information. Appropriate methodologies can be found in a number of reference sources or advice can be sought from professional bodies (see appendix).

Re-assessment of exposure

Re-assessment should be undertaken following:

- changes in work processes,
- changes in output levels e.g. due to seasonal demands,
- any workplace intervention.

Exposure assessment is an on-going process. Assessments records should be maintained to allow comparisons over time for various work tasks. Additionally exposure records for individual workers can be compiled.

Over the long-term, exposure data for different jobs should be generated and compared to other health indicators recorded at work (e.g. reported complaints or sickness absence).

The data from the exposure assessment/re-assessments can inform discussions with management on the priorities for change and the comparative effectiveness of different solutions to reduce WMSDs.
Development of QEC

The Quick Exposure Check [QEC] was designed at the Robens Centre for Health Ergonomics to meet practitioners requirements for a practical method of assessing exposure to WMSD risk factors in the workplace.

It was developed using a participatory ergonomics approach, with 200 practitioners involved throughout the process. It was developed, tested, modified and validated based upon both simulated and real work tasks. The tasks covered a wide range of work activities, such as manual handling, repetitive tasks, static or dynamic tasks, seated or standing tasks, and tasks with low or high visual demands.

Studies have shown that QEC has good sensitivity and usability, ‘acceptable’ or ‘moderate levels of agreement’ for its inter-observer reliability, and a good intra-observer reliability. Field studies have indicated that it is reliable in a practical context and suitable for a wide range of jobs.

Cost benefits

An approach to determine cost benefits of health and safety interventions has been developed by European Safety and Health. Details of these can be found at: http://europe.osha.eu.int/good_practice/risks/msd/.

Legal requirements to prevent musculoskeletal disorders

The European Directives that provide protection for workers against developing Musculoskeletal Disorders are:

- Directive 90/270 - identification and prevention of risks from work with display screen equipment, including minimum requirements for equipment, work environment and computer interface.
- Directive 89/654 - minimum standards for workplaces, including seating, lighting, temperature and work station layout.
- Directive 89/655 - suitability of work equipment.
- Directive 89/656 - suitability of personal protective equipment.
- Directive 93/104 - organisation of working time.

Details of these can be found at: http://europe.osha.eu.int/legislation/directives/

These are supplemented by further Regulations and Guidance within specific member states, e.g. Manual Handling Operations (L23) and Upper Limb Disorders in the workplace (HSG60) in the UK.
Professional societies and organisations
- The Ergonomics Society http://www.ergonomics.org.uk
- Institution of Occupational Safety and Health http://www.iosh.co.uk
- Health and Safety Executive http://www.hse.gov.uk
- Robens Centre for Health Ergonomics http://www.eihms.surrey.ac.uk/robens/erg/

Journals, books and reports

Upper limb disorders

Vibration

Stress
Quick Exposure Check (QEC)

QEC has been designed to:

- assess the changes in exposure to musculoskeletal risk factors of the back, shoulders and arms, hands and wrists, and neck before and after an ergonomic intervention
- involve the practitioner (i.e. the observer) who conducts the assessment, and the worker who has direct experience of the task
- indicate change in exposure scores following an intervention

The QEC Guide gives more detailed information about each question and the background to QEC.

Worker’s name: 

Worker’s job title: 

Task: 

Assessment conducted by: 

Date: _______________  Time: _______________

Action(s) required:

__________________________

__________________________

__________________________
Observer's Assessment

Back
A When performing the task, is the back (select worse case situation)
A1 Almost neutral?
A2 Moderately flexed or twisted or side bent?
A3 Excessively flexed or twisted or side bent?
B Select ONLY ONE of the following two task options:
EITHER
For seated or standing stationary tasks. Does the back remain in a static position most of the time?
B1 No
B2 Yes
OR
For lifting, pushing/pulling and carrying tasks (i.e., moving a load). Is the movement of the back
B3 Infrequent (around 3 times per minute or less)?
B4 Frequent (around 8 times per minute)?
B5 Very frequent (around 12 times per minute or more)?

Shoulder/Arm
C When the task is performed, are the hands (select worse case situation)
C1 At or below waist height?
C2 At about chest height?
C3 At or above shoulder height?
D Is the shoulder/arm movement
D1 Infrequent (some intermittent movement)?
D2 Frequent (regular movement with some pauses)?
D3 Very frequent (almost continuous movement)?

Wrist/Hand
E Is the task performed with (select worse case situation)
E1 An almost straight wrist?
E2 A deviated or bent wrist?
F Are similar motion patterns repeated
F1 10 times per minute or less?
F2 11 to 20 times per minute?
F3 More than 20 times per minute?

Neck
G When performing the task, is the head/neck bent or twisted?
G1 No
G2 Yes, occasionally
G3 Yes, continuously

Workers
H Is the maximum weight handled MANUALLY BY YOU in this task?
H1 Light (5 kg or less)
H2 Moderate (6 to 10 kg)
H3 Heavy (11 to 20 kg)
H4 Very heavy (more than 20 kg)

J On average, how much time do you spend per day on this task?
J1 Less than 2 hours
J2 2 to 4 hours
J3 More than 4 hours

K When performing this task, is the maximum force level exerted by one hand?
K1 Low (e.g., less than 1 kg)
K2 Medium (e.g., 1 to 4 kg)
K3 High (e.g., more than 4 kg)

L Is the visual demand of this task
L1 Low (almost no need to view fine details)?
*L2 High (need to view some fine details)?
* If High, please give details in the box below

M At work do you drive a vehicle for
M1 Less than one hour per day or Never?
M2 Between 1 and 4 hours per day?
M3 More than 4 hours per day?

N At work do you use vibrating tools for
N1 Less than one hour per day or Never?
N2 Between 1 and 4 hours per day?
N3 More than 4 hours per day?

P Do you have difficulty keeping up with this work?
P1 Never
P2 Sometimes
*P3 Often
* If Often, please give details in the box below

Q In general, how do you find this job
Q1 Not at all stressful?
Q2 Mildly stressful?
*Q3 Moderately stressful?
*Q4 Very stressful?
* If Moderately or Very, please give details in the box below

*Additional details for L, P and Q if appropriate
Exposure Scores

Worker's name ____________________________ Date ____________

Back

Back Posture (A) & Weight (H)

A1 A2 A3

H1 2 4 6
H2 4 6 8
H3 6 8 10
H4 8 10 12

Score 1

Back Posture (A) & Duration (J)

A1 A2 A3

J1 2 4 6
J2 4 6 8
J3 6 8 10

Score 2

Duration (J) & Weight (H)

J1 J2 J3

H1 2 4 6
H2 4 6 8
H3 6 8 10
H4 8 10 12

Score 3

Now do ONLY 4 if static OR 5 and 6 if manual handling

Static Posture (B) & Duration (J)

B1 B2

J1 2 4
J2 4 6
J3 6 8

Score 4

Frequency (D) & Weight (H)

D1 D2 D3

B1 2 4 6
B2 4 6 8
B3 6 8 10
B4 8 10 12

Score 5

Frequency (D) & Duration (J)

D1 D2 D3

J1 2 4 6
J2 4 6 8
J3 6 8 10

Score 6

Total score for Back

Sum of scores 1 to 4 OR Scores 1 to 3 plus 5 and 6

Shoulder/Arm

Height (C) & Weight (H)

C1 C2 C3

H1 2 4 6
H2 4 6 8
H3 6 8 10
H4 8 10 12

Score 1

Height (C) & Duration (J)

C1 C2 C3

J1 2 4 6
J2 4 6 8
J3 6 8 10

Score 2

Duration (J) & Weight (H)

J1 J2 J3

H1 2 4 6
H2 4 6 8
H3 6 8 10
H4 8 10 12

Score 3

Frequency (D) & Weight (H)

D1 D2 D3

B1 2 4 6
B2 4 6 8
B3 6 8 10
B4 8 10 12

Score 4

Frequency (D) & Duration (J)

D1 D2 D3

J1 2 4 6
J2 4 6 8
J3 6 8 10

Score 5

Total score for Shoulder/Arm

Sum of scores 1 to 5

Wrist/Hand

Repeated Motion (F) & Force (K)

F1 F2 F3

K1 2 4 6
K2 4 6 8
K3 6 8 10

Score 1

Repeated Motion (F) & Duration (J)

F1 F2 F3

J1 2 4 6
J2 4 6 8
J3 6 8 10

Score 2

Duration (J) & Force (K)

J1 J2 J3

K1 2 4 6
K2 4 6 8
K3 6 8 10

Score 3

Wrist Posture (E) & Force (K)

E1 E2

K1 2 4
K2 4 6
K3 6 8

Score 4

Wrist Posture (E) & Duration (J)

E1 E2

J1 2 4
J2 4 6
J3 6 8

Score 5

Total score for Wrist/Hand

Sum of scores 1 to 5

Neck

Neck Posture (G) & Duration (J)

G1 G2 G3

J1 2 4
J2 4 6
J3 6 8

Score 2

Visual Demand (L) & Duration (J)

L1 L2

J1 2 4
J2 4 6
J3 6 8

Score 2

Total score for Neck

Sum of scores 1 to 2

Driving

M1 M2 M3

1 4 9

Total for Driving

Vibration

N1 N2 N3

1 4 9

Total for Vibration

Work pace

P1 P2 P3

1 4 9

Total for Work pace

Stress

Q1 Q2 Q3 Q4

1 4 9 16

Total for Stress
Seminar, Meetings & Conferences

Presentations

1. G David, V Woods and P Buckle

*Musculoskeletal Risk: assessment methodologies Launch of a new version of the Quick Exposure Check*

Human Factors in the Process Industry, Institute of Chemical Engineers Symposium, Dennison Centre, University of Hull, Hull.

20\textsuperscript{th} March 2003

This presentation reviewed the extent of the current problem and recent scientific knowledge on the development and management of work-related musculoskeletal disorders. An overview of different types of assessment techniques was provided together with more detailed information about the further development of QEC.

2. P Buckle, G David and V Woods

*Musculoskeletal Risk: assessment methodologies*

Society of Occupational Medicine, Annual Scientific Meeting 2003, Southampton

8\textsuperscript{th} July 2003

This presentation reviewed the different types of assessment techniques for work-related musculoskeletal disorders including specific information about the development of QEC.

P Buckle, and G David

*Ergonomics Musculoskeletal Risk and Exposure Assessment*

Society of Occupational Medicine, Annual Scientific Meeting 2003, Southampton

8\textsuperscript{th} July 2003

This workshop was attended by over 50 members of the Society of Occupational Medicine. The majority of the participants was occupational physicians and came from a wide range of industrial sectors.

Few had used any formal technique for WMSD assessment; ad hoc evaluations were made based upon a site visit and attempting the activity themselves or based on a worst case, i.e. female worker. Of those who had used assessment techniques, a few had used the HSG60 checklists, and had documented records of the risk assessments that they had undertaken. Others had used RULA to quantify the level of exposure, and liked the fact that it put numbers to the main risks apparent for a task. They may also call upon the services of other health and safety staff to undertake assessments.

Four examples of the many methods that have been developed for WMSD exposure assessment were presented and their comparative advantages and disadvantages discussed with the participants. The benefits of QEC were demonstrated by carrying
out a trial assessment from video film of a pipetting task. QEC was recommended as a tool that
- is straightforward to use by Occupational Health Staff or Managers,
- is suitable for a wide range of tasks,
- will encourage changes in the work system within their organisation,
- can be used to evaluate the proposed change in advance,
- will demonstrate the need for workplace improvements to managers.

The discussions confirmed the need to use tools wisely, and within the context of a general ergonomics approach to making interventions in the workplace.

3. **Assessing musculoskeletal disorders at work: which tools to use when?**

Robens Centre for Health Ergonomics, University of Surrey
17th July 2003

Over 60 people from a wide range of organisations attended this event, and the participants were mostly from health & safety related professions. The aims were:
- to review the issues surrounding exposure assessment and the techniques used at the workplace
- to consider the advantages and disadvantages of different techniques, and
- to identify what is needed with regard to WMSD exposure assessment in future.

The participants were provided with an overview of the topic by presentations covering the HSC strategies and targets, WMSD risk factors, exposure assessment techniques and their application within European standards. This was followed by short descriptions of a range of assessment techniques namely, those developed by the HSE for manual handling (including the newly introduced Manual Handling Assessment Check, MAC), Display Screen Equipment, and upper limb disorders. In addition, two further techniques, the Quick Exposure Check (QEC) and Rapid Upper Limb Assessment (RULA), were also described.

Two presentations, one from an expert and the other a practitioner, set the scene for the workshop discussions. The aim of the workshop session was to provide the participants with the opportunity to discuss salient issues about the application of current methods for assessing risk and exposure for work related musculoskeletal disorders, and then feed these back for general discussion at the plenary session.

It was apparent that participants had used a wide range of assessment techniques, including HSE Checklists and other tools such as RULA, REBA, and QEC.

The issues that participants considered important when selecting appropriate assessment tools for application in different circumstances were reviewed and the factors that should be addressed when making a choice of an assessment tool were identified.
The issues that must be addressed for the future, further development of assessment tools included:

• training and the competence of users
• legal compliance
• the available evidence for the risk assessment criteria chosen
• the assessment of additional factors and interactions between risk factors
• the epidemiological evidence underpinning the use of scoring systems
• the effectiveness of any proposed improvements
• making assessment tools more accessible to engineers and designers.

The discussions also confirmed the need to use tools wisely, and within the context of a general ergonomics approach to making interventions in the workplace.

A fuller report of the outcomes of this conference may be found at http://www.eihms.surrey.ac.uk/robens/erg/QEC.htm

4. G David, V Woods, P Buckle and D Stubbs  
**Further development of the quick exposure check (QEC).**

The XVth triennial Congress of the International Ergonomics, August 20-28, Korea, 2003,

This presentation was one of five papers presented at IEA symposium session S046 "Management of work related musculoskeletal disorders at a company level: new tools and new approaches"

The other presentations were – “New tools and new approaches” Hanne Christensen, Denmark; Jørgen Winkel, Sweden, Svend Erik Mathiassen, Sweden, Nils Fallentin, Denmark.

"Threshold limit values or ergonomics programs - an overview of developmental trends in EU and the US.” Nils Fallentin, Denmark.


"A database for control of work related musculoskeletal disorders” Tom Armstrong, US.

These presentations were followed by an open discussion amongst those attending.

Published Papers


Report and Guide References


Upper limb disorders


Vibration


Stress


## Appendix 1

### Issues and action points from Phase 1

A list of issues and suggested improvements were drawn up following the review of the interview, focus group and research team data, these are displayed below. Some of these points are inter-related. In addition the table indicates the ‘usability’ criteria the issue pertains to [Attitude (A), Learnability (L), Flexibility (F) and Effectiveness (E)].

<table>
<thead>
<tr>
<th>Layout</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Recording data at work site</td>
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<tr>
<td>- Single sheet (like RULA) is preferable</td>
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<td>x</td>
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<tr>
<td>- Space for jotting down additional comments</td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td>- Clarify back movement: B1-B3 vs B4-B5</td>
<td>x</td>
<td></td>
<td>x</td>
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</tr>
<tr>
<td>2. Ideally intuitive use needs to be considered/enhanced but balanced by guide</td>
<td></td>
<td></td>
<td>x</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Worker responses</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Link in with ergonomics participatory approach</td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>- Brief reference in Guide with more detail in Appendix</td>
<td></td>
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<tr>
<td>4. Specific questions: improvement by asking why?/better format/more objective</td>
<td></td>
<td>x</td>
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<td></td>
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<tr>
<td>- Work stress</td>
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<tr>
<td>- Pace</td>
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<tr>
<td>5. Clarification of weight handled question to relate to load borne by worker</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>6. Difficult for worker to stipulate weight of items handled</td>
<td>x</td>
<td></td>
<td>x</td>
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</tr>
<tr>
<td>7. Difficult for worker to stipulate force level applied by the hand</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>8. Value of dynamometer measurements &amp; workplace examples (e.g. bag of sugar)</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>9. Difficult for worker to respond to vibration question</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
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<tr>
<td>- Maybe give examples e.g. steering wheel vs pneumatic drill</td>
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<tr>
<td>10. Data gathering by practitioner alone to provide answers to the above questions would limit interaction with workers. The opportunity for interaction with workers should not be confined solely to the QEC format if additional points wish to be made by the workers</td>
<td></td>
<td></td>
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<td>x</td>
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<table>
<thead>
<tr>
<th>Other risk factors</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
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<tbody>
<tr>
<td>11. Possibly included environmental concerns</td>
<td></td>
<td>x</td>
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<tr>
<td>- E.g. temperature, space and layout</td>
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<tr>
<td>12. Important to ensure that any additional factors do not make it too long or complicated to apply</td>
<td></td>
<td>x</td>
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<table>
<thead>
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<th>Scoring</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>13. Transparency necessary to propose and prioritise need for change</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Interactions of risk factors should be apparent on scoring sheet as opposed to alphanumeric codes</td>
<td>x</td>
<td></td>
<td>x</td>
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</tr>
<tr>
<td>- Banding desirable to prioritise change: rationale should be logical but may be localised to individual body areas</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>- PC calculations hide interactions and do not stimulate consideration of how improvements may be achieved most effectively: manual vs automated; transparency vs ‘ease of use’</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>- Method: discussed electronic recording (not possible in</td>
<td>x</td>
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</tbody>
</table>

22
some workplaces due to contamination/fire risk)
- Validity vs hypothetical scores for single factors and interactions (ball park only)

<table>
<thead>
<tr>
<th>Guide</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
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<tbody>
<tr>
<td>14. See point 20</td>
<td>x</td>
<td>x</td>
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<tr>
<td>- To evaluate/define potential work restrictions for workers returning following injury</td>
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<td>x</td>
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<tr>
<td>15. Back-end of tool</td>
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<td>x</td>
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<tr>
<td>- Identify potential interventions</td>
<td></td>
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<tr>
<td>16. Supporting/stimulating the need for change</td>
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<td>x</td>
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<tr>
<td>- See point 16 &amp; 33</td>
<td></td>
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<td>x</td>
<td>x</td>
</tr>
<tr>
<td>- Presentation to management/workforce: link to participatory approach (point3) to propose/prioritise need for change</td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>- To assess the success of interventions: cost benefit potential</td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>17. Limitations in existing guidance: need to read full report to supplement this</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>- Case studies on how to use QEC, electronic, short video clips</td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>- Stick figure postures difficult to relate to actual workers</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>- How to assess crouching and kneeling</td>
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<tr>
<td>- Difference between motion and movement of the back</td>
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<tr>
<td>- More information on shoulder position</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>- Hand force examples needed</td>
<td></td>
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<tr>
<td>- Vibration - hand and/or whole body?</td>
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<tr>
<td>- Need to specify ‘worst case’ for all body parts</td>
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<tr>
<td>- More information on assessing manual handling/push/pull tasks</td>
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<tr>
<td>- Interpretation of hand movement variability</td>
<td></td>
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<td>x</td>
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<tr>
<td>- Initial discussions with management and workers to define expectations and reduce anxieties (point 34)</td>
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<table>
<thead>
<tr>
<th>Training</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>18. Practise necessary to build confidence in correct application</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>- Link to Guide</td>
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<tr>
<td>19. Enhanced/advanced training</td>
<td></td>
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<td>x</td>
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<tr>
<td>- Practice and feedback in small groups to formulate solutions</td>
<td></td>
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<td>x</td>
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<tr>
<td>- Improvement of intra/inter reliability</td>
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<tr>
<td>- Incorporation into ergonomics/MSD awareness courses: risk assessment and manual handling</td>
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<tr>
<td>- Mandatory group training may restrict accessibility to the tool</td>
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<table>
<thead>
<tr>
<th>QEC use</th>
<th>A</th>
<th>L</th>
<th>F</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Clarification of QEC’s function (exposure v risk assessment)</td>
<td></td>
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<tr>
<td>- Evaluation of existing guide on using QEC</td>
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<td>- Redesign of introduction and provision of examples</td>
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<td>21. Use within the context of the organisation’s H&amp;S policy, business plan and labour relations situation</td>
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<tr>
<td>22. Link to national/European risk assessment requirements</td>
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<tr>
<td>- Decide the place of QEC in risk assessment process, its relationship to HSG60 etc</td>
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<td>23. Establish priorities for improvements</td>
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23
- Explore banding, NIOSH lifting guidelines/approach, Compliment to MHOR L23 checklist or in-house generic checklists

24. Long term use of QEC data
   - Link QEC scores to outcome measures (e.g. sickness absence), Pain diaries, Health history, Reported incidence/prevalence of MSD to establish risk assessment guidance for specific organisations

25. Exposure assessment score charts kept on individual files to review future development of MSD

26. Evaluate results for individuals on basis of illness and injury records, but issues over confidentiality should be respected

27. Exposure assessment should be an on-going process as
   - a reference database/baseline
   - a basis for informing the management of change
   - a basis for development of a strategy for change, long term use

28. Observation of one repetitive task: suggestion of 20/30 cycles taking approx 10 mins. Re-observation may be necessary to confirm judgements made
   - Links to guidance points 14-17

29. Obscured views (and guidance on this)
   - Workers clothing

30. Guidance necessary on static postures (B4/B5) vs manual handling frequencies (B1-B3)
   - E.g. QEC used for assessment of more static, repetitive tasks performed at workstation whereas MHOR L23 used for less structured manual handling tasks?

31. If in doubt opt for higher score exposure category – link to guide

32. Need to observe more than one worker and more than one shift, to cover a representative sample of the workforce. Time required to do this

33. Immediate feedback to workers – desirable for credibility and useful for encouraging suggestions for improvements

34. Simple procedures for breaking down jobs. Guidance needed.
   - OCRA breakdown into discrete components. If more than one tasks is evident, then do more than one assessment
   - Cornell checklist and two body charts/to identify priority areas
   - Discussions with workers (or use worker diaries) to establish 5 main tasks and durations of these
   - Exposure for simple, evident tasks vs complete job/full shift
   - Occasional tasks
   - Repetitive vs variable tasks
Appendix 2
Listing of QEC modifications throughout the study

The design and development of QEC involved the following phases that were carried out between June 2002 – August 2003:

- Phase 1: Review of Use (interviews, focus group)
- Phase 2: Refining and Improving the tool
- Phase 3: Usability assessment
- Phase 4: Inter-user reliability
- Phase 5: Validation in the workplace

Modifications to the QEC form, scoring sheet and guide were made throughout the five phases and are documented in the following sections.

**Phase 1: Review of Use (interviews, focus group)**

a) Initial listing of problems with QEC, based on research team thoughts

**General**
- Task description/delineation – how to prioritise and breakdown jobs into tasks
- Range of factors considered
- Borderline decisions
- Possible guidelines for specific groups: manufacturing/service
- Build up database of tasks to use as examples

**Observation questions**
- Other factors not incorporated into QEC
- Scoring categories were based on median scores (around 3 times per min or less)

**Workers questions**
- Are workers able to estimate weights? If yes, how?
- Are workers able to estimate forces?
- Whole body or hand vibration?
- Insufficient psychosocial questions?
- Difficulty keeping up/stressful – emotive questions?

**Scoring**
- Inclusion of all user questions in scoring?
- Use of scoring systems
- Validity of scoring system
- Interpreting results from scoring system into action and change
- Resolving conflict between improvements in one body area versus deterioration for another
- Complexity of scoring system/interactions
- Scatter of scores

**Training**
- Is more required?
- Understanding what QEC does (i.e. exposure vs risk assessment)
- Examples of where it is feasible to use QEC
b) Following interviews and focus groups the following suggestions were made to modify QEC

- Revise worker questions: 5 questions were highlighted as requiring some change:

  1. What is the maximum weight handled in this task? Light (5kg or less), moderate (6-10kg), heavy (11-20kg) very heavy (more than 20kg), Suggestions: Provide everyday examples for these weights? Clarification of weight handled to relate to load borne by worker as opposed to whole task or with equipment. Rewording: What is the maximum weight handled in this task (i.e. weight of the box, loaded pallet, drain cover etc) then a) if lifting by hand, what is the weight you lift? Or b) If assisted lifting, tilting, pushing pulling (i.e. chain hoist, vacu-lift etc) what is the maximum force you have to apply?

  2. When performing this task (single or double handed), what is the maximum force level exerted by one hand? Low (e.g. less than 1 kg), medium (e.g. 1-4 kg) high (e.g. more than 4 kg). Suggestion: Provide everyday examples for these forces?

  3. Do you experience any vibration at work? Low or no, medium, high, Suggestions: Low or none = driving a car, high = using a hammer drill

  4. Do you have difficulty keeping up with this work? Never, sometimes, often, Suggestions: If often, please give details?

  5. How stressful do you find this work – not at all, low, medium, high, Suggestions: If medium or high, please give details in comment box?

- Revise observer assessment questions
  - Revise B4/B5
  - Clarify in guide and on assessment form the difference between B1-3 and B4-5
  - Ensure that people do not complete both questions
  - Suggestions Slight rewording and reformatting: FOR MANUAL HANDLING ONLY (i.e. moving a load) What is the frequency of back movement?

  OTHER TASKS (i.e. holding something in a fixed position) Is the task performed in static postures most of the time?

- Review scoring
  - Make transparent
  - Banding possible?
  - Ensure that people do not fill in a score for B1-3 and B4-5
  - Different ideas for presentation of interactions – interactions should be apparent on the scoring sheet as opposed to alpha-numerical codes

- Revise format
  - On one page?
  - Provide space for notes and for the 2 worker questions where we may add ‘please give details’
  - Depending on final scoring system, possibly remove a, b, c etc

- Changes to psychosocial questions

Discussion with experts concerning two psychosocial questions to bring them up to date with current research (e.g. The Bristol Stress and Health at Work Study):

  - Do you have difficulty keeping up with this work? Never, sometimes, often
  - Suggestions If often, please give details?
- How stressful do you find this work? Not at all, low, medium, high.
- Suggestions: - If medium or high, please give details?

- Neither question is considered in the interactions scorings but are part of worker score
- We do not particularly want to add additional questions to QEC
- We do not want the questions to be more obtuse for the worker
- Want them to be able to list problems if they have any
- The consensus from the QEC user interviews was that these are useful questions; one person found it helpful to ask for more detail if the person said they found the work stressful.

Phase 2: Refining and Improving the tool

The following changes were made to the QEC form based on the findings of Phase 1.

- 1 page layout for both observer and worker input
- Portrait format: more suitable for a clipboard
- Background details: boxed and more space
- Column titles: observer and worker assessment
- Central summary of observed exposures (recognising that the scoring system may still change) using a colour scheme (red/amber/green)
  - Need to think about position of letters
  - May add in ‘before’ and ‘after’ columns in central scoring
  - Amber/red positioning
- Added scoring summary table at end of form
- Space for additional comments at base of form
- Format of examples moved closer throughout form
- Would be useful to have black/white version as well as colour

Observer assessment
- Highlighted back, shoulder etc headings
- Revision of back movement (B1-B5): rewording and reformatting
- Changed C to clarify position of shoulder/arm/hand when conducting task - this was a concern and area for future research in the original report
- Edit on D: ‘arm’ removed from brackets
- Slight rearrangement of wording in E1-2

Worker assessment
- Change to exposure categories labelling of questions: upper case exposure category labelling
- Rewording of H to clarify question re weight lifted by worker as opposed to with the aid of equipment: ‘manually by you’
- Rearrangement of wording in J: grammatically better
- Rewording of K to ‘with one or both hands’: grammatically better
- Box space for comments on last 4 worker questions: M, N, P, Q
  - Should this include L as well?
- Examples added to vibration and then removed as unsure if these are good indicators of vibration levels
- Have split the vibration question into two, relating to whole body and hand arm vibration
- Slight editing of wording in responses in N – removed ‘there is’
• Stress question (Q) updated in line with current terminology (i.e. Bristol study)
• In questions (vibration and P, Q): changed job/work to task as the focus of all others questions is the task - have changed back as epidemiological evidence is in relation to whole job v task, should vibration questions refer to work/task.
Phase 3: Usability assessment

a) Feedback on QEC from user trials

QEC assessment form layout
- Assessment form is crowded - a lot of information on one page
- Colour coding is useful
- Closeness of the two sets of colour coding appears to imply a relationship between individual worker and observer questions
- Tick or X boxes – instructions needed on QEC form
- One person did not seem to realise that F1-3 is about the wrist/hand. Are the questions too close? Possibly separate out different body parts further or box in some way

QEC Content
- Definition of task needed at beginning
- Job analysis, how to break the task down into a component or a significant piece/segment/section/chunk to analyse. Would help to know the work process
- Important how introduce what you are doing to the worker
- Would like to see historical perspective of the job
- What is the peak load for the task – how do you identify the worst point? Is it where postures are worst for the task, realising that this could be a one off posture as opposed to another posture, maybe less serious, but which is the worse case due to the duration or frequency with which it is adopted? Currently the QEC guide asserts that it is the magnitude of the posture as opposed to the duration or frequency.
- Would like to be able to score right and left side of the body (like REBA)
- What about the lower limbs – why are they not included?
- Liked combination of observer and worker participation
- Gloves made it difficult to assess the hand/wrist postures
- People have different perception of angles
- More suitable for non-repetitive v manual handling tasks
- Decision reached on each question but some surprise from researchers re answers for A1-3 on back flexion
- Realised only had to answer 1 of 2 options (B1-3 or B4-5)
- B1 and B2 – too much difference between categories
- Comment re B1-3 – borderline decision about what type of task was being assessed as the back was at the worst position when the bolts were picked up from the box. One person assessed the task as a manual handling v static task
- Posture questions ok to answer but movement questions (D and F) more difficult to assess
- Time: most got through physical factors within 10 mins. Needed that time to refer back to guide. Would expect new users to do so

Scoring sheet layout
- Poorly delineated – need more compartmentalisation
- Poor position (on the wrong side) of grey boxes
- Too busy
- Need more space
- Three boxes (GAR) not useful, do not add anything
- Add up totals would be better wording for summary scoring box
- Took a while to add up total response
- C and J combined twice – this was confusing for one person
On the interactions chart: one person put the scores in the wrong area, score 3 results in score 2 result area
Due to layout, one person thought it might be possible to miss items
Separate cross referencing on scoring chart for each interaction would make scoring easier
Landscape layout may be better

Scoring sheet content
- The order of the items in the scoring sheet is not necessarily relevant to checklist
- Opposing set of axis/match worker assessment scoring to observer. But scoring relates to physical factors not worker/observer interaction – need more explanation of why comparison of what with what
- Interaction chart would require more education and training
- Better instructions to add up
- Scoring summaries for each body part should be separate from the grid as the presence of the axis makes this confusing

Guide
- Example needed for scoring
- Quite wordy
- Becomes clearer when doing the assessment
- Impact of presentation on guidance - quick reference guide (back p2, neck p3)
- Excellent guidance re posture
- Tabulated example needed for scoring

General
- Terminology which form is which – need to be consistent when talking about the check, the scoring sheet and the guide

b) Changes to QEC based on the above and general instructions to designers

Constraints
- Same order of question presentation
- Same wording of questions
- Differentiate body areas
- Preference for 1 sheet or landscape presentation (observer questions presented over worker questions)
- Area for additional comments
- Funds available
- Time span
- Proximity of coding – gives impression there is a link between worker and observer questions

Possibilities
- Pictures (probably on a double sheet)
- Colour not an issue at the moment
- Vibration questions – maybe two
- Work/job/task – decision about wording
- Guide: add in stool for worker. Pictures need to be realistic
- Cross referencing in guide

c) Changes to QEC following the first draft of the newly designed QEC
Page 1 (background data recording sheet)
- Remove assessment sheet from title
- Add introductory paragraph
  - Worker’s name – have added an apostrophe and dropped the capital on name
  - Worker’s job title - have added an apostrophe
  - For more information on the Quick Exposure Check, contact: have added the, removed s from checks and added a comma after check
  - Remove comma after Surrey
  - Larger font would be preferable for front page

Page 2 – observer and worker assessment
- B1-3 or B4/5 - Need ‘or’ to be more prominent
- Drop ‘position’ from E2
- Small letter for ‘not at all’ on L1 and M1
- Q – do not need colon after job
- Space required at end of page

Page 3 – scoring
- Title required: Exposure Scores

Back
- Reorder position of back scores – replace score 2 with score 4
- Back: score 4 and 5 OR score 6
- Back sum of score not 1 to 6: but 1 to 5 or 1-3 plus 6
- On scoring line: bring body part in line with total score e.g. total score for back at the same level as scoring for other body parts

Other
- Have made the typo changes on the sheet itself

Workers evaluation
- Worker Evaluation, change to Worker’s Assessment on QEC form
- First question should be driving, see sheet
- Add letter after work evaluation questions e.g. Stress (Q)
- Larger font, particularly for titles of each interaction box

d) Comments made about newly revised form at user trials

Assessment form
- Possibly add extra info on front of form: Clock/id number, Hours of work: full/part time, Actions/recommendations for change, Review date, Would be good to have the name at the top of each form, One person thought the front cover would not be used
- Liked that there was not too much on the form
- Liked to see scoring sheet and assessment form alongside each other – remove paperclip
- B1-3 option – could be bolder, made bigger or indented
- Perhaps some of the words on B could be capitalised to stress further the option
- Question B5 – quantifying ‘most of the time’
- L: what if the person drives for 2 hours, the categories are not right
- Same for M
- Question N (visual demand) lack of option; did not feel activity was high but description of high (i.e. some fine details) was accurate description of activity
• Not sure whether to ask workers questions or do them themselves (need to read guide better)
• Shading did not immediately jump out, question asked re which is the highest exposure category, by the time scoring, saw what was going on.
• It is not always obvious which is the higher risk category (until you have done it once or see the obvious pattern) for when on the cusp of two choices
• Use of videos for training
• Where there is great variety in the nature of the tasks within an activity, would need to be assessed separately
• Really liked one sheet
• Needs to be more in guide re F, wanted to focus on the repeated posture not repeated task
• Did not notice ‘give details’ on N, P, Q
• People steered off wording on sheet
• Easy to use generally, not too many questions or tasks to complete

• Liked tick boxes and not having to write too much
• Transparent as to how its measures are calculated, enabling you to see where action could be taken to reduce them
• Following one route from assessment to scoring
• Quick and easy, appears concise, single sheet, very handy
• Cross checks variables (i.e. J and H), simple to use
• Difficult to use in loud environment where verbal communication would be problematic
• Confined areas or multiple staff task areas: questioning staff member and confidentiality
• Large operations where it is difficult to see the task

Scoring
• Possible to drift and make mistakes
• 2 mistakes made on scoring (n=1)
• 5 errors (n=1) – 2 of these due to mislabelling on the assessment form
• Easy to follow
• Exposure scores (B1-3), not clear that you miss this if completing B4/B5. Needed to keep track on what I was scoring as tendency to confuse scores
• Easy to make a mistake with the need to refer back all the time, ideally should be on facing pages
• Did not understand, I needed clarification, i.e. I did not have answers B1-3, it was clear that I skip answering those scores
• So do the scores highlight I should introduce and intervention, at what point?
• Had to read ‘now do 4 and 5 or only 6’ twice
• Might miss the workers assessment summary score due to the position
• Missed out answering a question (ticked the table but forgot to put score in box), good practice to put 0 in box
• Need indication of what the scores mean. Although the neck was at serious risk in the observed task, because it only incorporated two factors, the score was much lower than the others – would a % score be better (i.e. 18 for the neck looks a lot less than 46 for the back even through both are very serious). This is important if this is to be used as a tool for management
• Discussed computer scoring – the group did not want the impact of the interactions to disappear
• Workers assessment – could not follow where scores 1-4 were located, had to point this out – thought they should be on left
• Think it would take some getting used to
• Difficult to cross reference but would get easier on using a couple of times
• I found the scoring sheet time consuming and had to concentrate more. It was helped by the fact questions were numbered

Guide
• Liked diagrams, arm positions were quite extreme, in the assembly task the arms looked like they were between chest and waist height so was not sure what to answer
• Clear guide, did check back once about wrist position
• Referred back once for definitions for back positions. Didn’t use the instructions for scoring except when looking for an answer on B1-3 difficulty
• Shading should be clarified at the start
• Found the instructions confusing, requires clarification
• Guide was concise although ‘assessment of back’ explanation section had to be re-read a couple of times
• Consulted guide for angles and interpretation but this could reduce with experience
• Back postures need to be labelled A1-A3
• Wrist postures need to be labelled E1-E2
• Having a guide was good to relate scoring to degree of risk as it could be used as a tool to persuade management to take some remedial action
• Software would support the counting and results

Phase 4: Inter-user reliability

Front sheet
• Changes to wording of QEC introduction
• Add ‘Action required’ after time and date – this will require more space than currently allocated.
• The section allocated to contact information could be less.

Assessment sheet
• Add Worker’s name and date at the top of this sheet

Observer’s Assessment - Back
• This is an error from the previous draft of the form. The questions under A should read A1, A2, and A3.
• The distinction between B1-3 and B4-5 could be further enhanced. We would suggest that ‘either’ and ‘or’ are in capitals and that perhaps a grey line could be placed between B1-3 and B4-5 to match the scoring sheet.

Worker’s Assessment – L
• Change L2 to More than 1 hour per day

Worker’s Assessment – M
• Change M2 to More than 1 hour per day

Worker’s Assessment – N, P, Q
• The asterix both beside the letter (i.e. N2*) and beside the text underneath the question needs to be larger, many people missed this in the user trial.

Exposure Scores sheet
• Add Worker’s name and date at the top of this sheet
**Back**
- Instruction ‘now do 4 and 5 etc’ could stand out more

**Worker’s assessment on scoring sheet**
- Remove the heading worker’s assessment
- Driving, Vibration, Work Pace and Stress should be given individual orange/white headings like the Back etc
- The work question should be ‘Work Pace’
- No longer need for numbers 1-4 beside each individual score
- In this draft, the individual score boxes had disappeared, still want these
- Remove the total score for worker’s assessment

**Neck**
- This section could be moved down if more space is required to restructure above
Phase 5: Validation in the workplace

Observer assessment

Back
- A **Select worst case situation** in italics after the question in bold
- B Add more caps: Select ONLY ONE of the two following task options
- In order to emphasise the focus of the question, we need to make the actual question stand out something like:
  
  **For lifting, pushing/pulling and carrying tasks (i.e. moving the load):** Is the movement of the back
  
  **For seated and standing stationary tasks:** Does the back remain in a static position (remove for) most of the time?
- In addition, and this will effect the scoring sheet, we would like to change the order of the questions so B4/B5 would become B1/B2 and B1-3 would come B3-5 – this provided an opportunity to consider fully if the task was either done in a static position or was a manual handling task prior to deciding on the frequency of back movement

Shoulder/Arm
- C **Select worst case situation** in italics after the question in bold
- D Slight change of wording: Is the shoulder/arm movement (remove ‘repeated’)
- For D1, D2, D3, make the words infrequent, frequent, very frequent

Wrist/Hand
- E **Select worst case situation** in italics after the question in bold
- E1 should read ‘...an almost straight wrist’
- F Change the wording so it reads…'Are similar motions patterns repeated'

Neck
- Remove ‘excessively’ from the question

Worker’s Assessment
- K remove from the question: ‘with one or both hands’
- L1 and M1 should read Less than one hour per day or Never
- And then something else that will effect the scoring sheet: we would like to move N up the page before the vibration questions so the visual demand question becomes L, the driving question becomes M and the tools question becomes N so the task questions are followed by the questions that relate to the whole job

Exposure scores sheet
- In general this was found much easier to use however a mistake that was commonly made: adding the driving, vibration, workplace, stress and neck scores together to form the neck score
- Based on the changes of the assessment page, the following adjustments will be necessary for the scoring sheet:
- Back:
  - Score 6 (relabelled to score 4) will need to be moved up and score 4 and 5 (relabelled 5 and 6) moved down
  - On score 4, 5 and 6 the labelling on the score box will therefore need to change
- Old score 4: B3, B4, B5 across the top
- Old score 5: B3, B4, B5 across the top
- Old score 6: B1, B2 across the top
- Also the words needs to change to Now do only 4 if static or 5 and 6
- The total scores at the bottom need to change to: Sum of scores 1 to 4 or scores 1 to 3 plus 5 and 6.
  ➢ Driving labels need to change to M1, M2, M3
  ➢ Vibration labels need to change to N1, N2, N3
  ➢ Neck
    - Visual demand is now L so this needs to change in the box title and also the labelling for N1, N2 to become L1, L2

And additional changes

First page
- first section: Change ‘The Guidance’ to ‘The QEC Guide’
- second section: Action(s) required as opposed to Action required
- Copyright University of Surrey

QEC form
- Question B: Either/Or make more noticeable
- Question H: Remove ‘what’ at start of sentence
- Question K: Remove ‘what’ from middle of sentence
- Questions L, P, Q: make asterisk more noticeable

Scoring form
- Back: Now do only 4 if static OR 5 and 6 if manual handling - make as noticeable as possible, many people still missed this in the trials
- Shoulder arm: Transpose height/duration Score 4 and frequency/weight Score 2 to make the scoring easier to complete
- Wrist/hand: Transpose repeated motion/duration Score 4 and wrist posture/force Score 2 to make the scoring easier to complete
- Neck: as people totalled neck and driving, vibration, work pace and stress, we would like to move neck to the top of the page.
Further development of the usability and validity of the Quick Exposure Check (OEC)