EFFECTIVELY SOURCING ERGONOMIC PRODUCTS

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Ergonomists typically receive very little training regarding how to effectively source products that might resolve issues that cause musculoskeletal disorders (MSDs). This paper reviews examples of how ergonomic solutions can be successfully sourced, using a step-by-step process. While the use of the internet has increased the availability of information about various products, these products are not always available locally, and cannot always be shipped to Canada. Further, the available "off-the-shelf" products don't always suit the intended purpose, and can sometimes cause more issues than they solve. Ergonomists must consider all aspects of the work design (i.e., workstation dimensions, load weight, working heights, and reaches), when selecting appropriate products, and must anticipate how the new tool will impact the overall job demands.

This paper discusses methods and tips for finding appropriate products for specific applications. The process typically begins in-house, using the resources available within the plant, including those on the plant floor, the ergonomist, engineering, management, health and safety, and purchasing. These "leads" often result in research outside the organisation, using personal contacts, vendors established with the company, sister/similar facilities, and the internet. When a suitable product can be found, the procurement process needs to include some type of product trial with the possibility of product return. When no suitable product can be found, an ergonomist needs to work with the company to find the resources to have a product constructed.

Key words: ergonomic solutions, ergonomic products, process, sourcing

ACQUISITION EFFICACE DE PRODUITS ERGONOMIQUES

En général, les ergonomes reçoivent très peu de formation sur la manière de s'approvisionner efficacement en produits susceptibles de régler des problèmes qui entraînent des troubles musculo-squelettiques (TMS). Le présent article examine des exemples de manières possibles de s'approvisionner avec succès en solutions ergonomiques grâce à un processus par étapes. Grâce à Internet, la quantité de données sur divers produits auxquelles il est possible d'accéder a certes augmenté, mais ces produits ne sont pas toujours offerts localement et ne peuvent pas toujours être expédiés vers le Canada. De plus, les produits standards vendus en magasin ne conviennent pas toujours au but visé et peuvent parfois causer davantage de problèmes qu'ils n'en règlent. Les ergonomes doivent donc tenir compte de tous les aspects de la conception des tâches (c.-à-d. les dimensions des postes de travail, le poids de la charge, les hauteurs de travail et les distances d'atteinte) au moment de choisir les produits appropriés et doivent prévoir l'incidence que le nouvel outil aura sur les exigences globales du travail.

Le présent article traite des méthodes et des trucs pour trouver les produits appropriés pour des applications précises. Le processus commence habituellement à l'interne avec les ressources disponibles dans l'usine, y compris celles qui travaillent dans les locaux mêmes de l'usine, l'ergonome, le service d'ingénierie, la direction, le personnel de la santé et de la sécurité et le responsable de l'approvisionnement. Ces « pistes » mènent souvent à une recherche à l'extérieur de l'organisation, auprès de relations personnelles, de vendeurs

réguliers de l'entreprise, d'installations associées/semblables et au moyen d'Internet. Lorsqu'un produit convenable peut être trouvé, le processus d'approvisionnement doit comprendre une forme quelconque d'essai du produit et de permettre de le retourner au besoin. Lorsqu'aucun produit convenable n'est trouvé, l'ergonome doit travailler avec l'entreprise en vue de trouver les ressources pour faire faire le produit.

Mots clés : solutions d'ergonomie, produits ergonomiques, processus, approvisionnement

INTRODUCTION

This paper outlines a step-by-step process to select and source appropriate ergonomic products, and provides case studies to demonstrate the process. For the purposes of this paper, we assume that the MSD hazards have already been evaluated. Examples of "off-the-shelf", "custom fabricated", and "vendor-customised" interventions are provided.

PROCESS FOR SOURCING ERGONOMIC PRODUCTS

1. Solutions meeting: Define the problem and brainstorm solutions

If a problem is complex or the solution to an issue is not obvious, a brainstorming approach should be used to identify possible solutions. The following steps should be followed:

a) Include operators, supervisors, engineering, management, maintenance, and other relevant key stakeholders in the brainstorm session. The "invitees" will vary depending on the project. Buy-in from operators is critical, as they will be the end users of the proposed solutions. Sundin et al. (2004) found that a participatory approach resulted in improved efficiency (faster assembly time) and ergonomics (less physical stress), and ultimately fostered communication and co-operation between workers and designers during the design process.

b) Review the risk assessment results and develop a problem statement which clearly defines the potential or existing MSD hazards. Describe the underlying concern or the "root" cause and its impact in measurable terms, identify where/when the problem occurs, and give the project team a clear vision of the problem. Record the problem statement on a flip chart or white board, where everyone can see it throughout the session.

c) Assign a skilled leader/facilitator for the session. The facilitator must be willing and able to draw ideas from all members of the group, encourage creativity, and shut down discouraging comments. All ideas that are generated should be recorded.

d) Compose a short list of the brainstormed ideas. Review all ideas and obtain consensus on those that are not reasonable. Record why these ideas are being removed, for later reference if needed. Of the remaining ideas, select the "top five" for an initial investigation. For each of the top solutions, assign responsibility for investigation. Record by whom, when and how the investigation will be done, and set deadlines to ensure the project is kept on track. Involve the person who came up with the idea as part of the investigation team if possible. The record of the remaining ideas should be retained in case none of the top five ideas are feasible to implement.

2. Use available resources to research ideas

Whether the solution is an in-house fabrication, an off-the-shelf product, or a customised product, the same resources are available:

a) Operators are the experts on the job. They may have insight into what has been tried before and what challenges may arise from potential ideas. Provide time off-line and access to resources if you plan to have operators conduct research.

b) Engineers/maintenance/facilities personnel can provide technical guidance (i.e., engineer drawings, available power source, voltage capabilities, etc.), and can identify potential difficulties with implementation, staffing requirements to implement solutions, timelines for implementation, and cost of materials and labour to construct.
c) Purchasing/procurement employees can assist with product and vendor research, and can usually obtain product costs, Canadian vendors or vendors with existing company accounts, and vendor catalogues.
d) Vendors can provide guidance on the most appropriate solution, cost, durability, usability, and warranty, new ideas/tools available on the market, product specifications, and products used in similar facilities or similar applications.
e) Sister facilities, or similar companies in your industry, can provide input regarding what has been used/trialed and what worked or didn't work for particular problems, pros/cons of potential solutions, challenges they faced, vendor recommendations, and best practices.
f) Internet search engines assist in identifying products, product specifications, costs, and new ideas. Discussion groups can also be used to gain feedback on specific products. Popular, useful search engines include ThomasNet (www.thomasnet.com), Google product search (www.google.com/products), and GlobalSpec (www.globalspec.com).
g) Industrial catalogues and magazines advertise new products, vendors, and product specifications. Purchasing, engineering, safety, and maintenance employees often subscribe to trade magazines that may include useful vendor and product information.
h) Industrial tradeshows showcase new and existing products. Attending tradeshows provides an opportunity to view product demonstrations, trial products, obtain catalogues (and occasionally samples to take with you), and interact directly with vendors to obtain information on product specifications, customised products, and cost, etc.

3. Review ergonomic design guidelines

When selecting a product, review the product specifications against ergonomic design guidelines to ensure that the most appropriate product has been selected, before obtaining the product on trial or purchase. If the product does not meet ergonomic design guidelines, contact the vendor to obtain information on alternate products or customised solutions. If designing a custom solution, use the guidelines to determine appropriate working heights and reaches. Adjustability will generally accommodate more people, but where adjustability is not feasible, determine the impact of designing for an average person, and recognize the consequences of this design choice. (Taylor Van Velzer and Morose, 2009).

4. Conduct mock ups or product trials

Mock ups and product trials, using real workers, are an effective way to determine if an idea is feasible, and if the solution truly addresses the MSD hazards. Mock ups and product trials can help to identify potential issues, especially when it is not possible to easily predict the outcome of a proposed change, or when detailed ergonomics guidelines are not available for a particular design parameter (Morose, 2009). Ensure that operators are involved and obtain their feedback, as quantitatively as possible.

Tips that have been useful while conducting mock ups and product trials include:

- Consider safety first! Make sure that the plant safety contact provides you with safe access to forklifts, lift tables, tools, etc..
- Make the mock up as realistic as possible, using actual tools and parts from the job. Wobbly jigs and cardboard cut-outs will not get easy buy-in.
- Use a quantitative rating scale to gather feedback from employees. For example, develop a "mock up evaluation sheet", using a 10 cm scale, and ask each employee to rate the

existing job or product, and then rate the mock up or trial product. These ratings can be mathematically compared for a quantitative estimate of the impact.

- Ask for tall, small, average, and left-handed operators to be involved in the mock up or trial. If possible, get workers from all shifts. If your facility includes both male and female operators, include both in your trials. Make sure the workers you select know the job well. Ask to involve "vocal" workers (especially those who originally expressed the concern); their buy-in will be valuable. Include a Joint Health and Safety Committee representative to help support worker buy-in.
- Consider product flow through the workstation, not just the task of interest. Where will incoming parts be? How are outgoing parts handled? Include these aspects, if feasible, in the layout of the mock up.
- When mocking up height changes, determine, in advance, whether adjustability is an option. If so, you can set each person's height at his/her preference, and document the selected height. If adjustability is not an option, mock up *only* the proposed heights. (This process requires more pre-work to identify the proposed height and to set up the mock up appropriately (Morose, 2009 and Taylor Van Velzer and Morose, 2009).
- When mocking up reach changes, ensure that any reach or height obstacles (e.g. guarding, toe clearance) are the same in mock up as they are in the working condition. If operators lean on something during the job, provide a sturdy surface for them to lean against during the mock up.
- Consider the effect of gravity during work surface angle changes – will the operator have to hold a part continuously to prevent it from sliding? Can gravity be used to direct product flow? What angle optimises force application?
- Consider grips – would a handle in a different location help or hinder? (Use clamps to mock up handle orientation.) Is clearance available for the hand throughout the process? In what orientation should the handle be presented? What size? Surface?
- Consider clearances – does the proposed change allow toe clearance? Are racks and parts still accessible?
- During a mock up, document all relevant heights, reaches, operator heights, platform heights, etc. Take lots of photos. (Develop and use data collection forms as appropriate.)

5. Cost-effectiveness analysis and cost-benefit analysis

A cost-effectiveness and cost-benefit analysis should also be completed to help determine the most effective solution. A cost-effectiveness analysis compares the estimated effectiveness of various solutions against the costs of the solutions, in order to encourage selection of the lowest cost, most effective solution. A risk assessment and operator feedback obtained from mock ups and products trials can be used to estimate the effectiveness of a potential solution.

To conduct a cost-benefit analysis, investigate and list the economic value (injury expenses, productivity problems, etc.) associated with poor ergonomics at the workstation or job, estimate the percentage of improvement that you might reasonably expect with the proposed change (based on risk assessment), and calculate the total expected savings (benefits) associated with implementing the change. Tally up the cost of the proposed change, and compare the costs with the expected benefits. The ratio of the cost to the benefit can be used to calculate the pay-back period for the change. For example, if an intervention costing $5000 produced an expected benefit of $10000 per year, then the ratio of $5000/$10000, or 0.5, would represent the time to pay the investment back, in years. Cost-benefit analysis isn't necessary for all interventions. Product trials that are highly successful and readily accepted by workers are often immediately implemented without investing the time to analyse costs and benefits.

6. Select the best solution

After completing the steps above, meet back with those involved in the initial brainstorming session and any new key stakeholders to review the solution investigation results and to make a decision about which recommendation to take forward to the implementation stage. Hamid et al. (2009) reports that "selecting the most suitable equipment...and optimising them...in order to attain an optimum solution" minimises the total operating and investment costs of the selected types of equipment. In most facilities, the selection is typically a management decision, and not necessarily a consensus decision.

7. Implement and follow up

After the solution has been implemented, and before operating the solution at full production rates, conduct another risk analysis to ensure that the solution effectively mitigated the MSD hazard. Follow up with operators to obtain comments and concerns regarding the changes. If outstanding ergonomics concerns exist, the implementation process will have to be repeated to determine alternate solutions. Once production is at full capacity, follow up again to ensure that all original concerns have been addressed and that no new concerns have materialised.

CASE STUDIES

The following case studies are taken from client facilities in a variety of industries.

Cart with cut-out sides

The garbage cart was large and difficult to manoeuvre in the narrow hallways, and required forceful pushing, especially when taken outside in the snow. Awkward back postures to load and unload the cart were also identified as concerns. After meeting with the operators and management to brainstorm and determine their needs, the group agreed that a smaller cart with larger wheels was the preferred solution. The ergonomist measured the workstation (including passageways), consulted the purchasing department, other ergonomists, and the internet to find suitable products and local vendors. The purchaser contacted the company's preferred vendor, found a potential cart, and provided the vendor's cart specifications to the ergonomist. After reviewing the cart specifications against ergonomics guidelines for cart design and clearance, the ergonomist confirmed that the suggested cart was suitable, and the purchaser ordered the cart. The selected cart had larger wheels, two of which swivelled, was narrower, and had cut-out sides. The operators provided very positive feedback on the trial as the cart was easier to manoeuvre both inside and outside, and they were able to load and unload the cart using more neutral back postures. For this case study, a cost-benefit analysis was not required.

Modified end effector for existing hoist

A hoist had previously been installed to eliminate the need to lift 16.5 kg totes. The hoist could be used successfully for most totes. However, the clamp on the hoist did not allow operators to place one specific style of totes in their intended position on the pallet on the first try. The clamp required space on either side of the tote to be released. Therefore, operators had to set the tote down, release the clamp, and then reposition the tote to its final position on the pallet. As a result of the extra steps required to use the hoist, operators preferred to manually lift the totes. The ergonomist and engineering manager evaluated the hoist design and brainstormed potential solutions. The engineering manager designed a modified end effector, which was built in-house by maintenance staff. Once the clamp was modified and introduced, operators completed surveys, which were used to evaluate the effectiveness of the change. They provided positive feedback, and can now use the hoist as intended (D. Van Winckle, personal communication June 18, 2010).

Manually handling mufflers

An ergonomics assessment identified a high risk lifting concern for material handlers. Awkward grip, back and shoulder postures were also observed to transfer two mufflers at a time (each weighing 6.5 kg), from a large bin located on the floor to a thigh-high roller conveyor. Meetings with key stakeholders resulted in a decision to raise and tilt the bins to minimise awkward postures and encourage material handlers to lift one part at a time using two-hands. Keeping the plant's priorities for self-powered and ergonomic design in mind, the engineer's first design iterations involved determining what bin angle would best present the parts at an optimal height (between knee and shoulder) and with minimal reaches. The engineer used a 50th percentile male in his drawings as a reference, but took into consideration the small female regarding heights and reaches. Once an optimal angle had been agreed upon on paper, a forklift was used to mock it up on the floor. Material handlers were asked to trial the new set-up, in an effort to gain consensus on the proposed height and angle. The mock-up identified several concerns: parts, as they were currently packed, could not be grasped easily; unloading the top row required above shoulder lifting to clear the bin; and the new layout required twisting 180° to load the line side conveyor. Based on these trials and feedback from the material handlers, further alterations to the design were made and the supplier was asked to pack mufflers differently to optimise gripping postures for the handlers. A raised gravity-fed conveyor with a manual tipper was built. Unfortunately, this second design resulted in unforeseen safety concerns (pinch points while tipping), and additional handling concerns with manually tipping full totes, and removing empty totes from the tipper. The tipper was scrapped at a cost to the company. Through additional meetings and trials, the final design kept the raised conveyor, eliminated the tilting mechanism, and took advantage of the drop-down door on the bin. With the new set-up, implemented six months after assessment, material handlers were observed to lift in more neutral postures and naturally used two-hands to lift. A follow-up assessment also demonstrated an acceptable risk rating. In this case study, consideration of alternative layouts earlier in the process could have averted the cost to scrap a prototype.

CONCLUSION

Although the process to source an effective ergonomics solution may appear arduous, costly mistakes can be avoided, and buy-in from production employees can be expected if a process is followed. One case study (cart) demonstrated that when the solution is obvious (e.g. when an off the shelf item would be appropriate), then an expedited process can be followed to arrive at a quick and successful conclusion. Another case study (hoist) demonstrated the need to consider all production conditions so that the solution works for all products. The final case study demonstrated that integration of safety issues into the review is critical in order to ensure that the solution meets everyone's needs safely.

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