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Review of the 3-Year HSE Mattress Manufacturing Initiative

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EXECUTIVE SUMMARY

Background

In 2005 the Health and Safety Executive (HSE) commenced a three-year initiative with bed manufacturers with support from the National Bed Federation (NBF). During 2005 HSE undertook visits to twenty-five manufacturers with a focus on manual handling risk factors and musculoskeletal injuries. The aim was to reduce the number of injuries within the industry. Manufacturers were asked to submit an 'Action Plan' to the HSE on how they planned to tackle the risks from manual handling over the next three years (2005-2007). HSE were due to follow up with manufacturers at the end of this period in 2008. However, due to personnel changes within HSE there was no one to follow up with this project and a delay of a year resulted. At the beginning of 2009 a new HSE officer was responsible for driving the project forward. This report presents the findings from the follow up conversations and site visits with the twenty-five manufacturers that participated in the initial project.

Objectives and Methodology

The aim of this research was to complete a review and assessment of the effectiveness of the HSE initiative that was undertaken with mattress manufacturers that began in 2005. In order to achieve this aim the following activities were carried out:

1. Telephone interviews with manufacturers who had previously submitted action plans to the HSE were undertaken;

2. Up-to-date action plans that determined changes that manufacturers had made were reviewed;

3. From the telephone interviews companies where there had been positive changes as a result of the intervention were identified and revisited to document the changes;

4. The findings, particularly any good practice that had been identified, were reported in order to continue to raise awareness of the risks from manual handling in this industry and to offer solutions to reduce the risks employees are exposed to.

Main Findings

- **Response Rate:** Of the twenty-five companies initially contacted in this follow up project, only eight were available and accepted the invitation to comment on their involvement in the HSE initiative. Of these, five site visits were undertaken, however, two of these were with the same company. The low response rate was due to a variety of reasons, such as companies closing down over the summer period, or HSL being continuously unsuccessful in being able to speak with the right person in the organisation. However, the information obtained from the manufacturers that did contribute was useful and it is apparent that within these companies positive steps have been taken to reduce the risk of musculoskeletal injury from manual handling.

- **MSD Injuries:** The eight companies that participated in this follow up reported that they had seen a reduction in musculoskeletal injuries over the last four years, which they attribute to the interventions that they had implemented, including the introduction of mechanical handling aids. One manufacturer reported that in 2004/05 they had 93 injuries related to manual handling and in 2008/09 this had reduced to 53 manual handling related injuries. However, as one manufacturer reported, part of this decline could also be partially attributed to a reduction in the workforce as a result of the current economic situation. Many companies have restructured their payment methods,

opting to remove piece-rate pay schemes, which is viewed as a positive step forward by the HSE in reducing the risk of musculoskeletal disorders (MSDs).

- **Work Organisation:** Of those that participated, manufacturers have considered work organisation factors that may reduce the risk from manual handling. One example of this was a modification to the flow of products through the factory, minimising the need for the products to be manually handled. As an additional benefit several manufacturers reported increased productivity as a result of improving work organisation.
- **Use of Mechanised Equipment:** Companies reported that they were still willing to invest in mechanised equipment however, significant changes would currently be delayed until the economy improves. Examples of mechanised equipment are the installation of mattress turners, conveyors, assisted tape-edging machines, and automated packaging, and tufting machines. Other small changes that were observed during site visits which may help to reduce the risk of injury from manual handling included having workbenches at the same heights so that products can be slid from one workbench to the other rather than lifting and carrying.
- **Use of Handling Aids:** A variety of trolleys and dollies remain an important and simple means of transporting mattresses and divans within a factory, reducing lifting and carrying items.
- **General Issues**
    - **Storage of Products:** Other improvements were observed in how mattresses and divans were stored, making them easier to be transported on pallets or in stillages thereby reducing unnecessary manual handling.
    - **Reduction in Storage Heights:** The height at which products were stored was observed to have been lowered which will help to reduce the lifting and reaching above shoulder height.
    - **Housekeeping:** Clearly marked walkways were also observed and helped to keep the workplace ordered reducing some of the risks of individuals slipping or tripping.

Recommendations

- **Dissemination of Findings:**
    - The findings of this project should be disseminated to the manufacturing industry as appropriate, and should be accessible through the HSE Website. Ideally, HSE and the NBF should work together to raise awareness amongst manufacturers of the findings of the report. This will help to further inform manufacturers of the risks from manual handling and possible risk reduction measures to reduce the risks from MSDs.
    - It is possible that there is still a need to reach smaller manufacturers who may not be aware of the manual handling risk factors and potential musculoskeletal injury they are exposing their workforce to. Therefore, every effort should be made to distribute this report to all manufacturers, not only those members of the NBF.
- **Future Research:** To have the maximum impact within the industry, future research could best be directed at the distribution and delivery of mattresses once they have left the manufacturers site. In the meantime, manufacturers could reduce the number of mattresses in the vehicle so it is easier to unload or to take a trolley on board to assist with the delivery. However, it should be noted that decreasing the number of items in the vehicle is likely to have a cost implication. Further, in regard to home deliveries,

manufacturers could give delivery drivers greater power to refuse to deliver if they consider that the route within the property is unsafe. In order to prevent non-deliveries, communication between the retailer, delivery driver, and customer will be important (e.g. to ensure a pathway within the house has been cleared so they can easily handle the mattress to where it is required). When delivering to retail premises it will be important to ensure that there is assistance for the delivery driver to help him unload the vehicle. A trolley stored within the delivery vehicle to assist with deliveries may also be possible.

- **Labelling of Loads:** The Manual Handling Operations Regulations 1992 (as amended) does not place a duty on manufacturers or suppliers to mark weights on loads. However, they do have a duty under sections 3 and 6 of the Health and Safety at Work Act 1974 to protect people not in their employment who may be affected by handling loads they have supplied. Therefore, manufacturers still need to improve how they label the product weight on the finished item so it can quickly and reliably warn handlers when the load is heavy. Clearly marking products with the correct weight will help to enable all those in the distribution chain in making a dynamic risk assessment in terms of how they handle the product (e.g. do they need to use a trolley or seek assistance from a second individual?).
- **Work Organisation and Work Systems:** Any changes to work organisation or to the work system should be trialled initially. Worker involvement in any new ways of working is of paramount importance from the outset. Manufacturers must also consider solutions that suit their individual needs. The introduction of any new equipment should be trialled first before widespread implementation. In addition, individuals should be consulted at the start of the process in order to ensure the solution is something beneficial and practical for use. However, there is likely to come a point where the employer will have to enforce the use of the equipment. Changes to work organisation may also have an additional benefit of improving productivity.

1 INTRODUCTION

This report presents the findings from follow up investigations with bed manufacturers after the completion of an HSE initiative aimed at reducing the number of musculoskeletal disorders (MSDs) within the industry, which commenced in 2005. The HSE initiative identified seven tasks within the manufacturing of mattresses and divans that exposed individuals to a risk of musculoskeletal injury. It is the purpose of this current report to review these tasks and provide additional information as to how companies have made changes in order to reduce the risk of musculoskeletal injury that their employees are exposed to. By discussing changes made with companies, this report also considers if HSE's involvement has been effective in raising awareness about MSDs within the bed manufacturing industry. Where possible good practice is presented for the relevant tasks that have been identified from recent site visits to manufacturers.

1.1 BACKGROUND TO THE RESEARCH

Concerns with regard to manual handling within the bed and mattress manufacturing industry were raised and an HSE project was initiated in 2005. The aim was to reduce the number of MSDs (including upper limb disorders - ULDs) within the industry. Video evidence of both good and bad practice was collected and analysed. The objectives of the original study were:

1. To identify the work tasks presenting the most risk of injury to employees;
2. To perform an assessment of the risk for manual handling and upper limb injuries once the work tasks have been identified;
3. To provide an indication of risk priority for the identified tasks;
4. To identify risk controls that employers have already introduced within their own factories and to suggest new risk controls; and
5. To disseminate the findings of this investigation to the industry.

The findings of the study were initially presented at a pilot workshop held by HSE for members of the National Bed Federation (NBF) in the South West and Wales in March 2005. Following this, a further two workshops were held in Bradford and Leicester in June 2005.

A total of five companies participated in the original site visits, varying from large to small employers. A walk-through of the work environment was performed and video footage was taken. Health and Safety Managers participated in the site visits by providing necessary information and allowing for video footage to be recorded. Access was also provided to talk with operators.

Observational analysis was performed in the laboratory using the video footage. Handling techniques, posture and tasks requiring performance of repetitive actions were analysed. Relevant pictures to illustrate both good and less ideal handling techniques, postures, and repetitive actions were captured. Analysis of each of the tasks was performed to identify the specific and relevant task components of key significance that may expose operators to a risk of musculoskeletal injury. These key areas were then investigated further in order to pinpoint areas for improvement.

Factories that were investigated were predominantly those that mass-produce beds/mattresses. RIDDOR information suggested that this was the area where significant numbers of manual

handling injuries occurred. Additionally, smaller factories operating at the top-end of the market producing hand-made beds/mattresses were also considered.

1.2 FINDINGS FROM THE ORIGINAL RESEARCH

In total, seven tasks were identified that present the greatest risk of injury to employees across the bed manufacturing industry. The five main tasks assessed, and found within all of the bed manufacturers visited include:

1. Divan assembly and 'dressing';
2. Mattress assembly;
3. Tape-edging;
4. Tufting; and
5. Handling in warehouse areas.

An additional two tasks that are specific to only some of the manufacturers involved were also identified:

6. Spring assembly; and
7. Hand stitching of mattresses.

The original report found that the two tasks that posed the greatest manual handling risk to operators were tape-edging, predominantly in companies with little or no automation, and the warehouse/distribution areas where operators have to frequently handle mattresses and divan bases. Mattress assembly, divan assembly/dressing, tufting, and hand stitching presented a medium level of risk to operators depending on the techniques employed. The tape-edging task is one that presented the greatest level of risk to operators of developing an upper limb disorder, as this is a high skill task repetitively using the upper limbs. Divan assembly/dressing, mattress assembly, tufting and spring assembly all represented a medium to high risk of injury, predominantly due to the postures involved in these tasks and the high degree of upper limb use, particularly when using hand tools. Hand stitching presented a medium level of risk and the warehouse/distribution areas presented a low to medium level of risk of upper limb injury to operators.

Specific recommendations were made that related to each of the seven tasks discussed within the original report. Additionally, more general recommendations were made and presented to the industry. These findings and recommendations are reproduced within this report (Chapter 4, page 12). A number of automated systems such as conveyors, mattress turners, auto-tufters, and automated packaging machines were reported to reduce the risk of MSDs by reducing the amount of manual handling individuals have to perform. Handling aids, including a variety of trolleys and dollies, were found to be effective within some companies to reduce the level of manual handling operators performed. Work organisation issues, the work environment, psychosocial risk factors and individual capabilities were all important factors that needed to be considered to help minimise the risks of manual handling and upper limb injuries that are prevalent within this industry (reported in the original document). Prior to making any significant changes within the work system, including the incorporation of any new automated machinery, it was recommended that individual companies should assess their requirements, as well as what tools and equipment would best suit their needs.

2 AIMS AND OBJECTIVES

The aim of this research was to complete a review and assessment of the effectiveness of the HSE intervention that was undertaken with mattress manufacturers that began in 2005. In order to achieve this aim the following objectives/activities were identified:

1. Telephone interviews with manufacturers who had previously submitted action plans to the HSE were undertaken;

2. Up-to-date action plans that determined changes that manufacturers had made were reviewed;

3. From the telephone interviews companies where there had been positive changes as a result of the intervention were identified and revisited to document the changes;

4. The findings, particularly any good practice that had been identified, were reported in order to continue to raise awareness of the risks from manual handling in this industry and to offer solutions to reduce the risks employees are exposed to.

3 METHODS

An initial meeting between HSE and HSL took place on the 12th February 2009. The purpose of the meeting was to discuss the aims and objectives of this current study and to identify the actions needed in order to complete the project. From this meeting the following key activities were identified in order to gain the most information from participating companies about the usefulness of the three-year project:

3.1 TELEPHONE INTERVIEW

Twenty-five organisations were involved in the initial project. Fifteen of these were visited by HSE/HSL and ten were unvisited, however, all submitted action plans as part of the original project. In order to follow up with the twenty-five companies involved in the project HSE initially telephoned each of them to update the contact list and to advise them that someone from HSL would telephone them to go through a telephone questionnaire, and request an updated action plan.

HSL developed a questionnaire and telephoned the twenty-five companies to discuss it with them. The questionnaire had some general questions about the process of developing the action plan and whether there had been any changes in how MSDs are thought about or dealt with by the company. More specific information was also requested about each of the five main tasks identified within the original report and whether they had any good case examples of where improvements have been made.

During this process three of the HSE visited companies could not be contacted, one company had contracted out their bed production so the mattress initiative was not relevant to their current operation and another had not followed through their action plan due to a loss of contact with HSE. Furthermore, two of the companies had combined and were the responsibility of a group manufacturing Health and Safety Advisor. This reduced the number of companies originally visited by HSE that were available for comment to ten; of these, six were extremely difficult to contact at an appropriate time. On this basis, the questionnaire was e-mailed to the contacts provided by HSE. Four did not respond to the email. One of these companies did not respond to the e-mail but had a prior relationship with HSE and had submitted a detailed action plan covering the majority of issues raised in the questionnaire. A visit to examine the changes made as a result of the mattress initiative had already been agreed.

With regard to the unvisited companies, the contact details of nine companies were provided by HSE, most of these contact details were no longer valid. New contact details were found for six of the companies, however, two were switchboards and there was no answer when redirected to their Health and Safety representative. Several other companies shut down during the questionnaire period due to the current economic climate. Due to the recession a number of bed manufacturing companies have either merged, reduced work or ceased to trade. Indeed, many of the companies had reduced production and were either working a three-day week or were closed for a month. This made both initial contact and companies finding the time to complete the questionnaire within the desired timeframe difficult. In total, six responses were received by telephone and two others were completed during the site visits. All of the six companies that responded had been involved in the original initiative.

The questionnaire had some general questions about the process of developing the action plan and whether there had been any changes in how MSDs were thought about or dealt with by the company. More specific information was also requested about each of the five main tasks identified within the original report and if they had any good case examples of where improvements have been made. Unfortunately, many of the original contacts had moved jobs

and given the extended time frame of the follow up, knowledge relating to certain elements of the initiative was limited. In particular, responses relating to the main tasks and MSDs were often covered within more general responses regarding safety culture and in the discussion of their current Health and Safety action plan (if one was in place).

3.2 FOLLOW UP SITE VISITS

Follow up site visits were made to four companies (on five sites – two different sites were visited that were owned by one manufacturer) involved in the original initiative. The visits involved initial discussions with the Health and Safety Managers about MSD issues and how they have addressed these issues over the last four years.

A walk-through of the work environment with the Health and Safety Manager was performed and video footage or still photographs were taken. Discussions with individual workers also occurred. Particular attention was given to the five key tasks that were identified in the original report. These were:

1. Divan assembly;
2. Mattress assembly;
3. Tape-edging;
4. Tufting; and
5. Warehouse and distribution areas.

Still photographs were captured from video footage where appropriate. Any other 'good practice' or changes to the task design in terms of the introduction of handling aids or job re-structure that were identified from the visits was also compared with the initial site visits.

4 KEY FINDINGS FROM 2005 RESEARCH: REVIEW OF SPECIFIC TASKS, KEY RISK FACTORS, AND RISK REDUCTION MEASURES

4.1 INTRODUCTION

This section summarises the findings outlined in the original HSL report. The following tasks were identified in the original report as presenting the most significant level of risk of musculoskeletal injury to operators. Essentially the tasks carried out in the various factories observed are the same with some small differences; therefore some generalisations have been made when describing these tasks.

4.2 DIVAN ASSEMBLY/DRESSING

Divan making occurs in various parts. Generally, pieces of timber are stapled together (using a compressed air gun) to make a larger unit (i.e. one side panel of a divan). These units are then stored close to the operator who has just performed this task and the next operator in the production line. The next operators' task may be to staple all the pre-made units together to make the divan base. The divan base is then stored within close proximity to the operators whose job it is to 'dress' the divan in the specific fabric. Once again a staple gun is used to attach the various materials and any 'feet' that may be required are hammered in. Once this process has been completed the 'dressed' divan then makes its way down the production line (Photograph 1 and Photograph 2).

Photograph 1. Divan construction

Photograph 2. Divan dressing

4.2.1 Manual Handling Risk Factors

Overall this task presents a medium level of risk to operators with regard to manual handling. Handling of divan frames (as in Photograph 3a&b) is prevalent amongst operators who 'dress' the divans, lifting them onto their workbench or off the workbench that they were assembling on. However, the need to lift on to or off a workbench may be unnecessary as they can usually be levered on and off tables.

a. b.

Photograph 3. Handling of divans

With regard to upper limb injury the risk may vary from a medium to high level of risk depending on the type of tools that are used. During the assembly of the divan frame there is frequent use of a staple-gun that requires the operator to activate the trigger in rapid succession often working in awkward postures, stooping down, working with the elbow at or above shoulder level and extending the arm forwards. Additionally, the operator must grip the staple-gun and apply some level of force whilst activating the trigger and the wrist often works in awkward postures (i.e. extreme flexion as in Photograph 4a&b). The key risk factors to be considered to minimise ULDs include: repetition and frequency of use, the force exerted on the hand-tool, individual capability, and psychosocial factors which may include: a lack of control over their work and their decision making ability, work demands may be viewed as excessive (e.g. daily production targets may be set to high, where some individuals feel they cannot cope), individuals are required to perform repetitive, monotonous tasks, and the pay structures (e.g. piece-rate, or team bonus systems) may encourage some individuals to work too quickly and not take adequate breaks.

a. b. c.

Photograph 4. Upper limb use and frequent work postures performed by operators

4.2.2 Key Risk Factors

- Loads of approximately 20kg or less being frequently handled over the duration of the working day;
- The size of divans makes them difficult to handle;
- Repetitive use of upper limbs and awkward wrist postures when using staple-guns;
- Repetitive application of pressure on the staple-gun trigger;
- Risk of cuts/puncture wounds from staple-guns.

4.2.3 Recommendations for Risk Reduction

- Job rotation and/or reducing the task duration will help to minimise the level of risk operators are exposed to. This is particularly important in reducing the level of muscle fatigue and in aiding rest and recovery of the muscles (particularly muscles of the upper limbs).
- Reduce the bending and stooping that operators have to perform. Height adjustable tables would be useful to help reduce some of the awkward postures they have to work in.
- Most of the assembly and dressing is performed in cells therefore lifting and carrying distances are relatively short. However, if divans are carried over long distances, reassessing the work layout and work organisation is important.
- Operators use staple guns for a large proportion of their day and are likely to benefit from having low vibration stapling guns suspended from the ceiling on a counterbalance to help minimise the amount of muscle fatigue.
- Where possible automated systems such as conveyors may be useful and if they were set to table height the 'dressed' divans can then be pushed straight across from the worktable onto the conveyor to avoid having to carry them.
- In some circumstances it may be unsuitable to use automated systems therefore working in teams of two may help to reduce the risk of injury to both the upper limbs, from repetitive use of the staple-gun, and manual handling of the divans.
- Changes to how the departments operate may also help to control the psychosocial risk factors. For example:
    - Job rotation and job enlargement may be useful in breaking the monotony of highly repetitive and monotonous tasks.
    - Removing piece-rate or team-based bonuses may help to reduce the pressure some individuals may feel. E.g. working through their tea break in order to catch up with work so as to not let the team down.
    - To increase the amount of control individuals have over the tasks they perform they could be able to decide how they work and when they take their breaks.
- Daily production targets could be altered amongst individuals and would be particularly important if individuals with learning, or physical disabilities are employed where their workloads could be adjusted to better suit individual abilities (e.g. by reducing their daily production targets).

4.3 MATTRESS ASSEMBLY

Various techniques for assembling the mattress together were observed. Generally, components of the mattress were put together, stored and then transported to the next area where they were required. For example fabrics were sewn together in one area then loaded into trolleys or stillages and taken to the next area when full. Techniques varied depending on the type of mattress that was being made. For example, mattresses that use a base of springs then have to have the various layers of materials attached to them by using a 'hog-ringing' tool (compressed air/pressure-activated tool). This tool fixes a clip attaching the material to the springs. The mattress must then be handled to go to the next station in the production process. Other mattresses have the springs sewn inside fabric. This requires operators to layer the fabric and springs into a moulded table/board of a certain size (i.e. required mattress size). The completed fabric mattress then has some form of reinforcing such as a metal frame attached around it.

Additional fabric layers are then attached around this base by various clipping guns (e.g. hog-ringing gun). Mattresses are then carried by either one or two operators to a storage area or placed onto a conveyor belt. (Photograph 5).

Photograph 5. Hog-ringing task

4.3.1 Manual Handling Risk Factors

The risk of musculoskeletal injury to operators is variable for this task, ranging from medium to high and is dependant on several factors. Assembling the spring base and foam layers used in constructing the mattress can be performed by one or two operators. Turning the mattress over on the worktable will require less effort with two operators compared to a single operator. So too will lifting and carrying the mattress from the worktable to the storage area or conveyor. In Photograph 6a&b a single operator is seen manoeuvring the mattress on the worktable and lifting it by supporting it on the shoulder before carrying it a short distance to be placed on top of another mattress on the conveyor (seen in the background of Photograph 6a).

The weight of mattresses is variable depending on the size, dimensions and quality. (Higher quality mattresses will include additional materials such as increased layers of foams and springs, therefore increasing the mattress weight and thickness). Double mattress weights observed during site visits ranged from 22-61kg, when completed and will weigh slightly less than this at this stage. Mattress dimensions vary from singles, with average dimensions of 190cm (length) x 90cm (width) x 26-30cm (height), doubles 190cm (length) x 135cm (width) x 26-30cm (height), kings 200cm (length) x 150cm (width) x 26-30cm (height), and super kings 200cm (length) x 180cm (width). As the size of the mattress increases so too will the difficulty in handling them, as due to the nature of the product there is an absence of any handholds that operators can use. The larger mattresses will be particularly unwieldy if handled by a single operator. In Photograph 6a the mattress being lifted off the workbench will be placed on top of the mattress on the conveyor or work table which is not ideal as this increases the height at which the individual is handling the load.

a. b.

Photograph 6. Mattress handling from adjustable worktable to conveyor

Operators using hog-ringing guns repetitively and on a daily basis may be exposed to a medium to high level of risk of upper limb injury. This is predominantly due to the frequency of working in stooped postures that are adopted due to the high visual demands of the task. The hand holding the hog-ringing gun is held away from the body for short periods of time, but is done so repetitively and may increase the level of local muscle fatigue in the neck, shoulder and arm (Photograph 7 a&b). Additionally, when working in this posture there is intensive use of the hog-ringing gun that is trigger activated and if used frequently over prolonged periods of time will increase the risk of injury that operators are exposed to. These findings were determined using HSE Risk Assessment Worksheets in *Upper Limb Disorders in the Workplace, HSG60* and from RULA postural analysis. Operators may be exposed to high level of risk of developing an ULD if there is high usage of the hog-ringing gun when working in stooped postures, individual capability and psychosocial factors may also increase the level of risk.

a. b.

Photograph 7. Activities and postures performed during mattress making

There is an additional risk to operators if the work environment is untidy, particularly if foam and material cuttings are scattered across the floor where operators had to carry mattresses through. This situation will increase the risk to operators of slips and trips which will be particularly detrimental, if they occur, when carrying heavy mattresses as their ability to maintain their balance will be diminished and so their risk of musculoskeletal and/or other injuries is likely to increase.

4.3.2 Key Risk Factors

- Handling by a single operator of a spring-based mattress when semi-complete; load approximately 15-30kg for double mattresses;
- Size of mattresses and lack of handholds make them difficult to grip and handle;

- Slipping/tripping hazards from cuttings on the floor when carrying the load;
- Risk of cuts/puncture wounds from hog-ringing guns.

4.3.3 Recommendations for Risk Reduction

- Organising the work system so operators minimise the amount of lifting and carrying they perform will be beneficial in reducing the risk of musculoskeletal injury. It may be possible to slide the mattresses off the worktable straight onto a conveyor or onto another table ready for tape edging.
- Consideration should be given to job rotation and job enlargement. There appear to be a variety of tasks these operators can participate in and will help to minimise the time they spent bent over the mattress using the hog-ringing gun. (i.e. can they collect springs, foams and materials from storage areas?).
- Production issues could also be considered. For example if conveyors are used and operators have to place mattresses on top of one another there may be problems down the line in the tape-edging area as to why the backlog is occurring.
- If mattresses are to be stored in piles prior to tape-edging there should be a limit as to how high they are placed to avoid operators having to lift and lower them above shoulder height and from ground level. A spring-loaded table or scissor lift may be useful in minimising the vertical lift distance.
- Operators could work in teams of two when performing this task, including both the hog-ringing and manual handling aspects. This may help to reduce the amount of time operators are working in stooped postures when operating the hog-ringing gun and will more evenly distribute the load when lifting and carrying the mattress onto and off worktables, conveyors or storage piles.
- All operators should receive specific manual handling training that is relevant to the tasks that they perform and the monitoring and encouragement of good handling techniques from team leaders or designated safety representatives/team employees should be encouraged.
- General work areas should be kept clean and tidy, clearing away material scraps on the floor regularly throughout the workday. This will help to reduce the risk of slips and trips, which is particularly important when handling heavy and awkward loads.

4.4 TAPE-EDGING

This is a highly skilled task but also involves operators having to lift mattresses off conveyors or storage piles/tables. In the majority of companies this was observed to be a one-person lift with the possible exception of very large double mattresses. Once the mattress was on the table it could then be sewn together by the operator bringing the two sides of the fabric together (i.e. by firmly grasping fabric and pushing down on the mattress) and operating a machine that stitches on a tape-edge to hold them together.

A variety of machines were found to be in use across the manufacturers visited. The most common machine is an older style with a clutch-operated system where the operator shuffles backwards around the table using their knee to operate the machine. The machine only has one-speed level. Slightly newer machines are similar in design but have a control panel whereby operators can adjust the stitching speed (e.g. normal speed for straight edges and slower for going around corners). Alternatively, several factories are also using new machines where the mattresses are turned automatically allowing the operator to remain in one position and virtually eliminating the need to manually handle the mattress.

The older machines require an operator to sew both sides together and then flip the mattress over on the worktable. Once the mattress has been sewn together with the tape-edge, the operator must then lift/carry the mattress off the table to either a storage area or onto a conveyor (if it can not be slid onto it). In the newer, more automated systems the operator simply needs to press a button on the control panel to advance the mattress along a conveyor

4.4.1 Manual Handling Risk Factors

Generally a single operator lifts and carries mattresses of varying dimensions and weights short distances between the worktables and the storage piles or conveyors that the mattresses are stored on. This occurs both prior to stitching and after stitching. Photograph 8a shows an operator about to place a mattress on his worktable and he has to reach up well above head height in order to select the mattress. The second picture (Photograph 8b) shows an operator placing a completed mattress on a conveyor after having carried the mattress a short distance above his head.

Tape edging is a highly skilled task and due to the high skill requirements of the task, operators do not generally participate in any job rotation. Therefore stitching the mattresses and handling them onto and off the worktable and storage piles/conveyors constitute their main activities. Over the course of the day (8-9 hours), they may handle approximately 120-140 mattresses, which may increase during busy periods, placing them at increased risk of developing musculoskeletal injuries. Due to the size and nature of a mattress there are no handholds available for the operators to use (handles may be present on the sides of mattresses but producers do not want operators using them as this may lead to the material stretching and the product being returned by the customer). These issues combined with the traditionally 'macho' culture that exists within the industry are likely to have led to the handling techniques outlined in Photograph 8a&b being employed. However, the industry do not encourage their employees to handle mattresses above their heads.

a. b.

Photograph 8. Less than ideal mattress handling techniques observed when removing a mattress off a storage pile to be tape-edged and placing a completed mattress onto a conveyor

Tape-edging is a highly-repetitive, skilled task and due to the high visual demands of the job, requires operators to stoop forwards over the mattress in order to see what they are doing. Therefore operators' postures are constrained when stitching the mattress and they work with their back and neck flexed forward whilst operating a clutch operated system with their knee, or their foot is flexed when using a foot pedal-operated system (Photograph 9).

Fabric is cut to allow for very little excess therefore high gripping forces appear to be necessary to pull the fabrics together in order to stitch them (Photograph 10). The fabric is gripped with each hand between the thumb and the first finger. The hands and fabric are then pulled together

and the operator must then apply a downward force with the hands held gripping the fabric in order for the tape-edge to be stitched on. It is anticipated the gripping forces will increase when the last edge of the mattress is being stitched together as there will be less slack and increased tension in the mattress material.

Additionally, psychosocial risk factors may increase the risk of ULDs in this group of operators. Operators may feel they have little control over their work, as there appears to be a constant pressure to keep up with the flow of mattresses along the conveyor or to work on the mattresses off storage piles based on observation during site visits. Some operators may have difficulty coping with production demands whilst maintaining a high standard of work and may be more at risk of upper limb injury. All of these factors combine to place operators at a high risk of upper limb injury.

Photograph 9. General working posture

Photograph 10. Wrist postures

Factors that may increase the level of risk include highly repetitive actions performed frequently in constricted work postures. Individual capability and psychosocial factors may also contribute detrimentally.

4.4.2 Key Risk Factors

- Load Weight: handling heavy loads, predominantly by one individual, above shoulder height and below knee height (11kg-61kg mattress weights observed);
- Size of mattresses and lack of handholds make them difficult to handle and can constrict the operators posture;
- Visual requirements require frequent bending/stooping forwards over worktable often whilst shuffling backwards operating the tape-edge machine (on clutch operated machines);
- High gripping forces are required to pull fabrics together whilst pushing down on the mattress when sewing edges together;
- Highly repetitive, skilled task;
- Psychosocial risk factors may increase the risk of ULDs in this group of operators. Particularly, the amount of control operators feel they have over the task they perform and their ability to cope with production demands whilst maintaining a high standard of work.

4.4.3 Recommendations for Risk Reduction

- Install automated systems to remove the need for mattresses to be handled. (i.e. conveyors, mattress turners).

- If handling is required set-up the work area so that mattresses can be slid onto/off conveyors or tables to reduce the amount of handling operators have to perform.
- Limit the number of mattresses piled high to avoid operators having to reach above shoulder/head height.
- Consider job enlargement to give the operators more variety and incorporate longer periods of rest and recovery, particularly for the upper limbs.
- Consider workflow/work organisation issues. This is particularly important if conveyors are being used but mattresses are being piled up on top of each other. (i.e. Look for answers to these problems: Are production demands too high? Are operators off work and few operators are trying to cope with production demands?).
- Team handling should be considered if lifting and carrying is required.
- Operators should receive manual handling training that is specific to the activities they perform.

4.5 TUFTING

Once the mattress has been tape-edged it can then be tufted (pierced to attach buttons). This process involves operators lifting/carrying mattresses off storage piles/tables or conveyors or carrying them straight from the tape-edge table and into tufting machines. The tufting machines tilt into a horizontal position, allowing operators to lift or slide the mattress into the machine. Once in the correct position the machine compresses the mattress and it is mechanically tilted to a vertical position. A coloured sticker-system is generally used to indicate to operators where the tufts need to be made. These stickers are placed at various points along the metal frames of the tufter. Operators then use a sharp rod and loop the tuft around the rod before they pierce the mattress through to the other side. Usually a second operator works on the other side tying the tufts. Once all the tufts are made the machine is tilted back to the horizontal position and either one or two operators (usually two, depending on the size of the mattress) will pull the mattress out of the tufter straight onto a table or conveyor (Photograph 11 and Photograph 12).

Photograph 11. Inserting mattress into tufter

Photograph 12. Making tufts in the mattress

4.5.1 Manual Handling Risk Factors

This activity presents a medium level of musculoskeletal injury risk to operators and the risk of injury will depend on a variety of factors. Two operators were observed in all site visits to lift and carry the mattresses into and out of the tufter therefore the load is shared between them. However, operators still have to reach upwards at or above shoulder height to grasp the mattress

and potentially have to bend/reach at or below knee height depending on the height of the storage piles/tables/conveyors. Generally the mattress is placed into the tufter at approximately shoulder height (Photograph 13a&b) requiring operators to co-ordinate their lift to perform this task. The mattress is then pushed or slid into the tufter. When removing the mattress from the tufter operators generally slide the mattress onto a worktable or storage pile requiring little heavy lifting (Photograph 13a&b).

a.

b.

Photograph 13. Lifting into and out of a tufting machine

The tufting action performed presents a medium to high level of risk of upper limb injury to the operators. The tufting task is repetitive, however, it is typically of a relatively short duration (i.e. for every mattresses that is tufted). There is some degree of force required to pierce the mattress when making the tufts and also a twisting action is performed by the lower arm and wrist. Operators can work in awkward postures when performing the tufts, however these are not static and the operator moves quickly between reaching upwards and bending downwards (Photograph 14a&b). Increased risk of upper limb injury is likely if this activity was performed exclusively during the course of the workday/week.

a.

b.

Photograph 14. Working postures when performing the tufts

The frequency with which mattress are handled, the work postures, individual capability and psychosocial factors could all contribute to increase the level of risk depending on the work environment.

4.5.2 Key Risk Factors

- Handling heavy loads particularly at or above chest height and below knee height (11kg-61kg mattress weights observed);
- Size of mattresses and lack of handholds make them difficult to handle especially when loading into or out of the tufter;

- Repetitive upper limb use when performing tufts (i.e. piercing the mattress);
- Some level of force is required when tufting to successfully pierce the mattress;
- Operators can work in awkward postures when tufting, reaching above shoulder height and below knee height.

4.5.3 Recommendations for Risk Reduction

- The installation of automatic tufting machines used in conjunction with conveyors will greatly help to minimise the amount of manual handling operators have to perform as mattresses can be rolled along the conveyor into and out of the tufter. The autotufter will also significantly reduce the risk of developing an upper limb injury by predominantly removing the need for operators to perform the tufts manually.
- If manual tufters continue to be used, workstations could be arranged so mattresses can be slid either into or out of the tufter minimising the amount of manual handling operators have to perform. Additionally tilting tufters may help to reduce the amount the operator has to bend when making the bottom tufts.
- Job rotation and job variation will also help to reduce the risk of musculoskeletal injury and is likely to be particularly important to ensure sufficient rest and recovery of the upper limbs if manual tufting is performed at a high rate over the course of the workday.
- Team handling and working should be performed if manual tufters are being used.
- Specific manual handling training should be performed with the operators to ensure that if handling is required it is done so in the best possible way and should be monitored when back in the work environment.

4.6 WAREHOUSE/DISTRIBUTION AREAS

Once they have been packaged mattresses and divans are transported using various methods from within the factory. Conveyor systems have proved popular in transporting products to the warehouse and were also observed to transport mattresses into the back of lorries. Additionally, trolleys are widely used, whereby completed mattresses or divans are placed directly onto them and wheeled into the warehouse areas and stored (Photograph 15). Manual handling off roller conveyors was also observed, where operators had to lift and carry mattresses to where they had to be stored. In larger warehouses some mattresses and divans would be stored on pallets and lifted by forklifts to high storage areas.

In distribution areas lorries were observed to be loaded in a number of ways. A conveyor system was observed going to the back of a lorry then operators had to lift the mattress or divans off the conveyor and carry them into the lorry to be loaded (Photograph 15). Alternatively, several products from within the warehouse may also be collected on trolleys that are taken into the lorry and the mattresses are then loaded (Photograph 16a&b). In other factories products waiting to be manually loaded were observed at a particular loading bay waiting to be lifted and carried into the vehicle. Loading of products is a repetitive task requiring operators to walk back and forth carrying the heavy, awkward mattresses and divan bases and working often in confined spaces due to the tight packing of products.

Photograph 15. Loading mattresses onto a conveyor

a. b.

Photograph 16. Using a trolley to move a mattress

4.6.1 Manual Handling Risk Factors

Operators who perform this task are exposed to a high risk of musculoskeletal injury, particularly that of the lower back. The majority of site visits showed that within the warehouse and distribution areas a significant amount of manual handling is performed, Photograph 17 and Photograph 18. Due to the nature of the loading task whereby limited timeframes to load the lorry may be an issue, operators are particularly at risk of suffering a manual handling injury due to the frequent handling of loads, particularly lifting, lowering and carry tasks.

The weight of the loads can vary widely depending on the product being handled (i.e. single or double mattress, or divans) and the vast majority of companies visited do not label these with any weight warnings. Therefore any individual along the supply chain is unaware of the product weight.

The size of the mattresses and lack of handholds make them difficult to grasp and often, particularly when loading into the lorry the operator(s) are working in confined spaces and may have to adopt awkward postures. Reaching above shoulder or head height when working in awkward postures and handling these large and heavy loads results in increased stress on the operator's body, including their lower back placing them at increased risk of injury.

Photograph 17. Bending to lift a large mattress

Photograph 18. Standard carrying technique

In terms of ULD risk this task presents a low to medium level of risk to operators. The task is repetitive with the arms working in awkward postures and above head height, placing additional pressure on the wrists as in Photograph 19a&b. However, the task is dynamic and may be performed intermittently with the time spent in these postures varying from picking or placing mattresses from low to the ground to above shoulder height. There is also no fine motor control required of the wrists and fingers therefore the larger muscles in the arms and back are performing most of the work, reducing the risk of injury.

a.

b.

Photograph 19. Lifting mattress/divans above head height within the warehouse and during lorry loading.

Repetitive handling, work postures, individual capability and psychosocial factors can interact to influence the level of risk operators are exposed to.

4.6.2 Key Risk Factors

- Handling heavy loads particularly at or above shoulder height and below knee height (11kg-61kg mattress weights observed);
- Size of loads and lack of handholds make them difficult to grasp and handle;
- Repetitive lifting and carrying over variable durations particularly when loading lorries;
- Operators may work in awkward postures due to one-person lifting techniques and space constraints when loading lorries;
- Repetitive use of the upper limbs in awkward postures, particularly above head height;
- Lack of handholds makes loads difficult to grasp, placing additional pressure on the upper limbs, particularly the wrists.

4.6.3 Recommendations for Risk Reduction

- The use of handling aids such as trolleys and conveyors will be beneficial in reducing the amount of manual handling operators have to perform.
    - For example levering completed/packaged mattresses off the conveyor straight into a trolley rather than lifting and carrying. The mattress can then be transported into the warehouse using the trolley. (Caution: if trolleys are used within the warehouse they should not be overloaded and may require two operators to move as this may introduce new risks of injury from pushing and pulling).
    - Levering and manoeuvring mattresses onto trolleys can also be used to move mattresses from storage piles into the back of lorries when they are being loaded.
    - Alternatively having conveyors going into the lorries will help to reduce carry distances.
    - Dollies (i.e. like a skateboard) are useful for moving divans within the warehouse and when loading lorries.
    - Adequate training, monitoring, and maintenance of any equipment used or new equipment introduced should occur to avoid introducing new risk factors.
- Efficiently ordering the vehicle during loading will be important to reduce handling (e.g. items loaded first will be the delivered to the last delivery address). Alternatively, if vehicles are delivering to a couple of stores or a distribution centre it may be possible for mattresses and divans to be placed on pallets or stillages. This will minimise the amount of manual handling for both the customer and manufacturer, however, these options will take up more room in the vehicle.
- In situations where handling of mattresses does occur it may be beneficial to perform the handling with two people, particularly when lifting and carrying heavy mattresses. Ideally, for a two person team handling operation the aim would be to keep the load weight below 50kg (e.g. in the green or amber sections of the MAC). A two-person lift with a load weight of 35kg or less represents a low level of risk; a two-person lift with a load weight of 35-50kg represents a medium level of risk; and a two-person lift of between 50-85kg presents a high level of risk.
- Operators should receive specific manual handling training and it is particularly important for this group of employees as they spend a large percentage of their day handling mattresses often in confined spaces and working in awkward postures (e.g. when loading lorries).

4.7 SPRING ASSEMBLY

A number of companies import spring bases, but several make their own springs. Once the springs have been coiled they can be used to make the spring bases in mattresses. Observations in one factory showed springs stored on-top of the machine where the operator must reach up to collect of number of springs whilst standing at the machine and then feeds the springs into it (a similar action to that of dealing a pack of cards). Small adjustments may then have to be made by extending the arms into the machine and pulling/pushing them into the correct position (Photograph 20a&b).

a. b.

Photograph 20. Reaching for springs and placing them in machine to make spring bases

4.7.1 Manual handling risk factors

Overall the level of upper limb risk for this task is high if this is the sole task that this operator performs. When assessed using RULA an average score of 5 results. This indicates that investigation and changes are required soon. It is highly repetitive in nature with frequent reaching above shoulder height, the neck is predominantly flexed forwards and there is frequent forward and sideways bending of the trunk to view inside the machine and reach to adjust any coils if required (Photograph 21a&b), and there appears to be little job rotation. Additionally, there is a lot of fine motor control using the fingers to grip and place the springs inside the machine and is frequently repeated. All of these factors expose the operator to an increased risk of developing an ULD.

a. b.

Photograph 21. Postures and activities observed

Level of risk will vary depending on the frequency the task is performed, and postures worked in, as well as individual capability and psychosocial factors.

4.7.2 Key risk factors

- Repetitive handling of spring coils into spring machine;
- Frequent reaching above shoulder height for spring coils;
- Frequent trunk flexion to view inside spring machine and reaching forward to adjust coils (i.e. small pushing and pulling actions);
- Repetitive task performed for the duration of the operators shift;
- Lack of job rotation.

4.7.3 Recommendations for Risk Reduction

- Job enlargement/job rotation could be considered (if not already in place), so the operator is not performing this task over his entire working day. This will help to allow the operator to get sufficient breaks by performing other activities and to allow for rest and recovery of frequently used muscles.
- Redesign of machinery and placement of coils to minimise amount of reaching upwards and bending down to view coils once in the machine.

4.8 HAND SIDE-STITCHED MATTRESSES

Other factories produce beds on a made-to-order basis, and are generally catering to the higher/quality end of the market where hand stitching of the mattress is a key operation. Operator's work at tables that are raised to approximately just below shoulder height as the task has a high visual component. Long sharp needles and thread are used to stitch around the sides of the mattress and operators must pierce the mattress with the needle requiring some degree of force (Photograph 22). Additionally, one or two operators must lift and carry the mattresses on and off the worktables from storage areas or tables.

Photograph 22. Hand stitching mattresses

4.8.1 Manual handling risk factors

A medium level of risk of injury to operators from manual handling exists for this task. Generally mattresses that are hand side-stitched are at the quality/high-end of the market and can weigh significantly more than standard mass produced mattresses. (E.g. single mattresses from 22kg-32kg, double mattresses from 34kg-61kg or more). However, lifting of the mattresses can occur from approximately knee height to shoulder height. These mattresses are handled by two operators and as they take a longer period of time to work on and stitch (possibly up to one hour per mattress). Therefore, mattresses are handled less frequently (approximately 8-20 per day) compared with mass-produced mattresses. One operator generally handles a single mattress, whereas two operators should handle a double mattress.

This was determined by using HSE Checklists in Manual Handling Operations Regulations 1992 (as amended), L23 and from REBA postural analysis. The level of risk will be dependent on the weight of the mattress, how frequently they are handled and the number of people lifting it and how high it is lifted.

This task presents a medium level or upper limb injury risk to operators predominately due to the high degree of arm use, particularly that of the wrist and the pinch grip on the needle whilst applying enough force to pierce the mattress and make the stitches. Table heights are often raised to meet individual operator's requirements and comfort and usually raised to approximately chest height to allow them to have good vision of what they are stitching.

However, this can mean that the shoulders may be raised for part of the time when they are performing the stitches although this is a dynamic activity and holding the arms statically as pictured in Photograph 22a&b does not occur for any length of time.

4.8.2 Key risk factors

- Handling heavy loads particularly at or above chest height. Observed mattress weights: singles from approximately 22kg-32kg, and doubles from 34-61kg. However, some of the large sized double mattresses are likely to be greater than 60kg;
- Size of mattresses and lack of handholds make them difficult to handle when lifting onto and off high worktables;
- Repetitive use of the upper limbs at chest height or above;
- Stitching task requires force to insert the needle through the mattress.

4.8.3 Recommendations for Risk Reduction

- Powered or spring-loaded, height adjustable tables could be useful so that mattress transfer can occur at a lower level, and can then be raised to suit individual needs.
- Lighting for this task is important so operators do not have to bend their heads forward excessively.
- Magnifiers may also be useful to help the operator see more clearly where they are stitching and may also minimise the amount of forward flexion of the neck.
- Ensure team handling of large mattresses occurs onto and off worktables.
- Ensure individual workstations have been assessed for individual comfort and to allow them to work in postures that are as unconstrained as possible.
- Operators should allow for frequent mini-breaks or job rotation to allow them time to let their upper limb muscles recover after having spent a lot of the work-day with their arms held away from the body and working at approximately shoulder height.

4.9 GENERAL RECOMMENDATIONS

In addition to the specific recommendations for risk reduction for each of the seven tasks identified, some general recommendations that can be applied to all of the tasks within the bed manufacturing industry were made.

4.9.1 Automation

- Where possible and practical, automated processes should be put in place in the first instance. The use of mechanically driven systems such as conveyors will help to significantly reduce the amount of manual handling operators have to perform.
- Auto-tufters used in conjunction with conveyors will also reduce the amount of manual handling operators have to perform. In addition, the risk of upper limb injury is significantly reduced as the machine is performing all of the tufts. However, occasionally, the machine misses a tuft and will this have to be added manually.

4.9.2 Handling Aids

- In addition to automated systems, effective use of handling and moving aids will help to further reduce the amount of handling operators have to perform.

- Trolleys should be used that are specific to the task they are required for and should meet individual company requirements. If something does not exist companies could consult handling aid manufacturers, working together to develop something specifically for them. Trolley maintenance is also important, particularly clearing threads and fabric caught in trolley wheels that may make them increasingly difficult to move.
- Dollies are also particularly useful when moving individual divans and can also be taken into the back of lorries when they are being loaded if ramps or docking stations allow for this.
- Order pickers or other purpose designed load carrying devices should be used if products need to be accessed from a height.
- Maintenance of handling aids should be performed on a regular basis and maintenance records should be kept.
- Operators should be sufficiently trained to operate safely any handling aids or devices that they have been given to use. This will help to ensure they use the aids and do not revert back to manually handling products. Additionally, introducing new handling aids may also introduce new risks to the operator. If operators do revert back to manual handling methods, there could be a variety of reasons for this, but it could also mean that the handling aid is not best suited to the task it is being used for. Employers should discuss with operators their ideas on what would be useful and get them involved from the outset. Hiring or getting a few prototype devices made initially so operators can trail them, giving feedback on what is good or where improvements need to be made will help to ensure that operators use the devices in the long term.

4.9.3 Work Organisation

- All manufacturers should consider how the work is organised in terms of productivity and reducing manual handling, which may be related. Companies should consider the flow of materials and products through the factory. If materials and products are flowing efficiently through the company then this can reduce the amount of double handling along the production chain. Discussing current workflows with operators may provide management with useful information as how to best organise the factory and what type of work methods should be employed.
- Currently cell or team working is favoured and has its advantages, but if combined with piece-rate working is likely to discourage job rotation, as operators will often only want to do the well-paid tasks, or work on those tasks which they are most proficient.
- If job rotation is to be implemented, companies should discuss this with employees to ask their opinion on how the process should work and be implemented. There may be reluctance for employees to participate in job rotation as there may be less favourable tasks than others to perform and may be paid at different rates.
- Adjustable workbenches will be particularly useful if job rotation is in place where a variety of operators will be stationed at the same workstation. Individuals can then adjust the workstation to a height that suits them. If this is not possible providing a platform for shorter individuals may be a compromise.
- Team handling should also be considered if there are some tasks that cannot be automated or other handling aids are unsuitable. This will help to reduce the load that one operator has to lift or carry. However it does not mean that as a pair they can lift or carry twice as much as an individual. HSE (2004) states that for a two-person team the capability is "*two thirds the sum of their individual capabilities*".

- Companies should review how they are currently loading their trucks and consider using a bottom loading approach where several mattresses (e.g. three high) are placed so they are lying flat on the vehicle floor. The remaining mattresses can then be stacked vertically on top. However, this may not be possible as damage to the mattresses may occur. Alternatively, in-vehicle lifts may be beneficial, as they have been designed to improve manual handling safety inside trailers/lorries. In addition, the load capacity within the lorries can be increased.

4.9.4 Work Environment

- The work environment should be well lit, particularly for those tasks that have high visual demands to avoid operators having to unnecessarily stoop down to see what they are doing.
- The work environment should generally be kept in good order with walkways clearly marked and any obstacles removed. Flooring should be swept regularly to remove any material scraps to avoid slips and trips. Having clear floors will also minimise the amount of threads getting caught in trolley wheels.

4.9.5 Individual Capability

Consideration should be given to individual capability when performing particular tasks. It is likely that even with automation there will still be some form of manual handling that operators have to perform. This may include the pushing and pulling of handling aids or mattresses onto or off conveyors. Avoiding or reducing the amount of manual handling that operators have to perform is of primary importance. However, currently there is still a lot of manual handling individuals have to perform and therefore specific manual handling training should be provided to all operators.

5 FINDINGS FROM TELEPHONE INTERVIEWS

This section of the report discusses the findings from the present study.

Twenty-five organisations were involved in the initial project. Repeated attempts to contact the twenty-five manufacturers were made, however, only six participated in the telephone interview and an additional two completed the questionnaire during the site visit.

Speaking with the eight organisations it was apparent that there had been a significant change in attitude and a greater realisation of the importance of manual handling related issues compared to when the initiative started in 2005. This has led these organisations to revisit their Health and Safety Action Plan and to consider the possible MSD and manual handling issues associated with the tasks performed. Many of these companies have now introduced targets into their general business plans for reducing manual handling injuries.

The majority of companies reported that they had made significant changes to the mattress production process as a consequence of the initiative. The extent of these changes varied and ranged from the complete redesign of the way they make mattresses and divans to identifying specific tasks where improvements could be made. For example, introducing mechanised/assisted tape-edging machines, introduction of trolleys, and changing the type of seating offered to staff in sewing areas so that each chair is adjustable, thereby reducing the need to adopt awkward postures.

The majority of companies had introduced trolleys, installed gravity rollers and conveyor belts throughout the production process and provided battery operated pallet trucks and trolleys in the warehouse and distribution areas. Where handling aids had not been introduced or were difficult to use, companies now insisted that employees adopt team-lifting strategies. Additionally, the majority also plan to further increase the number of trolleys available throughout their facilities.

Examples of the types of changes some manufacturers have made following the commencement of the initiative are:

- Lightweight hog-ringing guns have been introduced where possible. This occurred as a result of an investigation into hand-arm vibration (HAV) exposure with individuals who used the guns over a prolonged period of time;
- Height adjustable workstations have been introduced that can be individually adjusted allowing individuals to avoid working in awkward postures;
- Benches/workstations have been moved to the same height where possible to reduce manual handling. This allows products to be slid from one work area to the next rather than being lifted;
- Heights have been reduced for stacking stock to decrease the amount of lifting above shoulder height;
- Team working and handling have been introduced where mechanisation is not possible;
- Storage problems have been reduced by communicating with suppliers and changing from stock based to ‘made to order’ products;
- Within the warehouses mattresses and divans are now stored in the order they will be loaded onto the vehicle;

- One company reported that they compress the mattresses where possible, making them easier to handle, store and transport;
- Loading bay ramps have been improved particularly in reducing the incline making it easier for trolleys to be pushed up and down;
- Walkways and storage areas have been clearly marked;
- Job enlargement, whereby each individual completes a full mattress, has been implemented. This now means there is no longer a production line.

The majority of companies that undertook major re-design projects during the initiative included their workforce at each stage of the re-design process. Explaining the motivation behind the changes served to both increase awareness amongst staff of the risks associated with manual handling and to reinforce the need to follow an appropriate reporting procedure. The majority of respondents reported a greater commitment to record all incidents and provide data to RIDDOR.

Further, a number of manufacturers reported changes to their pay schemes. This involved the introduction of a flat rate of pay with a total productivity related bonus, rather than paying per mattress, on a piece-rate system. Manufacturers who have implemented the new pay structure reported they did so in order to encourage safer working practices and increase job rotation. This is viewed by HSE as an extremely important step in helping to reduce the number of MSDs in the manufacturing industry as individuals should no longer feel pressured to work extremely quickly (e.g. taking short-cuts that may increase their risk of MSDs) or skip breaks, etc, in order to meet targets.

Companies have realised the importance of investment in 'human capital' and have placed a greater emphasis on training. For example, one company has created a dedicated training facility that offers comprehensive courses not only to their own staff but also to others in related industries, while another company offers manual handling seminars and 'City and Guilds' level training to all staff. Of the eight manufacturers who took part in the interview, many reported that they have seen a reduction in the number of MSD related injuries reported and days lost since the initiative began in 2005. One manufacturer reported that in 2004/05 they had 93 injuries related to manual handling and in 2008/09 this had reduced to 53 manual handling related injuries. However some manufacturers suggested that a contributing factor in the reduction of reported MSD related injuries might also be explained by a reduction in staff levels in the recent year due to the recession.

In summary, the general consensus was that the initiative was worthwhile and many of those who engaged in the process have seen tangible benefits to their business despite the current economic climate. Many of these companies are currently facing difficult challenges and may be required to downsize or examine ways of restructuring the workspace to improve efficiency and increase output. However, others have seen an increase in their business. Many companies are unwilling to 'take a backwards step' in the progress they have made during the initiative. Most manufacturers are constantly looking for ways to reduce risk and improve productivity through mechanisation of the mattress production process and streamlining the flow of products through the factory. A summary of the findings for the relevant questions from the questionnaire is presented in Table 1.

Table 1. Summary of responses from the telephone interviews

Question	**Summary of Responses**
1. Did you attend one of the workshops (e.g. South West, Bradford, Leicester)?	7 out of 8 manufacturers attended
2. Do you have an up to date action plan?	All had an updated action plan
3. Has there been a change in how MSDs are thought about or dealt with in your organisation?	5 out of 8 manufacturers reported that they and there employees are now more aware of the risks of MSDs from manual handling
4. Have you noticed or recorded any measurable reduction in MSD injury or lost time?	6 out of 8 manufacturers reported that they have seen a reduction in days lost and MSDs being reported. 1 company is relatively new and have had no cases of MSDs reported
5. Specifically, how did you deal with the five key tasks that were identified in the HSL report: "*Musculoskeletal disorders in the bed manufacturing industry: an investigation of manual handling activities*" (this was only given to participating companies)	These are highlighted in the previous text
6. Have you dealt with any other factors in addition to those outlined above or on your action plan?	Other factors that manufacturers have looked at are: • The total redesign of the task and how mattresses are made • The use of hog-ringing guns and Hand Arm Vibration (HAV) issues • Revised pay schemes to have a flat rate of pay with a bonus • Improved seating for sewing machinists
9. Do you have any current and/or future plans for reducing the risk of MSDs and/or managing them in your workplace?	6 out of the 8 manufacturers reported they are continually looking to improve their work practices in regard to manual handling
10. Any other comments about the initiative?	6 out of the 8 manufacturers reported that the exercise was useful, particularly in that it made them address the whole production process. As a result several reported that they also were able to increase production following the introduction of new systems

6 FINDINGS FROM FOLLOW UP SITE VISITS

Site visits to four manufacturers (on five sites) were performed where it had been established from the telephone interview that improvements had been made. This section will summarise the findings from the follow-up site visits in 2009 and any additional recommendations that were identified from either the telephone interviews or action plans.

6.1 WORK ORGANISATION

Beds continue to be manufactured in a work-group or cell basis whereby the appropriate materials are placed in close proximity to where they are required by operators at various points along the production line. Once a certain task is completed the product passes down the production line for the next process to be completed. However, several of the manufacturers visited have improved upon this process by redesigning or altering the flow of materials through the factory in order to reduce handling the product and also to improve productivity. Raw materials enter the building at one end, and the finished product leaves at the other, with each manufacturing step completed in sequence as materials travel through the factory.

Some manufacturers have also improved layout of the work areas, clearly marking the floors for walkways or storage areas. This will help to generally keep the factory tidy and reduce the risk of people tripping over items that are in the way. It also allows for items to be easily handled and manoeuvred within the factory (Photograph 23a&b).

a. b.

Photograph 23. Example of clearly marked walkways

Further, storing raw materials in individual trolleys or stillages that can be easily moved within the factory helps to maintain order within the factory and reduce the risk of items being damaged. It also may help to make them easier to handle (Photograph 24a-d). For example, one company now stores the metal frames for the mattresses on specially designed trolleys (Photograph 23a). The trolleys allow the mattresses to be easily moved to where they are required and keeps them organised in one location.

Metal frames stored on trolley

a.

Raw materials stored in stillage

b.

Raw materials stored on trolleys

c.

Fabric stored in stillages

d.

Photograph 24. Examples of how raw products are stored

Other organisations have reorganised raw product storage areas, using shelves to organise products as shown in Photograph 25. This photograph also shows the use of cardboard cylinders to keep smaller fabric rolls in. This allows individuals to access the fabric they want much more easily as they will not have to move other fabric rolls in order to access the one they want. Further, this company placed the most frequently used fabric rolls in the middle shelf at approximately waist height. This will help to reduce the amount of bending or reaching when accessing the rolls.

Photograph 25. Use of racking and cardboard cylinders to store fabric rolls

Storage of the finished mattresses on trolleys or in allotted storage areas is beneficial for preserving the quality of the product and allowing for an organised workplace. Photograph 26a-

c, shows two types of storage areas observed that can be used in conjunction with trolleys. These help to protect the mattresses and keep the warehouse ordered and well organised.

a. b. c.

Photograph 26. Examples of allotted storage areas

One manufacturer introduced a 'goods in' board that outlines all the products that have been delivered or are due to be delivered to help them manage their stock levels better (Photograph 27).

Photograph 27. Example of a 'goods in' board

Many of the organisations visited reported they had reduced the height that items are now stored at. Some companies reported that they have instructed individuals to only place 'x' number of raw products or mattresses on a conveyor or worktable to reduce the height at which individuals are reaching. This will help to avoid lifting at or above shoulder height. One company has also painted a line on the wall where products are stored to indicate that items should not be stored above this height. This is shown in Photograph 28.

Photograph 28. Storage height restrictions

Organising equipment so that the mattress or divan does not have to be lifted is an effective way to reduce the risk of MSD injury. There will still be some level of manual handling but this is more likely to be from pulling or pushing and not directly lifting the awkward load. An example of where workbenches are set at the same height as the conveyor is shown in Photograph 29a&b. Photograph 29b also shows two workbenches set at a slight angle to the main bench, making it easier for the mattresses to be pulled across from one to the other (as the individual is doing in the photograph).

a. b.

Photograph 29. Workbenches set at the same height as the conveyor

In order to promote a tidy work environment, one manufacturer has incorporated specialist workstations and tool storage systems. For example, Photograph 30 shows an area where cleaning equipment is stored so it is always easily accessible. In this way, individuals can always easily access equipment to sweep the floor clear of debris in order to reduce slipping and tripping hazards. This will also reduce the amount of thread that could get stuck in trolley wheels, making them easier to push or pull and reducing maintenance time to remove the thread. Photograph 31 shows a storage system for tools associated with a particular task. Each item required for the task is kept in a specially deigned cut-out made of wood. Both of these examples are likely to help keep the work environment tidier and therefore more organised.

Photograph 30. Clean up station

Photograph 31. Tool storage system

6.2 MECHANICAL ASSISTANCE

All manufacturers use automated equipment where possible, and some have introduced machinery such as mattress turners and assisted tape-edging machines. However, during the site visits some manufacturers reported that individuals dislike the new equipment and prefer to perform the task how they have always done it using the older machinery. The reasons for this probably need to be investigated by manufacturers in greater detail to determine the factors involved in the lack of uptake using the newer machinery. For example, is the newer equipment

inferior to the older equipment or have the individuals not been given enough time to adjust to using the new machinery (e.g. they cannot meet their targets); or, could this simply be a reluctance to change?

The use of conveyors remains widespread and is an efficient way of transporting mattresses and divans from one area to another and reducing manual handling. These are particularly useful where the workbenches are at the same height and the mattresses or divans can be pushed onto the conveyors (Photograph 32a&b).

a. b.

Photograph 32. Examples of different types of conveyors used along the production line

Once the mattresses and divans have been packaged they can then be transported via the conveyor into the warehouse where they can be picked and either stored or put directly into the delivery vehicles. One manufacturer has extended the conveyor system to reduce the distance that individuals have to walk and to overcome a difference in level at the loading dock into the back of the vehicle. Once the mattress or divan comes to the end of the conveyor in the back of the truck the individual loading the vehicle only has to walk a few steps to place it into position. This system is shown in Photograph 33a&b.

Mattress being loaded onto conveyor Loading from the conveyor in the vehicle

a. b.

Photograph 33. Loading the delivery vehicle from the conveyor

Automatic mattress turners are particularly effective at reducing the need to manually handle mattresses. An example of a mattress turner is shown in Photograph 34. How this is positioned allows the mattress to move straight from the mattress turner after it has been tape-edged, onto the conveyor without needing to be manually handled. The mattress then moves along the conveyor to the packaging area.

a. b.

Photograph 34. Mattress leaving the mattress turner and moving onto the conveyor system

Automatic packaging machines (Photograph 35) are now quite widespread and are beneficial to reduce the manual handling of finished mattresses. This is particularly important, as the finished product will weigh more than it has done along the production chain.

Photograph 35. Automated packing machine

One company has introduced an airflow-stitching table. Although not a high-risk task for manual handling this table can make stitching the fabric easier (Photograph 36a&b). There are tiny holes in the table that blow air (similar to an air hockey table) and this allows the fabric to be turned more easily by the operator, which is likely to have a positive effect on productivity.

a. b.

Photograph 36. Airflow stitching table

6.3 MOVING AND HANDLING ITEMS

Depending on the layout of a factory some manufacturers have to transport mattress or divans from one level to another. Conveyors, lifts, and chutes can all be used effectively to do this. This will help to reduce the manual handling that individuals have to undertake. An example of a chute that is used by one company is shown in Photograph 37. Part of the mattresses' assembly is completed upstairs. They are placed on a roller conveyor that feeds onto the chute where they are pushed down. At the ground level (Photograph 38) they are then collected by trolley to be transported to the next step in the assembly process. Photograph 39 shows a lift used to transport items from one level to another.

Photograph 37. The chute where mattresses are delivered from the upstairs production area

Photograph 38. The end of the chute on the ground level

Photograph 39. Lift used to transport items from one level to another

Other devices that were observed to assist in the movement of items within a factory included rollers. These were used to help move the divan bases within a cage/stillage. This is shown in Photograph 40, although the rollers on the left were slightly damaged and awaiting repair during the time of the site visit. Such devices can help to reduce lifting and carrying of divans, thereby reducing the risk of musculoskeletal injury. However, there will still be a small amount of pulling or pushing required to move them along the rollers.

Photograph 40. Rollers used to help transport divan bases

Trolleys remain in regular use within the manufacturers visited and there have been some modifications made through trial and error, discussing the requirements of the trolleys with the individuals that use them. One manufacturer had tried several trolleys within their warehouse, only to find them discarded in a corner after a time. After several iterations and discussions with warehouse employees they now have a trolley that is used by all employees and this has now also be incorporated by employees into their delivery vehicles to assist in deliveries. This highlights the importance of including individuals in the design of any new aids or changes to the work system. Examples of some trolleys observed during the visits are shown below. Photograph 41a&b shows a trolley that has rollers in the middle of the trolley to aid with sliding the mattress on or off. The trolley also tips to aid loading or unloading. This design has been found to be very effective by employees.

a.

b.

Photograph 41. Specialised trolley to transport mattresses

Photograph 42 shows a trolley used to move fabric rolls. It has been modified to include to stabiliser wheels at the back.

Photograph 42. Specialised trolleys to transport fabric rolls

Loading ramps to bridge the gap between the vehicle and the warehouse are beneficial to ensure that trolleys can transport the mattresses into the back of the vehicle, without the warehouse operatives having to lift and carry individual mattresses. Pushing or pulling a trolley with one or two mattresses is a preferred method compared to lifting and carrying and will reduce the risk of musculoskeletal injury that employees are exposed to (Photograph 43a&b).

a. b.

Photograph 43. Loading ramps from the warehouse into the delivery vehicle

Photograph 44 shows an example of a large warehouse storage area and the use of an order picker to access the products. The individual stands in the cage (harnessed on) and selects the mattress for the order. The mattresses are then placed on a trolley and taken to the loading bay for loading onto the delivery vehicle.

Photograph 44. Using an order picker to access products in large storage areas

The labelling of the weight on the end product still does not regularly occur, and usually only does if the customer requests it. This is still an area where manufacturers could improve. The Manual Handling Operations Regulations 1992 (as amended) does not place a duty on manufacturers or suppliers to mark weights on loads. However, they do have a duty under sections 3 and 6 of the Health and Safety at Work Act 1974 to protect people not in their employment who may be affected by handling loads they have supplied. Therefore manufacturers still need to improve how they label the product weight on the finished item so it can quickly and reliably warn handlers when the load is heavy. Clearly marking products with the correct weight will help to enable all those in the distribution chain in making a dynamic risk assessment in terms of how they handle the product. This is still one area where manufacturers need to improve.

Other companies might put a warning sign on the packaging, particularly on that of larger products, indicating a two-person lift is required (Photograph 45).

Photograph 45. Example of a warning label for a heavy product

Within warehouses mechanical handling aids and trolleys can be used to handle the products. However, some manufacturers of certain products (usually at the top end of the market) will box the entire mattress to protect it. One company has also considered several different handholds that delivery operators can use, and these mattresses are always delivered in a two-person team. The specialised packaging and handholds is shown in Photograph 46.

Photograph 46. Specialised packaging and handholds

7 CONCLUSIONS AND RECOMMENDATIONS

Consideration of manual handling issues was evident from the manufacturers that were revisited over the course of 2009 compared to the initial visits that occurred in 2005. All of the companies that participated in the revisits or telephone interviews reported that they had thought about manual handling issues in greater detail than they had previously. This suggests that for those that did participate in the HSE initiative and those that completed the 'Action Plans' it was a worthwhile experience and prompted them to think in greater detail about how to reduce the risks from manual handling during the manufacturing of beds (mattresses and divans). The removal of a 'piece-rate' pay system by many companies is also viewed as a positive step in assisting to reduce the risk of MSDs within the industry.

Those that participated mentioned that they had seen a reduction in musculoskeletal injuries over the last couple of years, which they attributed to the interventions they have introduced, including the introduction of mechanical aids and training the workforce. However, as one manufacturer reported, part of the reduction in injuries could be partially attributed to a reduction in the workforce as a result of the current economic situation. However, one company reported there were busier than they ever have been and have to employ more staff.

The availability of mechanised equipment (e.g. mattress turners, and conveyors) and automated processes (e.g. packaging and tufting machines) are all efficient ways of reducing the risks associated with manual handling. However, it is acknowledged that in some situations these are not practical or viable solutions, therefore, other alternative means of risk reduction may need to be considered. Further, by its very nature the production process requires individuals to handle the items. For example, at a minimum the items need to be pushed or pulled such as when being transferred from one workbench to another or onto a conveyor. In smaller organisations heavily automated systems may not be practical and therefore alternative handling aids, such as trolleys and dollies, should be used where possible to transport the mattresses and divans within the factory. Alternatively working in a two-person team can help to reduce the risk from manual handling.

Independent of the size of a company, simple measures can be implemented to reduce the risk from musculoskeletal injury. For example the work organisation is an important factor. Manufacturers should consider the workflow of products through the factory so that the raw products enter the factory at one end, work their way through the production line and the finished product leaves the building at the other end. In this way manual handling of items should be reduced, particularly if used in conjunction with mechanised handling aids (e.g. conveyors) or trolleys/dollies. Several manufacturers mentioned that this intervention has also brought about an increase in productivity.

A well ordered and tidy work environment (e.g. clearly marked walkways and clean floors) will help to reduce the risks from slips and trips and provide order to the workplace. This will also reduce the amount of thread that can get stuck into the trolley wheels that may make them more difficult to push, increasing the risk of MSD injury. Storing raw materials and the finished products on pallets, stillages or trolleys will also help to keep the work environment ordered and allow for items to be easily moved within the factory (e.g. by trolley or pallet truck). Although there will still be an element of pushing or pulling, this is more desirable than lifting or carrying. As observed during the follow up visits and illustrated in this report there are many alternative ways of transporting products within a factory. Manufacturers face individual issues in regard to the buildings in which they occupy. This can require some thought in methods of transporting products within the building in order to reduce manual handling. For example, transferring products from one level to another can be achieved by the use of conveyors, lifts,

chutes, or ramps and trolleys. It is therefore important that individual companies investigate methods for reducing manual handling that suit their organisation. For general movement of items around a factory, the use of conveyors, order pickers, pallet trucks, forklift trucks, trolleys, and dollies are all suitable methods and what methods are used will depend on the layout and organisation of work in each individual company.

Reducing the height at which raw products or mattresses are stored is another simple measure that all manufacturers can employ, and many reported that they now have set levels at which products are stored. This will help to reduce the lifting and reaching above shoulder height and help to reduce the risk of musculoskeletal injury.

Any changes to work organisation or to the work system should be trialled initially. Worker involvement in any new ways of working is of paramount importance from the outset. Manufacturers must also consider solutions that suit their individual needs. The introduction of any new equipment should be trialled first before widespread implementation. In addition, individuals should be consulted at the start of the process in order to ensure the solution is something beneficial and practical for use. However, there is likely to come a point where the employer will have to enforce the use of the equipment. Changes to work organisation may also have an additional benefit of improving productivity.

Manufacturers still have some way to go in terms of product weight labelling. Some manufacturers do supply the weight of the finished products, however this may only be if the customer requests it. Alternatively it may be on the sticker with the product codes but may not be immediately apparent due to its small size. As outlined in the Health and Safety at Work Act 1974 manufacturers have a duty to protect people not in their employment who may be affected by handling loads they have supplied. Therefore, it would be beneficial, and is recommended, that manufacturers supply the weights on their products. Clearly marking products with the correct weight will help to enable all those in the distribution chain in making a dynamic risk assessment in terms of how they handle the product.

In conclusion, the HSE initiative does seem to have had a positive effect on those that participated in completing the action plans and had the time to participate in this follow up study. While some manufacturers have a greater awareness of the musculoskeletal injury risks from manual handling and are taking positive action to reduce the risks it is possible that there are many, particularly those who did not participate in the initiative or were ‘unavailable’ for this follow up study that may still need to make improvements. It is therefore suggested that the findings of this report are disseminated to the manufacturing industry as appropriate. The HSE and NBF should consult on how to best raise awareness of the finding from this report that should be accessible on the HSE website.

Further, while the initiative and this follow up study have looked at manual handling in the manufacturing process, to have maximum impact within the industry, future research could best be directed at the distribution and delivery of mattresses one they have left the manufacturers site. In 2009 HSL have received several queries from companies who transport mattresses seeking guidance on manual handling issues. Any additional research should look at the weight of the products handled, how they are transported, if handling aids can be used, the type of packaging used and the use of handles or handholds and the delivery itself. These are all common issues shared by other similar industries (e.g. white goods). In the meantime, manufacturers could reduce the number of mattresses in the vehicle so it is easier to unload or to take a trolley on board to assist with the delivery. However, it should be noted that decreasing the number of items in the vehicle is likely to have a cost implication. Further, in regard to home deliveries, manufacturers could give delivery drivers greater power to refuse to deliver if they consider that the route within the property is unsafe. In order to prevent non-deliveries,

communication between the retailer, delivery driver, and customer will be important (e.g. to ensure a pathway within the house has been cleared so they can easily handle the mattress to where it is required). When delivering to retail premises it will be important to ensure that there is assistance for the delivery driver to help him unload the vehicle. A trolley stored within the delivery vehicle to assist with deliveries may also be possible.

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