Sustainable Prevention and Work Environment

Studies and Research Projects

REPORT **R-784**

Participatory Training in Manual Handling

Theoretical Foundations and Proposed Approach

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Legal Deposit
Bibliothèque et Archives nationales du Québec
2013
ISBN: 978-2-89631-678-6 (PDF)
ISSN: 0820-8395

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This study was funded by the IRSST. The conclusions and recommendations are solely those of the authors.
This publication is a translation of the French original; only the original version (R-690) is authoritative.

PEER REVIEW

In compliance with IRSST policy, the research results published in this document have been peer-reviewed.

ACKNOWLEDGMENTS

Thank you to all the workers and companies who, over the years, have graciously participated in our research and shared their know-how and enthusiasm with us. A special hat-tip to Marie Authier, Monique Lortie and Micheline Gagnon, all of whom paved the way on issues of manual handling training. Their contribution constitutes the foundation for the approach presented in this report. Special thanks to Josée-Marie Couture for her generosity in sharing the fruits of her professional practice and the wealth of knowledge she has developed. We are also grateful for the participation of Danik Lafond, a professor at the Université du Québec à Trois-Rivières, who attended some of our meetings and enriched our debates with very useful comments. And last, to all those who commented on this report, thank you for your generous feedback.

ABSTRACT

Manual handling is often the cause of musculoskeletal injuries—especially to the back—and has been the subject of many studies and prevention efforts over the years. Handler training is a common avenue of prevention. One of the prevalent training approaches consists in teaching basic guidelines, reflected in standard techniques that handlers are supposed to apply at all times. Recent studies question the effects of such training, and some shed a new light on the realities of manual handling. Handlers with many years of experience use methods that are more diversified than what is taught in training. Their challenge is not so much to apply a predefined technique as to adapt their work methods to the varying situations they encounter. A rethinking of training programs is critical in order to remain relevant to handlers' activities. We propose an approach focused on competencies and rules, rather than standard techniques.

This report—based on a critical literature review, exchanges by a group of experts and references to a theoretical framework that incorporates notions from four different disciplines—describes the proposed approach and its theoretical foundations, and offers practical tools for designing training programs that are more realistic and specific to the workplace. We present a three-phase strategy for workplace implementation, with the key imperative of starting from actual work situations and the work methods already in use, rather than imposing methods from the outside. Although training is central to our approach, the conditions likely to influence the presence of risk in handling operations are also considered. Taking work conditions into account means providing operators with ways to exercise and develop their skills. Time considerations and the competence of the people giving the training—two aspects likely to impede the implementation of this approach—are discussed as well. In addition, comments are offered on the rules of manual handling, which are key to this approach, and we include comments on the limitations of the approach itself.

Keywords: skills, competencies, handling training, handling rules, developmental research, back pain.

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NOTE TO READERS

The authors wish to clarify two points for the reader preparing to consult this report. Our intention is to anticipate questions or objections that would detract from the reading of this report and obscure its most significant contributions. The first point has to do with the existing handling training programs and the need to rework them. The “Introduction” and “Background” sections contain all the arguments justifying the need to change the current offering. The text is written so as to highlight the differences between the available training programs and what we would like to see. We do not recommend flipping straight to the results section, because the logic leading to the proposed approach will greatly aid in the reader’s comprehension. Some may conclude that we want to sweep aside all current practice, but this not the case. The safe techniques now taught have their place in our approach, with the important caveat that they are one way of doing things, among other possible ways, and are therefore no longer central to teaching. Although our proposals mean a paradigm shift, they do not negate what has gone before, but rather seek to build on existing knowledge.

The other point to clarify has to do with the approach used to conduct this study, which is in contrast with more conventional studies of the experimental type, or even with the inductive approach characteristic of qualitative research. Developmental research—described on page 25 – is not well documented in manual handling and is therefore unfamiliar. Yet it is a recognized research approach, used mainly in education, which is where most of the literature about it is found. One of the particularities of developmental research, as used here, is that it provides a bridge to the existing research data on handling—previously isolated—to reveal integrated and therefore new knowledge. Added to this process were expert feedback, reference to a theoretical framework and validations with user populations. This triangulation made it possible to validate the proposals advanced. In other words, we have a review of a vast body of literature, whose contradictions and shortcomings, if any, were compensated by the other sources. This methodology has proven well adapted to the needs of this project, the objective of which was to develop content for a training program, as well as workplace implementation guidelines. The proliferation of knowledge, combined with the increasing desire that knowledge be used in practice, calls for innovation in our way of conducting research. This situation leads us to think about the boundaries between research and knowledge transfer, and about their respective roles, especially in occupational health and safety (OHS), where questions about relevance and use of research results are a particular concern. Developmental research has proven to be a response to these concerns.

Using this methodology particular to developmental research, we are able to propose that the techniques used by experienced handlers are often in opposition to those recommended in training; that two competencies seem to us essential to develop in handling training; that handling is not a monolithic activity but can be broken down into situation types with different demands; that know-hows can be correlated and interpreted through handling rules; that a participatory training approach is best for promoting learning among handlers, etc. These assertions have not been demonstrated through experiments but arise from the consultation of various documents and studies by experts on the subject. There is no single study dealing with these matters, hence the necessity of pooling the results from many studies to arrive at our results. However, let us stress that this project is not a simple process of adapting previous study results but of creating knowledge which is just as relevant as the original studies on which it is based. The handling rules and situation types are good examples.

Readers familiar with scientific literature will thus recognize that this is not a traditional report with original data from a single study whose results are compared against similar studies. Rather, it is a construction based on previous studies. Apart from the fact that this type of research is little known and may give rise to questions, we see two other issues. The first issue is the difficulty of systematically supporting the assertions made in the report, i.e., citing sources in the text as is conventionally done. It is not always possible to cite references since most of the assertions are from combinations of sources and result from the superimposition and intersection of various data. Even if it was theoretically possible to cite the myriad studies that collectively informed our statements, the consequence would have been to make the text unreadable.

The other matter concerns the style adopted in the writing of this report, which is somewhat different from a conventional report. In particular, the section on results includes, here and there, comments usually reserved for discussion. The decision was to comment on each section to facilitate reader comprehension. Since the results are commented, the traditional “discussion” has been replaced by a section called “Issues and perspectives”, which is more appropriate for this report. We think that this approach is more in line with the nature of the data presented and will facilitate their understanding without affecting their scientific quality.

More generally, this report is the culmination of several years of research, discussion and scientific presentations, but also seminars, vocational training and university teaching. These myriad experiences have yielded many informal exchanges which have made it possible to confront the theoretical aspects described in the literature with the reality expressed by the event participants. Our proposals are thus based not only on research but on practical reality.

With these comments in mind, we hope you will enjoy our report, and we remain open to your comments and suggestions.

1. INTRODUCTION

“Lift with your knees, not with your back.” This has become the ubiquitous catch-phrase for how to lift a load properly. Add a few more instructions such as “Face the object head-on” and “Lift slowly, with a constant speed,” and you have the basics of most handler training courses currently on offer. Widely used in workplaces, such training programs are focused on applying a predefined technique.[1] This simple approach is attractive, but as we will see, it does not rise to the goal of injury prevention.

In contrast, anyone watching experienced handlers at work will quickly come to the conclusion that their methods are richer and more diversified than the simple slogans above (Denis et al., 2007; Couture and Lortie, 1999; Baril-Gingras and Lortie, 1995). Several field studies conducted in different handling contexts help us understand the difference between the techniques recommended in training and what is actually being done in the workplace. The easy solution would be to hold the handlers responsible: they are simply not making an effort to change poor work habits acquired over the years. However, current knowledge allows us to propose more credible and realistic explanations for the reluctance of workers to use these allegedly safe techniques on a regular basis.

Having observed the failure of current training methods, and using the results of studies on actual working situations, we are proposing to update manual handling training so that it is more in line with the job requirements. The new training method must be based on a solid, credible theoretical foundation.

1.1 Manual handling: A widespread activity with risks

This development effort is justified on two grounds. Firstly, although the number of workers who bear the official title of handler is limited, manual handling in various forms is part of many jobs (construction, industry, agriculture, transport, municipal work…). People tend to think that mechanization has replaced manual handling in the workplace. However, according to new data from the French SUMER survey, it has done no such thing (SUMER, 2006). For four out of ten employees, load-handling is part of their duties, and three out of ten workers carry loads at least two hours per week. These statistics hardly budged between 1994 and 2003, when the SUMER surveys were conducted. Although the SUMER study has no equivalent here, we can assume a similar trend in Québec. In addition, a recent report commissioned by the French government on projected labour market needs for 2015 indicates that in a globalized economy, trade in goods will continue to develop, requiring a growing number of materials handlers (Chardon and Estrade, 2007).

Secondly, manual handling is recognized as a high-risk activity (Troup et al., 1988; Kumar, 1994; Lortie et al., 1996; National Research Council, 2001). Handling is associated with workplace accidents and with the progression of musculoskeletal disorders (MSDs), especially in

1. This is only a partial picture of the approach so widely used in manual handling training, but it is a fairly accurate summary of the general philosophy.

the lumbar region.[2] Even young workers (age 15-24) are not immune: materials handling is the primary cause of workplace accidents for this age group (Ledoux and Laberge, 2006). The *Commission de la santé et de la sécurité du travail du Québec* (CSST), the worker's compensation board in Québec, has identified handling as a priority area for MSD prevention over the coming years.

1.2 Choosing training as a preventive method

The primary area of interest in this report is training. It is possible to use other means to improve manual handling by equipping workplaces with better working conditions (e.g., adjusting pickup and delivery heights, improving accessibility, providing workers with handling aids). But the fact of the matter is that in many sectors, training is an appealing and even essential preventive method. Strictly from our perspective as researchers, we have observed a widening gap between the handling training offered and the knowledge yielded by field research in various areas where handling is practiced, and we thought that this was an avenue for making a significant and original contribution to general knowledge on the subject. We can't emphasize enough that the risks associated with manual handling can be reduced or eliminated by preventing them at source (Rodrick and Karwowski, 2006). A prevention policy based mainly on training can be seriously flawed (Hale and Mason, 1986). Therefore, an ergonomic approach must be implemented as well. The reader will notice that this accent on expanding prevention beyond training is very present in our approach.

In addition, through training, we hope to contribute to an improved recognition of handling work, which is currently perceived as an "all brawn and no brains" job with an easily replaceable, unskilled workforce. Manual handling tasks are often done behind the scenes, and are therefore ignored or seen as insignificant. People still see handling as an undesirable task—a necessary evil—not as an activity that can add value to a business. But in many cases, good handling can be an advantage in the production process, in terms of both quality and quantity. For example, among order-pickers, how well the boxes are stacked on the pallet ensures the physical security of the contents, the balance of the loaded vehicles—essential to safe driving—and also optimizes load volumes (Couture, 2000). We feel that updating handling training will allow us to change or at least improve the unfortunate public perception of the job, contribute to improved recognition of the useful skills of handlers and prevent the MSDs associated with the work.

1.3 Training: Adapting to new models

The workplace has been undergoing major changes since the 1980s and 90s. New forms of work organization and production tend to promote autonomy, initiative, versatility and, some would say, skill. These changes require training, and training models are also evolving. Traditionally offered in a classroom, training is taking place more and more often right at the workstation: at the shipping dock or on the production floor. Organizations seek operational and contextual training that meets the immediate needs of the job, which means that not only training locations

2. For a complete statistical portrait, we invite the reader to consult the IRSST handling website: (www.irsst.qc.ca/manutention).

are changing, but also training methods. Learning no longer means simply memorizing facts presented by an external trainer; people are discovering the value of training in actual work situations (Darvogne and Noyé, 2000; Fernagu Oudet, 2006) and the potential of workshops where experienced workers share their skills with new employees (Cloutier et al., 2002; Gaudart et al., 2008).

In this perspective, training no longer involves learning a set of facts to be applied on the job. Instead, it aims to create conditions that help trainees understand the situations they will face, and to build context-specific knowledge. This form of training is not just about acquiring technical knowledge or performing a task correctly, but rather aims to give the trainee the means to enter a workplace culture, to participate in it and transform it (Lave and Wenger, 1991; Hutchins, 1994; Lave, 1996). The approach presented here uses this same philosophy, viewing training in a broader context. Nowhere in this report will the reader find a recipe for a nice, ready-made training program. We are instead working on an approach that, although it is structured, can be applied in a flexible and adaptive way: it is detailed in Section 6 of this report. While remaining faithful to the foundations of training, it can take various forms and configurations depending on the handling activity it is used for. We hope that this will promote rather than discourage its use.

With regard to the people for whom the training is intended: although it may be used for any manual handlers, we feel that employees who work as full-time handlers will benefit the most from it. Manual handling requires a certain skill set that can only be developed after a sufficient amount of time spent handling. If the training method is to be used for workers who perform less than a minimum daily amount of handling, the proposed approach must be adapted to their needs. At present, there is not enough information on the subject—particularly on motor learning—for us to understand how and at what speed handling skills are acquired. Are part-time or occasional handlers who perform handling tasks at fixed periods during the year (seasonal workers) able to apply our training as well? The question is open; it may be answered during our planned follow-up on the training results.

1.4 Report structure

This report should interest anyone required to provide handling training, especially for moving inert loads. Ergonomists in particular will be able to relate to our approach, as it is influenced by the trend in activity-based analysis. The report has two guiding principles, the first being to base our proposed approach soundly in theory. We have thoroughly elucidated the theoretical justifications of our choices and development logic. This attention to scientific and theoretical foundations is essential to the credibility of our propositions. Our second principle is to expose the pertinence and significance of the project, so that is it seen as incontrovertible to materials handling training. As we want the approach to be pragmatic, we also propose concrete tools and suggestions.

Aside from this short introduction, the report contains seven sections. Section 2 is where we discuss the handling training currently on offer, its shortcomings, and the orientations that should be adopted in the development of a new approach. This contextualizes the study for readers, so that they can understand current practices and why we want to overhaul the existing model. A theoretical position is presented in Section 3. As our approach is based on competency development, we offer a model of competency that integrates complementary notions from four related disciplines, with an emphasis on activity-based ergonomics. Section 4 describes the process we used to develop the new training approach, which is informed by trends in developmental research. Recommendations are made in two chapters: the first (Section 5) for training content and the second (Section 6) for implementation in the workplace. Key challenges and outlooks are found in Section 7, followed by a brief conclusion. We also invite readers to peruse the bibliography, an innovative compilation of publications on handling and various other themes addressed in this study.

2. BACKGROUND

The safe techniques briefly mentioned in the introduction have been promoted with massive campaigns and are now well anchored in the workplace as being the only way to lift loads without getting hurt. We must take a moment to explain why we feel it necessary to review the training currently on offer. Firstly, we will show that, despite the fact that training is prevalent in the workplace, it does not meet the needs of either workers or employers. We propose some explanations for this failure. Since these explanations have become the elements we worked on to improve the training, describing them here will allow readers to better understand the changes we propose at the end of this section. The explanations concern two aspects of the training program: the content and the setup, i.e., the pedagogical scenario designed to guide the trainees' activities such as learning sequences, objectives, and the means to be employed to achieve these objectives (e.g., teaching material, duration, follow-up). We then discuss implementation, or how training is put into practice in the workplace.

2.1 Safe techniques training: Mixed results

At present, manual handling training uses a one-size-fits-all approach, with no consideration for specific handling situations, as though everything was always dangerous. Mainly developed through biomechanics and based on laboratory studies, these techniques aim to reduce mechanical stress (overexertion) on the spine, especially the lumbar region (lower back). Mechanical stress, not just overexertion but also cumulative loading, is recognized as a leading cause of back pain, and is therefore a main focus in training programs. This is why certain handling techniques are called "safe lifting" (Authier and Lortie, 1995). Emphasis is placed on the lifting phase, because that is the moment of maximum back loading. However, a handling task is not limited to just lifting. We will see later on that, even at the lifting phase, handlers are concerned about deposit delivery.

Such training generally tries to instill "good" work habits—safe movements and good posture—that will become automatic when used on a daily basis, independent of the context and without considering the worker's experience (Teiger, 2002). Handling training programs have been implemented in the workplace, with mixed results (Kroemer, 1992; Wood, 1987). Their relevance has recently been called into question (Haslam et al., 2007; Martimo et al., 2007; Martimo et al., 2008; Clemes et al., 2009). Workers use methods other than those recommended, even after they have received training (Harber et al., 1988; St-Vincent et al., 1989). The incidence of musculoskeletal disorders related to handling remains high. And although we are not sure why the current training programs are turning out to be ineffective, we can put forward some reasonable hypotheses.

2.2 Factors neglected by the current training model

To conclude that the current training does not achieve its objectives can be seen as a starting point, pushing us not to call into question the use of training as a preventive method, but to review the approach. However, the studies criticizing the current training methods do not explain how to do things differently. Here, then, are a few elements that seem to have been neglected in the current training model. We relate each of them to factors that are characteristic of handling that should therefore be taken into account in any restructuring of handling training.

2.2.1 Handling is a diversified activity

As we become familiar with the environments in which handling occurs, the immense diversity of handling activities becomes clear. In many companies, the relatively simple, monotonous and tedious handling tasks have been automated, while the ones entrusted to workers are much more complex and require the handling of very different kinds of loads (e.g., in terms of weight, volume and shape) in contexts that are both diverse (e.g., variable delivery/pickup heights, space limitations) and changing (e.g., delivery to various clients, preparation of a variety of orders, variable weather conditions when working outdoors). It is not surprising that these tasks are done manually, precisely because their extreme diversity makes them more difficult to mechanize.

And therefore we must ask ourselves: how can we deal with this kind of diversity? Should we distinguish between the work of a mover, a delivery person, a shipping dock worker and a baggage handler, or are they all performing handling work? In our opinion, the training on offer is not adapted to such diversity. To illustrate this point, let’s make an analogy with auto mechanics. To perform their jobs, both handlers and mechanics need tools. The toolbox of a mechanic is usually well stocked. The more a mechanic is required to repair different makes of cars, the more his toolbox must expand to contain adaptable tools and/or tools specific to each make. Part of a mechanic’s job is to choose which tool is best for the task at hand. Of course, the choice is determined by the nature of the part he must repair, but also potentially by the space limitations imposed by the vehicle configuration, how easy the tool is to use, or simply his own preference for certain tools that he has more skill with.

The work tool of a handler is his body. He must learn to use it and to make the very most of it. His skills reside in his body’s own knowledge. Handling is inescapably linked to this physical dimension, and unlike many other work activities, handling mobilizes the entire body and requires the development of essential physical skills such as balance, control and coordination. Along with the back, the role of the hands and feet, while often underestimated, is extremely important. Requiring handlers to place their feet one way (facing the load), or that they always lift the load in the same manner (with a symmetrical grasp, preferably using handles) means insisting that they always work with the same type of tool, despite the variability of handling situations. We would never ask a mechanic to work with one tool all the time, so how can we ask it of a handler? Instead, we should try to enrich the toolbox of the handler and especially teach him to identify the most appropriate tool for the job, which can vary depending on the load to be lifted and the specific handling context. The personal characteristics of the handler, such as skills, previous injuries and current state of fatigue, can also be criteria that contribute to this choice.

2.2.2 Handling involves several distinct risks

As we have just seen, handling cannot be regarded as a single task. Instead there are many handling activities taking various forms, and having requirements that can vary widely. Strangely, a similar phenomenon is observed in terms of the risks involved in handling. The current trend consists in focusing on a particular type of risk, without taking into account all the other risks involved in handling. Because the lower back is the most affected area, and because excessive effort is the cause most often linked to lower back injury in accident databases,[3] research has been mostly focused in this direction. Based mainly on biomechanical studies conducted in laboratories (Sedgwick and Gormley, 1998), prevention focuses on "accident analysis": temporary overexertion of the lumbar area. Biomechanics explains the distribution and intensity of the efforts exerted by the body responding to an external stimulus. Therefore most guidelines suggest standard procedures—often involving the initial lift—that aim to protect the back from overexertion: stand close to the load, face the load, keep your back straight and bend the knees, maintain your balance, lift the load slowly, etc. These techniques have the objective of distributing the load evenly over the spinal column and limiting the stress to what the spine is capable of supporting.

However, we know that handling risks can vary widely, depending on the work context. Handling often seems to involve incidents and unforeseen circumstances (Lortie et al., 1996; Lortie and Pelletier, 1996; Lortie, 2003) that can lead to overexertion of tissues and may cause injury or lead to risky responses (e.g., losing balance and attempting to regain it, dodging an object falling from a pile). The quintessential recommendation—"keep your back straight and bend your knees" —can be seen as unsafe in certain conditions. While unloading a trailer, for example, it is essential to remain mobile to avoid being hit by falling merchandise. When a handler bends his knees, he reduces his balance—as his centre of balance is now over his toes—along with his ability to react quickly.

One fundamental aspect of handling risk is related to the frequency of load handling operations and its possible correlation with the development of general and/or local fatigue. Although some studies have documented this limitation (Gallagher et al., 2007; Wilson et al., 2006; Granata et al., 2004), prevention efforts have been primarily based on establishing threshold values (maximum handling frequency, daily tonnage limits, etc.). However, unlike lumbar overexertion, there have been no training guidelines addressing fatigue. The risk in question is not biomechanical in nature, but rather **physiological**. Recent developments in science suggest that muscular fatigue and the lumbar instability that results from it are potential causes of lower back pain (Granata et al., 2004; Kumar, 2001). A recent study shows that the oxygen requirements for back muscles (*erector spinae*) during a typical handling task increase over time and peak at the end of an eight-hour workday (Yang et al., 2007).

The idea here is that biomechanical balance can be affected by physiological muscular capacity. Muscle fatigue is a physiological reaction that may affect the quality of mechanical action. For physically demanding work with a high daily workload, trying to do the job without exhausting oneself seems logical, since undue accumulation of muscle fatigue can be a cause of injury. However, it is now recognized that safe lifting techniques have high physiological costs, and have the effect of slowing the rate of work (Garg and Saxena, 1985), which may partly explain the reluctance of workers to use them on a regular basis. The "back straight, knees bent" method is perfectly appropriate in certain contexts, for example when a load is heavy and/or there is little space to move one's feet. However, asking handlers to use this method universally is a mistake,

3. Studies show that many handling risks are not taken into account in these databases and that there are many classification problems (Manning et al., 1984; 1988).

partly because bending the knees involves major energy expenditure, which can lead to fatigue. The main point to remember is that risks differ depending on the type of handling task. Sometimes the risk of overexertion is predominant; in other cases, the major risk will be fatigue. Often these two are intertwined. And this is without even bringing up the incidents and unforeseen circumstances mentioned above. To address these numerous risks, handlers must have recourse to several different methods that will allow them to adapt to the situation.

2.2.3 In handling, more than safety is at issue

The emphasis placed up to now on risk prevention tends to make people forget that, just like other workers, handlers must meet their imposed production goals. If compromise is sometimes necessary to address the diversity of risks, it is also essential in meeting production goals. Experienced handlers seek to develop methods that minimize the costs inherent in their work while also allowing good productivity. They are looking for **efficiency**. Studies (Cloutier et al., 2005; Coutarel et al., 2003; Vidal-Gomel, 2007) have shown that experienced workers possess safety know-how that is literally interwoven into a collection of know-hows related to quality and production. It therefore becomes difficult to separate the protective know-how pertaining to health and safety from the more technical and/or practical know-how necessary to carry out routine tasks. Consequently, training should not be based solely on safety, but should aim more generally to train workers for the task as a whole, taking into account both the physical and cognitive aspects.

2.2.4 Handling is more than just an "all-brawn, no-brain" task

Handling is a manual task that includes, obviously, a physical component in which the effort to be deployed is clear to anyone. However, studies have shown that this work also includes a cognitive component, neglected until now (see Lortie, 2002). The handler must plan out his work, anticipate the characteristics of the loads to be lifted, and constantly develop strategies to take into account the changing physical environment and the variable characteristics of the loads. In handling, reading a situation and extracting information from it constitutes a key cognitive skill: it is what allows a worker to organize his work, make better decisions and anticipate the unexpected. A situation can vary because the objects to handle differ, or because the spatial context or the environment is changing. With this variability, knowing how to get information—looking, feeling, testing—is essential. Only then, on the basis of this information, can a specific action follow. Handling is characterized by the physical aspect, by physical and motor skills, but it is the cognition preceding the action that allows a worker to effectively determine the action. Moreover, handling is often a collective affair. Workers must divide up tasks, plan out who does what and when, establish priorities, etc. Cooperation in daily work among handlers is the norm in many workplaces.

2.2.5 Handling is harder than it looks

One reason to justify the current training model is the apparent simplicity of the work, given that handling is seen as a simple task that does not require specific skills. Employers underestimate the requirements of the work. They often request training that shows workers ***THE*** proper handling technique… in a half-day of training. In fact, the time allotted for training programs is typically very short—a few hours, sometimes a few days. And yet specific motor skills are not acquired quickly: they can be complex and take several years to refine. It is estimated that proficiency[4] is developed over a period of ten years (Farrington-Darby and Wilson, 2006; Ericsson and Lehmann, 1996). Brevity of training was identified by Hale and Mason (1986) as the largest barrier to effective transmission of handling knowledge and skill. And this was concluded after evaluation of a five-day training program, which is still longer than average. Sufficient training duration and post-training follow-up are therefore fundamental issues.

A recent study conducted on jobs in the future confirms that manual handling is poorly perceived (Chardon and Estrade, 2007). The authors mention that one of the main needs of companies in the years to come is for employees who are immediately operational for low-skilled jobs "in the sense that anyone could 'naturally' perform them right away." (our translation) The example given is hiring a young man to be a handler. Most of the training is left to knowledge transmission via socialization, with the current employees showing the new ones how to do the job without any intervention by management. Although this teaching method can be beneficial, we cannot forget that handling is a high-risk activity in terms of developing MSDs, and that numerous injuries happen in the first weeks of work (CSST internal data). A lack of training and/or unstructured training methods can therefore put new workers, especially young people, at an extreme disadvantage.

2.3 A new approach to handling training

In light of these observations, we have established four main avenues for improving training:

a. ***Enrich handlers' "vocabulary of motion"***: Given the variability of handling conditions and the associated risks, there cannot be only one way to handle loads without injury. The safe techniques currently taught should be among the resources available, but they should not be the only ones in a handler's repertoire. Training should be guided by the know-how of handlers at the workplace—especially those with several years of experience. Studies have given us a better understanding of the actual work activities of handlers, their operational conditions and the nature of the know-how used by experienced workers. One conclusion is that there are as many handling methods as there are different work contexts and physical profiles of handlers. These methods each have advantages and disadvantages: there is no single "right" method, but rather a variety of methods which handlers can select from depending on the context.

b. ***Learn to choose an appropriate action***: Having access to additional resources is important, but it is not enough to prevent handling injuries. The key to prevention is in choosing the action best suited to the situation. It is essential to ensure that the advantages of any action are greater than its disadvantages, depending on the handling context. The handler's capacity to analyze a situation and find an appropriate solution is crucial to protecting him from risk of injury, while allowing him to meet his production goals. He must therefore read each handling situation—as the situations often change—and adapt his load-handling methods according to

4. The referenced studies are in the field of sports, not manual handling.

this reading. As we shall see later on, it is not enough to have knowledge or know-how (point **a**.); the handler must also know when to use it, and for the right reasons (point **b**.).

c. ***Learn to organize the work***: Whenever more than one load must be handled, it is necessary to introduce rules of work organization. Aside from the complexity of the task, there are the production requirements (e.g., daily tonnage) and modes of organization (e.g., work in teams, stability of assignments, work schedule) established by the employer. These factors will influence the methods used by handlers in terms of both overall work organization and planning out specific handling jobs. Workers' organizational skills are another aspect neglected in current training programs. For example, in a survey of delivery people, respondents were asked what was the most important thing to know. All of them mentioned the knowledge related to work context: knowledge about customers, layouts, streets, and so on (Lortie, 1982). This lets them plan their work better and choose appropriate transport methods.

d. ***Provide conditions that promote learning:*** Without neglecting the cognitive component, handling is still a physical activity that requires certain motor skills. Because this is done through the body, the training must allow for periods of practice. Nor does a handler learn overnight how to make the right decisions and compromises according to the context. We must therefore acknowledge that learning motor skills takes time, which means that training programs must be organized in such a way that this time is made available. It's no longer enough to think only about training content; we must also consider the time needed for learning. Organizing the learning paths of new workers is a challenge not only for the trainer but also for the company, which must maintain productivity levels in order to stay competitive.

In summary, the table below compares the current training methods with the changes recommended.

Table 2-1 Current training versus our suggestions

CURRENT PRACTICE	*VS.*	*OUR PROPOSED APPROACH*
Teaching prescribed methods to be applied at all times		Development of competencies; the work situation is key
Emphasis on lifting		Consideration of all handling phases: lifting, transfer/carry, deposit
Focus on preventing lumbar overexertion		Consideration of all risks: overexertion, cumulative loading, fatigue, incidents
One-size-fits-all training that can be applied to all contexts		Context-based training, specific to the workplace
Emphasis on physical aspect and load-by-load handling		Consideration of the cognitive component, i.e., situation analysis and organizational skills
Short, theory-based training – classroom lectures		Longer training with emphasis on practice – training in action at the workstation
Prevention is based on training and worker responsibility		Prevention involves both training and taking action on other factors
“Expert” style training where the trainer is the source of knowledge		“Participatory” approach where handlers’ expertise is valued input

3. FRAME OF REFERENCE

3.1 The need for a theoretical position

The preceding chapters bring us to see the handler not as someone who must use the right work method, but rather as someone who makes decisions according to the context. This is the very foundation of the training that we want to promote and that is based on competency development. The concept of competency has taken on an important role in the workplace over the past several years and is present in several scientific fields such as ergonomics, managerial science, didactics and, more broadly, vocational training.

In spite of the widespread adoption of the concept of competency, there is still no consensus on a definition. The absence of conceptualization in the literature precludes the scientific use of the concept, and so it is understood in terms of general vocabulary, in which everyone has their own idea of its meaning. This section therefore aims to specify what we mean by “competency” and to present a model in order to have theoretical underpinnings for training development. The model has evolved over the course of this project, influenced both by data analysis and by the scientific literature, which we consult regularly.

In addition to a theoretical position—essential in this type of research—two other considerations guide this effort. Firstly, competency is often described in general terms—a kind of distancing that makes it difficult to put the concept into operation and identify the factors to be taken into account in competency development.[5] Efforts in this direction come mostly from academia—particularly universities—and are much less focused on workplace needs.[6] The transfer between these two worlds is no easy task, as is shown by some competency frameworks used by companies (LENTIC, 2005). As handling training mostly takes place in the workplace, some adjustments were necessary. The direct consequence is that we present a very specific view of competency for purposes of pragmatic and context-based implementation. We wanted to address the “how” in order to show the elements that are useful to handling operations. What aspects must we consider in describing these competencies and promoting their development? How are they put into practice, concretely? It is individual competency that is addressed here: the operator is, of course, part of one or more collectives, but we will focus on the individual in the explanation of the model.

It became obvious early in the project that competency is seen differently in each discipline, and despite many areas of overlap, some inputs—including ergonomics—were not always considered. We therefore wanted to articulate these different points of view in our model, by incorporating concepts from four different areas: activity-based ergonomics, vocational didactics, physical and sports education, and educational science. The model is built around the concepts of **competency** and **work activity**.

5. As stated by Fernagu Oudet (2006: p.52): “Most books and articles on competency seek more often to describe or define it than to understand how it is developed. And when they do, it is often at the expense of a prior clarification of what is or is not a competency.” (our translation)

6. The time span required to develop competencies is a notable example of the difference between the academic world and the workplace training community.

This entire report could have been devoted to the model, since the literature on this topic is so rich and extensive. However, to limit the length, we will keep to a summary description. This in no way diminishes its scope or the quality of its theoretical foundations. You will find in the bibliography a special section where all the literature used to develop this framework is listed (pp. 94 to 96). Note that the first section of the results, which deals with the contents of the proposed training program, reiterates each element of the model.

3.2 Activity and competency model

3.2.1 Action as a function of work situation characteristics

The *work situation* is the starting point of the proposed model (Figure 3-1: read from left to right). Every action is related to its context. The interpretation of the action is inseparable from the work situation, although this is not the only determining factor.

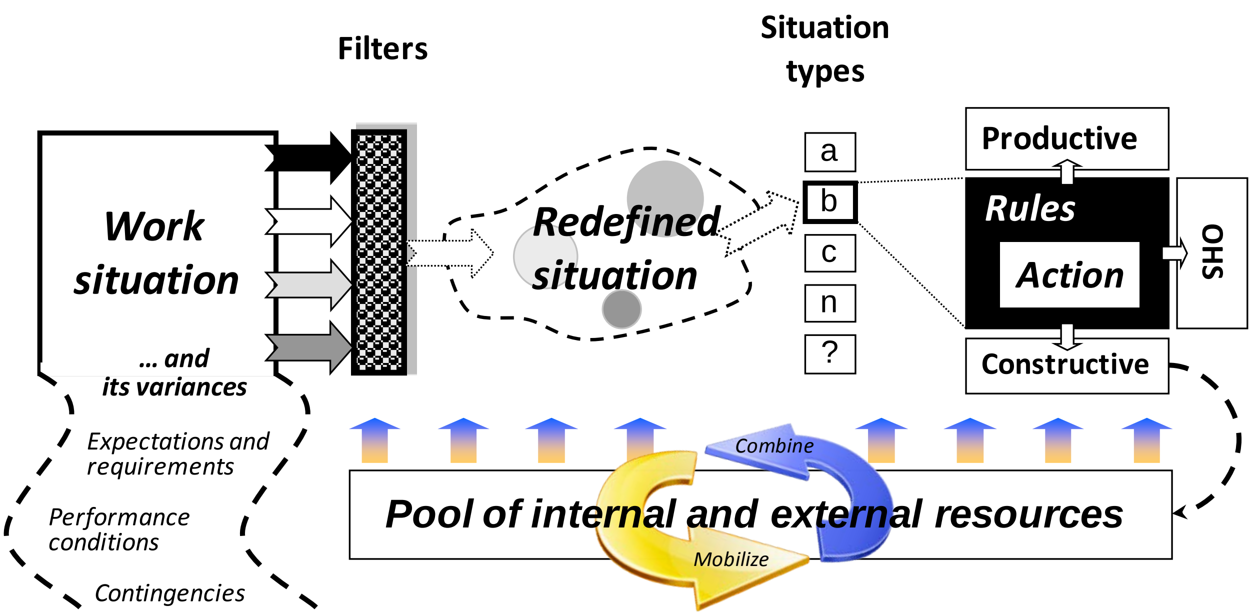


Figure 3-1 Activity and skill model

Any work situation has several components, most importantly the requirements and expectations placed on the workers—expressed in terms of desired quantity and quality—as well as the conditions and means offered by the company for reaching the stated goals. Although it is possible to look at a snapshot, the main characteristic of any situation is that it is not stable: it changes over time, to differing degrees. Part of this is predictable: a scheduled change in production, a peak period to respond to higher anticipated volumes, etc. In addition, a situation is subject to different types of contingencies and unforeseeable conditions that are also sources of variability and more difficult to anticipate: unpredictable operation of devices (e.g., changes in lighting, wear on equipment, constrained spaces), changes in work organization and production (e.g., last-minute requests, the absence of a co-worker, supply delays), and the varying characteristics of handled goods (e.g., shape, hand-load interface, fragility), etc.

Nor does the state of the operator—who is an integral part of this work situation—remain constant. The work requires physical, mental and emotional investments that vary with time. The worker can therefore experience varying degrees of fatigue, morale, joint pain, etc.

3.2.2 The work situation redefined: Personal and professional biases

The more variable and dynamic a work situation, with time constraints and incidents, the more it challenges the operator. He must decode the work situation in order to choose an appropriate action: this is the diagnostic phase that guides the ultimate action. To interpret a situation, the operator uses two types of filter. The first is greatly influenced by his value and belief system (personal filter: 3.2.2.1), while the second is more related to his experience and the knowledge he possesses (operational filter: 3.2.2.2).

3.2.2.1 Perceptive filter – Situation interpretation

The perception of a situation via our *perceptive filter* is not identical from one person to the next: it is possible to look at a situation in many different ways. The *redefined situation* therefore corresponds firstly to an individual's definition of the action needed: it is a form of appropriation in which a worker seeks to understand what must be done. The redefined situation is therefore the result of the worker's interpretations and is based on his perceptions, on the goals he has set, on his understanding of what is required and on what makes sense to him. This subjective and personal input is the first bias of the work situation, which we have represented by an irregular shape outlined by a dotted line, and which is different from the shape of the original situation.

3.2.2.2 Operational or functional filter – Towards action

The second form of redefinition is based on the goal of taking action. The idea is not to see all the elements in the situation, but to consider only a few elements, a few factors that are relevant to determining the action. The worker distinguishes what seems to be the most important information for action, by ignoring the small details. In scientific research, this filter has different names: operative image (Ochanine, 1978), functional representation (Leplat, 1985) and operative model (Pastré, 2006). The less important aspects constitute a background against which the more important factors appear and take shape, illustrated in Figure 3-1 by circles of different shades of grey. This reading of the situation, this identification of certain properties or relations as more important at the expense of others, can be guided by what vocational education calls organizational concepts (mainly pragmatic, but can also be scientific). These concepts allow the worker to read a situation by taking only the pertinent information, which is essential to making an appropriate decision. The analytical grid enables the worker to make sense of all the many signals generated by a work situation, and to concentrate his attention on the decisive factors.

3.2.2.3 Situation categorization

The recognition of certain factors and the dismissal of others allows an operator to identify the situation in order to guide his choice of action. He therefore places the work situation in a *situation type* or *class* with distinctive characteristics that must be taken into account in order to take appropriate action. This is a kind of categorization of situations: those belonging to the same type will be dealt with in a similar manner. Here, we insist on the use of the term "similar," which in no way means "identical." In fact, situation categorization guides the operator's choice of action, but in a general and broad way. He still has to identify the unique configuration that will lead to a specific action. Developing situation types is easier for situations that occur frequently (e.g., that are familiar) than for rare situations.

3.2.3 Handling rules: Guidelines for choosing an action

A logical next step would be specifying, for each situation type, what must be done: a standard procedure, a prescription or an operational range that can be applied. However, we have emphasized that work situations are extremely variable, subject to numerous contingencies: it is therefore unthinkable to establish procedures for each of them. Just as organizational concepts allow workers to guide their reading of a situation in order to classify it and recognize its configuration, similarly there is a set of *rules* that allows the worker to determine the action. These handling rules do not tell the operator what to do, as a standardized procedure would, but rather emphasize a goal, an objective that should be aimed for. We know that the best handlers do not all choose the same methods, but they all agree on the objectives (Authier and Lortie, 1993, 1997). The idea here is not to provide a formula to be applied to a given case, but rather to provide rules that workers can strive to follow. Such rules define "the conditions to meet and the factors to take into account so that the chosen action is effective" (Gréhaigne and Guillion, 1991) (our translation).

An example of a handling rule[7]

The "***body use***" rule states that it is possible to use your body to facilitate certain handling tasks. By leveraging your body mass through weight transfer, you can move loads more easily. Using your legs—the body's largest muscle masses—can be to your advantage. Some techniques you can use are bending the knees to work your leg muscles, or using one of your legs or your pelvis as a counterweight.

Depending on the type of situation, some rules might not apply, while others should be prioritized. They can even be contradictory in some circumstances. This requires the worker to judge how the rules should be interpreted within the context. The worker must experiment with them and, if necessary, break them or redefine them. For rare or uncommon situations, it is up to the worker to choose and shape the way in which the rules are applied. Conversely, other situations are so common that they lead the worker to develop routine methods. This allows for an automatic response to the most frequent situations, from which procedures or prescriptions—often called methods or techniques—can be easily established. Situation types and handling rules enable the worker to be more effective and efficient in identifying and responding to specific situations: they act as organizers of the activity.

7. Eight manual handling rules have been defined and are described in the recommendations section.

3.2.4 Aiming for compromise or balance

The action we have been referring to does not have goods and services production as its final aim. An operator's work is a compromise between *productive* (or functional) activity and *constructive* activity (Samurçay and Rabardel, 2004). Although productivity is the main goal, handlers are also trying, through their work, to develop skills, to be satisfied with and proud of themselves, to have a sense of self-worth, to have positive social relationships: in short, to "construct" themselves through their work. We emphasize learning associated with constructive action, learning that is done through responding to work situations. This is not the same as learning in an academic environment. On-the-job learning can be left to chance, or it can be optimized through organization. Under certain conditions, constructive action can lead to competency development (Fernagu Oudet, 2006). A higher level of competency is therefore possible for workers who can explain why they choose to deal with a situation in a certain way: this is metacognitive thinking and reflection put into practice (Schön, 1994).

To these two types of activities, productive and constructive, we add a third aspect that links them together: the *occupational health and safety* (OHS) of individuals. **The OHS aspect is here understood in the wider sense of the "human cost" (e.g., fatigue, emotional implications, fear of failure) of productive and constructive activities**. It refers to the concept of efficiency, meaning the achievement of a goal at the least cost or with optimal use of resources. These three concepts are inseparable when trying to understand the actions of a handler *in situ*. An action is never a strictly productive act, it is always a *compromise* between the productive and constructive, and must be carried out without endangering the operator's physical or psychological well-being. Of course, for a limited period of time, and to meet specific needs, the operator can prioritize productive action at the expense of the other two, but this cannot last for long without resulting in negative consequences for the operator. Given the risks associated with handling activities, this last remark is highly significant.

3.2.5 A competency-based approach distinguishing resources from their use

What does an operator use to diagnose and act on a work situation? His competencies.[8] A definition of competency that corresponds to our approach is that of Tardif (2006; p. 21): "A complex knowledge of how to act, based on the effective mobilization and combination of a variety of internal and external resources within a class of situations." (our translation) This is what we wanted to represent at the bottom of the model. The operator draws from his pool of resources those that are most pertinent to the situation. In order to do so, he must *mobilize* and *combine* resources: his own (i.e., *internal*: knowledge, know-how, tricks of the trade, skills, experience, social and emotional attitudes, etc.) and those from the environment (i.e., *external*: co-workers, documents, tools and equipment, procedures, etc.). This second resource category includes the more formal means that are offered by the company and that are useful in deploying competencies. According to Le Boterf, it is this combinatory approach that is the core of competency. Paradoxically, knowing how to combine (or knowing how to act, i.e., action management) is the "black box" of competency, in that it "is not visible and does not correspond

8. We speak of a person's *competence* to the extent that he has and uses several *competencies*. The development of competencies allows a person to become *competent* to various degrees.

to sequential programming". (our translation) There is no one right way to be competent in dealing with a situation; many different behaviours are possible.

Competency is useful in decoding a situation and identifying the significant elements, in classifying situations and finally in taking action using the appropriate rules, with the ultimate goal of reaching the best compromise. Le Boterf (2002) and Tardif (2006) make a distinction between the competency itself and the resources necessary to deploy it. Although having access to resources is a necessary condition to acting competently, it is not enough. Competency is expressed through the use of these resources, through their appropriate implementation (i.e., mobilization and combination) according to the context, in order to attain a goal that is an acceptable compromise between production, construction and preservation. Given that there is no single method that is optimal in all circumstances, knowing how to act competently requires a worker to take initiative and make decisions for action—often urgently —making choices that can involve risks, anticipating and reacting to unforeseen circumstances, etc.

3.2.6 A macroscopic look: The art of organization

Our model so far has allowed us to address different aspects related to handling individual loads, i.e., load-by-load lifting. However, the greater the load volume (tonnage), the more necessary work organization becomes. Aside from daily tonnage, the handler must also consider other factors: load characteristics, physical location, characteristics of co-workers and/or clients, his own condition (e.g., fatigue), etc. By evaluating the work to be performed and the conditions, he can come up with an initial plan for the work shift (Figure 3-2, right side). In doing so, he might ask himself questions such as: What should I start with? In what order should I proceed? When will I need help, and who can help me? Are there certain tasks that should be prioritized? And so on.

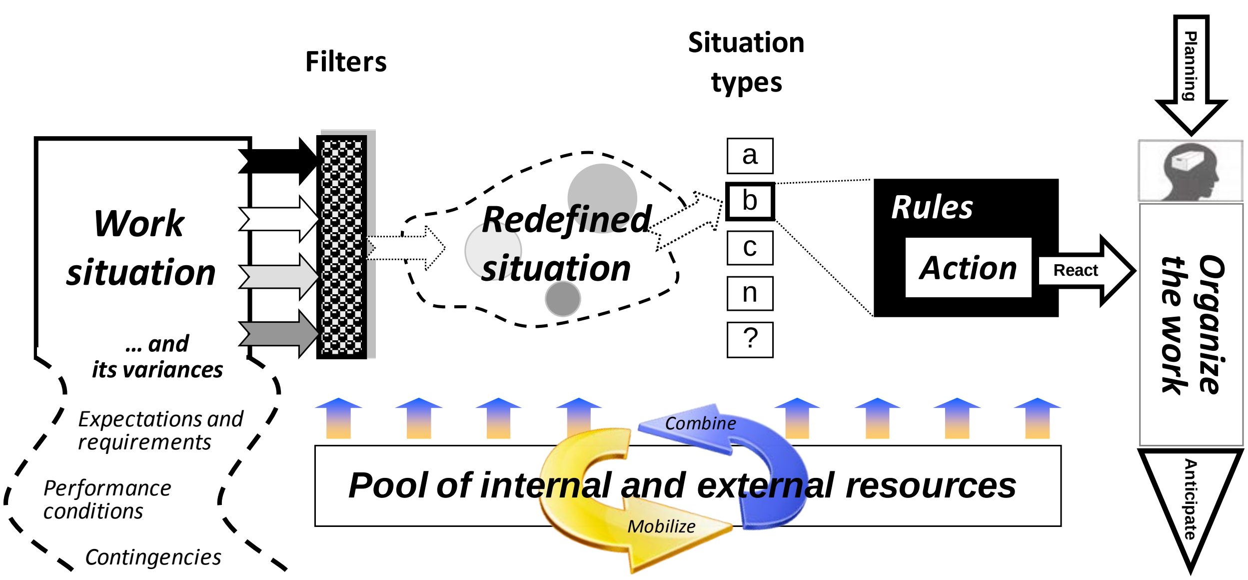


Figure 3-2 Work organization: Planning, anticipating and/or reacting

We have often repeated that work situations are not static: factors considered in planning at the start of the day can change or need to be adjusted to numerous variables. Two scenarios are then possible. The ideal is to be able to *anticipate* the changing situation, to revise the plan over the course of the shift and to adjust the action accordingly. Anticipation makes it possible to prepare in advance. Otherwise, the worker will have to *react* to changes. Although sometimes necessary, being in reactive mode requires on-the-fly adjustments for which the worker is not always ready. In addition, such changes are often made under time constraints and are thus more likely to cause an accident.

3.3 What can we learn from this model?

Briefly, here are a few conclusions to be retained from this model:

People are not competent "in general" but for a specific task: Competence is determined by the work situations already encountered. This is a reciprocal relationship. The more diversified and variable the situations encountered,[9] the more of a challenge they are, but also the more potential they have to develop the worker's competence (positive or constructive exposure: Zarifian, 2001). The more stable and common a situation, the more easily it can become a routine procedure with routine responses. It is clear that an experienced handler who has been exposed to many situations in his working life will have developed action strategies for a wide range of situations.

Competencies are partly subjective**:** Competencies are affected by the perceptions of the worker. There is always a personal, identity-based factor: the quality or beauty of the work, relationships with others, etc. As stated by Le Boterf, "the movement of a subject is not due to external stimuli, but rather to the meaning he gives them." (our translation) We therefore cannot ignore the influence of these perceptions and of this kind of appropriation, but neither can we limit our preventive efforts to this aspect, i.e., trying to change perceptions that are "erroneous" from a point of view external to the worker. Nonetheless, taking individual perceptions into account when several operators are training together is bound to be problematic.

Resources are not competence, but are ingredients of competence**:** To act competently, a worker must have a certain number of resources he can draw on according to the work situation. But competence means appropriate mobilization of these resources. Some of these resources belong to the operator (internal), while others are a function of his work environment (external) and are therefore controlled by the employer. Depending on who they **are** and what they **have**, two operators facing the same situation might not use the same resources. This fact has two implications. The first is that it is not enough to accumulate resources (a toolbox of skills); workers also need to know how to use them. Developing competence means putting an operator into a situation requiring action. The second implication is that competence is not strictly personal. If external resources are lacking or inadequate, the worker is missing essential ingredients. Developing competence also means providing adequate technical and organizational resources.

9. The words "complex," "critical" and "problematic" are frequently used to describe work situations. However, in our terminology we choose to emphasize their variable and unpredictable nature.

Competent action requires organization**:** Tools such as practice-based concepts, situation types and handling rules can structure the action and make for better handling of the situation. This is a major contribution of vocational didactics research. Studying these organizational tools increases our understanding of how an operator responds to a situation; it cracks open the black box of competence, revealing valuable information that can be used in training. In addition, a more comprehensive organization of handling activity is essential and often requires anticipating changes in the work situation, to avoid always having to react with urgency and lack of preparation.

Competence is not judged solely by an effective or appropriate response to a situation**:** An operator's choice of action is not solely based on the productive act, any more than on personal development or OHS issues. Very often, the action is based on a combination of these three factors, an acceptable compromise. Trying to act on one of these factors without considering the impact it will have on the other two may explain, at least in part, the oft-cited resistance to change. Most OHS training is focused strictly on accident prevention and has lost sight of the fact that working safely is not the only factor involved in doing a job well, but is just one of the concerns that guide a worker's choices. In this regard, the idea of efficiency certainly deserves more consideration, in terms of optimizing resource use to meet organizational and personal goals.

4. DEVELOPMENT PROCESS

4.1 Methodological approach

This project was developed using the **developmental research** approach found in the field of education.[10] While the methods for conducting developmental research are varied, for this study we adopted the one used by Loiselle and Harvey (2007). It is mainly an interpretive, qualitative and inductive approach, using existing scientific knowledge—often empirical data arising from the experience of the researchers involved—in order to generate an original, innovative new system. It is not simply applying or contextualizing established theories, but rather cross-tabulating and analyzing existing data which, seen from a new angle, often leads to new perspectives. In this method, the development and validation stages overlap, and successive versions of the system are created that take into account the reflections, observations and data gathered from the previous version (Figure 4-1). The developmental researcher must interact with other people—designers and end users—who provide input on the decisions to be made. This particular type of research is useful in developing new pedagogical/didactic materials (training content in the form of programs, manuals, literature, videos, etc.), as well as the specifications that guide their use (processes, strategies, methods, models, etc.). Most often, evaluations and trials are conducted while the system is being designed and developed, to verify its effectiveness in attaining the desired goals.

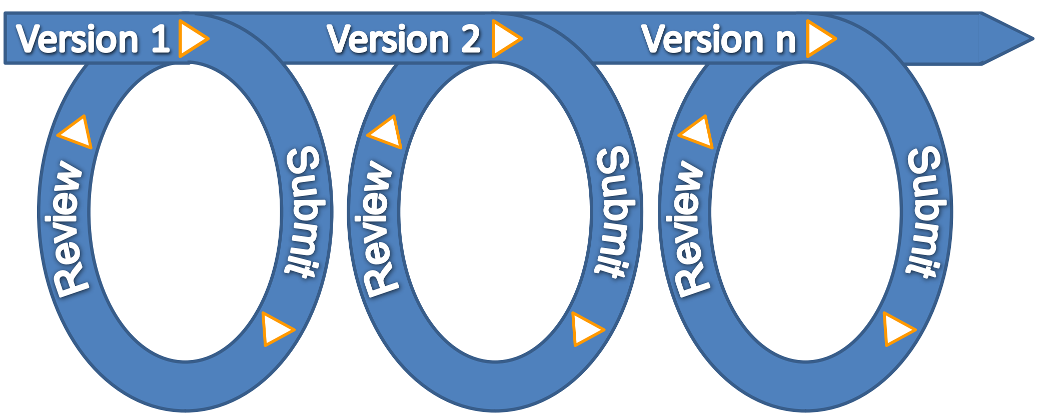


Figure 4-1 Feedback loop used in developing successive versions of the training program

In practice and often concurrently, literature reviews, debates about the theoretical framework described in the preceding chapter, and formal and informal exchanges with researchers and professionals involved in the study made up the majority of the source material used to develop the different versions of the training program.

10. See Loiselle and Harvey (2007) and Harvey and Loiselle (2009) for a more detailed description of this research trend, as it is not well documented in methodological works.

4.2 Material and resources used

4.2.1 Bibliographical references

The researchers pooled all the references from their respective databases, both scientific documents and grey literature,[11] that involved handling or that seemed pertinent to the project (n=452, Table 4-1). In addition to papers dealing with identifying and/or analyzing the know-how of various handler populations in various contexts (mostly applied research), there were experimental studies (occupational biomechanics, physiology, psychophysics, etc.) from various perspectives (e.g., study of the impact of certain methods on lumbar structures, motor learning). Some of these references (n=105) were more specifically used to identify and validate the handling rules (see Section 4.3.1).

Table 4-1 Bibliographical references consulted

Type of document	**Documents consulted** (n=452)	**Documents specific to handling rules** (n=105)
Articles	273	91
Peer reviewed	252	90
Not peer reviewed	21	1
Reports	72	3
HSE	13	-
INRS	10	-
IRSST	4	2
NIOSH	11	-
Other[a]	34	1
Internet files	44	-
Conferences	23	4
Books, chapters	21	6
Theses, dissertations	5	1
Other[b]	14	-

[a] Institutes in Oceania and Europe, Québec health network, etc.
[b] Video material, standards, etc.

11. The so-called “Luxembourg definition,” discussed and approved during the Third International Conference on Grey Literature in 1997 (cited on Wikipedia): “[Grey literature is] that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers.”

4.2.2 Researchers and professionals – Future users

A wide variety of professionals contributed to this multidisciplinary project, including ergonomists (n=4), biomechanists (n=2), a motor learning specialist and a specialist in competency-based approach. Most of these people—all of whom co-authored this report—are internationally recognized experts on manual handling and have been conducting research in the field for many years; their expertise was an essential contribution to this project. Ten formal meetings were held, each on one or more specific themes (see Section 4.3). Between the meetings, group members had to do "homework" according to their field of expertise. The members also formed sub-groups that met to work on specific deliverables such as the context analysis grid. In parallel with this formal, structured process, many informal discussions took place over the course of the project. These exchanges were facilitated by the fact that several contributors work at the same location and/or are involved in other research projects on handling.

When a version of the program was sufficiently advanced in terms of both content and structure, we submitted it to potential users. Six one-day training sessions, organized in collaboration with the Québec chapter of the Association of Canadian Ergonomists (ACE–Quebec), brought together more than 120 participants, mostly ergonomists, from all over the province. The comments and feedback were compiled and considered in each of the subsequent versions of the program. In addition, groups of future users (students, new and experienced practitioners) were used for more specific validation of the tools developed for the program.

4.2.3 Theoretical framework

This research was based on an inductive approach. Although developing a theoretical framework is essential in this type of research, referencing this framework was not the main or predominant element in our data analysis and decision-making process during program development. In this regard, as we have just explained, the ideas of the developmental researchers, the input of collaborators and users, and elements drawn from the literature review all contributed to the decision-making process that helped develop and refine the system. Nonnon (2002) noted that overly strict adherence to a theoretical framework limits the creativity of researchers, resulting in fewer new ideas. As stated by Loiselle and Harvey (2007), referring to the work of Savoie-Zacj (2000):

> "*Although this theoretical framework can be useful to a researcher in analyzing the qualitative data gathered and in making decisions to guide development, it should in no way be restrictive. The existing theoretical corpus will reinforce or put into perspective the data collected from the experiment, and will be taken into account in determining the project's future evolution.*" (our translation)

Our theoretical framework was not fixed at the outset and therefore evolved along with the project, remaining attuned to the orientations and decisions adopted throughout the process.

4.3 Themes developed

In keeping with the approach and the information sources described, we addressed different themes that allowed us to define training content and realistic terms of implementation in the workplace. The themes addressed are as follows:

Training **content**:

- Identification of handling ***competencies***
- Identification of ***indices*** to guide the gathering of ***information*** about the work situation
- Identification and validation of ***manual handling rules***
- Identification of ***situation types***
- Identification of ***work organization rules***

Training **implementation** in the workplace:

- Development of an ***implementation process*** for workplaces
- Proposal of ***concrete tools*** for the trainer

4.3.1 Manual handling rules: A special case

The identification and validation of handling rules was a central focus of the project, and one on which the team spent a considerable amount of time. We consider them to be a major and original contribution, and this is why we are including more specific methodological details for them.

4.3.1.1 Identification of rules

A metasynthesis (Beaucher and Jutras, 2007) was conducted on studies specifically focused on analyzing the know-how of different handler populations in various contexts (e.g., delivery people, order-pickers, garbage collectors). These studies had no common thread except that they all attempted to document and understand the activities of handlers, and, most often, to evaluate the impact of their actions on their musculoskeletal health. The goal was to see whether, despite the apparent diversity of know-hows identified by the researchers, it was possible to group them into categories with similar purposes. The categories—in keeping with our theoretical framework—were named handling rules or “rules of action” (Grehaigne, 1996). Eight such rules of action, or manual handling rules, were defined, based on the analysis of studies on various handler populations in real work situations.

4.3.1.2 Validation of rules

Following the identification of these eight rules, an additional validation process was used to put our different sources of data into perspective. As stated by Poupart et al. (1997, p. 261):

> “*[…] it’s the quality of the information, the diversity of the sources, the corroborations and the cross-referencing that give an analysis richness and depth. […] A credible analysis tries to cover all the bases by using information that represents as many different interests as possible, so as to obtain as comprehensive and diversified a point of view as possible*.” (our translation)

Along with the field studies mentioned above, we also used experimental studies, supplemented by the knowledge of the researchers and professionals in the group. For the literature review, a research professional read all the identified references in order to extract results that might confirm or invalidate the selected handling rules. The aim was to find a theoretical justification to support the addition of each rule to the training program, to find the advantages and the limitations of each one, or even simply to confirm the absence of studies on the subject. This information was synthesized into datasheets—one per handling rule. It should be noted that the rules were not validated by laboratory experiment to observe their effects on the body.

For each rule, therefore, we present a “validation” datasheet composed of four sections. The first section, which summarizes the results of the studies consulted for the rule in question, contains four types of information: 1) What are the guidelines recommended in the training programs; 2) The documented effects or impacts of these guidelines; 3) Elements observed or reported, mainly during field studies; 4) The effects or impacts of these observations. The information is given in point form in a four-part table, and we tried to stay as close as possible to the actual wording used in the studies. The symbol [E/N] indicates whether the study was conducted on expert/experienced handlers or on novices. The second section takes one of two forms, depending on the information collected about the rule: 1) Differences between expert/experienced handlers and novices, including data that could not be classified in the four preceding categories but that may be important to validate the rule; 2) Other pertinent information that does not fit in the table but offers an interesting perspective on the rule. The third section takes stock of the preceding information: What conclusions can we draw? Are there contradictions between the studies? Are there information gaps in the studies, elements that were not considered? We also sometimes formulate hypotheses and questions about the data collected. Finally, in the last section, we give details about the literature from which our information was taken. In addition to a table listing the documents consulted, we also show the number of studies that involved one or more authors of this report. The references are grouped according to the four parts in the first section.

RECOMMENDATIONS (CHAPTERS 5 AND 6)

Our recommendations are presented in two chapters. The first concerns the training program content and is structured around two competencies whose development, we feel, should be the top priority in handling. The other chapter discusses aspects linked to program implementation in the workplace. We propose a three-phase implementation process in line with a social constructivist philosophy, along with two tools: a grid for analyzing handling contexts and an observation grid for evaluating the handling techniques in use. The reader should not be surprised if we discuss certain topics as they arise, as opposed to a traditional presentation void of commentary. Given the nature of the subject, this type of presentation seems to us more appropriate and gives us a chance to offer details useful for gaining a better understanding of the topics.

5. CHAPTER 5: RECOMMENDATIONS ON TRAINING CONTENT

Competencies to be developed in handling

The training program is based on the idea that the handler must possess certain competencies in order to do the job. We have identified two that we consider essential:

a. The ability to gather the relevant information about a work situation and adapt his actions accordingly (applies to load-by-load handling)

b. The ability to organize his work so as to plan how the various tasks must be coordinated and anticipate any adjustments to the initial plan

Though there are only two competencies, they are inclusive and can be generalized to all handling activities; they can be described as “critical.” It is up to the trainer to decide whether other competencies are needed in a specific context. For instance, although no human relations skills were considered, such skills are obviously an asset for handlers who have to interact with customers—beverage delivery drivers and baggage porters, to name just two examples. With a few exceptions, handling jobs do not require technical know-how,[12] as is the case for plumbers, electricians, welders and so on. However, particular competencies linked to such know-how may be important in the context, and thus require inclusion.

Let us emphasize one thing: just because only two competencies have been retained for the training program, that does not mean handling work is simple. Anyone can work as a handler with no training, but only a few will be able to perform well—i.e., meet the production criteria—without hurting themselves. The first competency has been dealt with extensively, which explains why there is a relative abundance of literature on how to handle loads, compared with studies on how to organize the work on a daily basis.

12. Technical know-how means, for example, knowing how to use a software program or read an assembly drawing. Such know-how is often acquired in school and is mandatory for admission into the trade.

5.1 Competency # 1: Gather the relevant information and adapt action accordingly

This first competency concerns the handling of individual loads. It goes beyond the idea that in order to protect oneself from injury, all that is needed is to adopt the prescribed techniques and apply them at all times. Here the handler evolves from an executor to a decision-maker. This competency has two complementary components: the first consists in reading or decoding the work situation. The handler must know how to gather the relevant information in a situation and give it meaning, that is, interpret it. The second component concerns the operational or executive aspect: based on the information gathered, an action will ensue that must be coherent. We therefore propose rules that go beyond the traditional postural rules and will enable the trainer to interpret the handlers' working methods.

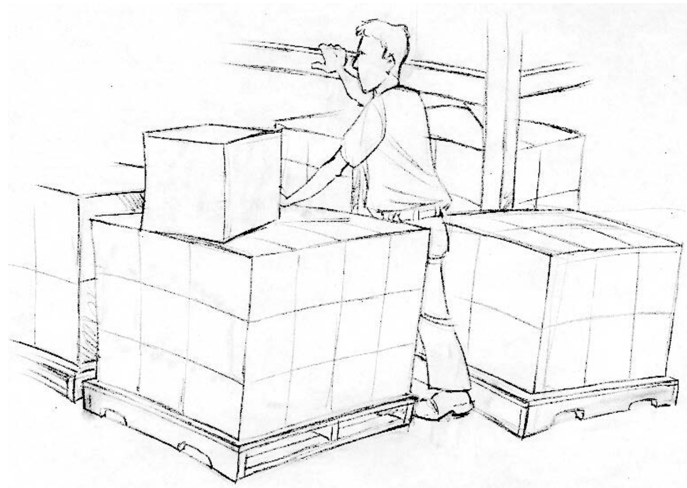
5.1.1 Indices for guiding information-gathering and orienting action

Table 5-1 proposes a list of aspects or indices about which the handler could gather information in a work situation. While we think these indices are important, we do not claim to have listed all the possible ones here. Each context can present its own indices that involve specific issues. In this sense, the trainer should identify them, ideally in collaboration with experienced handlers, so as to be able to present them during the training. Moreover, the stronger the connection between the indices and the trainee's specific work context, the more useful they will be. For example, handlers do not talk about "heavy loads" but about "sandbags" or "45-litre paint cans." When gathering information, we recommend distinguishing the indices inherent in the loads from those inherent in the work environment and in their relation to each other, i.e., their spatial layout. A first category of indices consists of characteristics of the load or of the environment that could present a challenge. Five load characteristics have been retained and are conventionally recognized as problematic; of these, the position of the centre of gravity (C.G.) is the least often cited. They are mainly related to the possibility of getting a good grip on the load (hand/load interface). As for the environment, the four indices are related to the possibility of positioning and moving the feet, failing which balance may be threatened. As for spatial layout, this is a matter of situating the load within its environment. The load position at lift, space restrictions at delivery, and the location of the pickup location in relation to the delivery location, as well as the presence of obstacles in between, are the indices retained.

Table 5-1 Indices for orienting action

Information about…	*Why pay attention to it?*
The load	
Weight	The factor most linked to lower back pain in handling. Large influence on mechanical stress and thus on the effort to deploy.
Volume and shape	Influences the quality of the grip and thus the degree of control, lever arm (i.e., distance from body) and one's ability to see while carrying. Can make it harder to make the load work in one's favour.
Fragility – Instability	Influences the quality of the grip. Often means having to support the load more, in order to compensate for its deformation. Can mean having to take precautions during deposit.
Gripping possibilities	Influences the quality of the grip (interface) and the possibility of bringing the load closer.
Position of C.G.	By knowing the position of the C.G., one can avoid surprises and use the C.G. to one's advantage.
Spatial environment	
Limited space for feet	Limits the possibility of transferring weight and recovering from loss of balance. Can lead to undesirable foot positioning (asymmetry).
Uneven floor	Influences balance and the ability to react to an unforeseen event. Makes weight transfer more difficult.
Slippery floor	Makes balance more difficult due to lack of friction between feet and floor.
Obstacles	Increases the risk of tripping and falling.
Spatial layout	
Object position at lift	Determines handler's position for load lift.
Height	A higher-lying load contains greater energy potential, which can be put to use, but the load can be more difficult to grasp.
Load/body distance	Influences lever arm and thus the effort needed for lift.
Possibility of bringing load closer	Influenced by a rough or sticky floor (friction), obstacles, containers that do not slide easily over each other, etc.
Accessibility / restrictions	Influences the handler's ability to get closer to the load.
Space restrictions at deposit	Implies a certain amount of precision when depositing the load, which increases effort. Requires the load to be set down completely, which is the most demanding.
Pickup location in relation to delivery location	Indicates optimum foot position to facilitate load transfer.
Carry distance	The greater the carry distance, the more the load must be fully supported by the hands, thus increasing effort.
Lift distance	It is better to work from higher (pickup location) to lower (delivery location), or at approximately the same heights. A low pickup and high delivery location requires more effort, since the handler is working against gravity.
Obstacles	Must be bypassed, which can make the carry route longer.

Unstable packaging makes gripping the load difficult; it can result in less control and require the load to be supported for a longer period



Space constraints lead to foot positioning that can impede balance and reduce the ability to recover from loss of balance; they can also lead to asymmetrical work

Figure 5-1 Examples of indices and their importance

These indices are used to assess not only the possibilities of action in a situation, but also the level of risk. In this sense, the more indices that are present in a given situation, the more likely it is that the situation is risky and caution is needed. It's one thing to identify the indices; interpreting them to give them meaning is another matter, and much more complex. This is a distinctive skill possessed by experienced handlers, who are able to assimilate more information—or the most relevant information—to guide their decision-making (Lortie, 2002). In any case, when a handler is faced with a situation he has seldom or never encountered, he must exercise caution. The handler must be alert to rare and unfamiliar situations; however, he must also learn to be wary of a situation that at first seems familiar but in which there are indices that could be missed in an overly rapid or superficial assessment.

5.1.2 How to gather information

In fact, knowing what to pay attention to is not enough; the handler must also know how to gather the necessary information. Two types of information-gathering are most used by handlers. The first is visual and the second is proprioceptive, i.e., mediated by contact with the object, the surface, etc. Other ways of gathering information are of course used by certain groups of handlers: for instance, garbage collectors often rely on noises or odours. Visual information-gathering can involve not only perceiving the size and shape of the object but also on more sophisticated methods such as reading a label on a box to find out its contents. Other visual indices are more subtle: a bag with a wide bottom may indicate that it contains dirt, sand or liquid, thus providing a clue as to its weight. A wet cardboard box or a bag that looks fragile (e.g., stretched or washed-out) will not have the same rigidity and may tear when handled; control problems must then be anticipated.

Although visual assessment is the most widely used, we must not neglect the importance of information-gathering through the handler's body. The load remains a major factor in handling. To decode characteristics that are sometimes difficult to detect visually, such as an off-kilter centre of gravity, the operator should gather information about the load before lifting, by doing pre-lifting manoeuvres. By making contact with the load—sliding it, tilting it—the handler gathers proprioceptive (or tactile) information that will help him assess the load characteristics and prepare for the handling operation. Pre-lifting manoeuvres enable the handler to anticipate and adjust the effort needed for pickup. This becomes less necessary when the loads are known. During the carry, proprioceptive information is critical for controlling the load, as vision is useful only for seeing where the handler is going at this stage.

We do not mean to imply that the information-gathering stage should require the handler to stop every time to examine conditions in detail before lifting a load. When we observe experienced handlers, information-gathering is not often detected as it is so tightly woven into their work methods. It is usually done on the fly and is not intuitive, that is, it must be learned (Nastasia, 2003). And yet it is essential. An experienced operator knows where to get the information, ignoring other extraneous factors that generate "noise" (Vion, 1993). Information-gathering is often implicit and therefore difficult for an outside observer to identify. In variable and changing environments, it can become quite complex; this is where it is critical to invest time in training. Novice handlers must be told what aspects to pay special attention to. These aspects can be easy to identify. In more complex environments, with greater variability, it can be more difficult: in such cases, priorities may have to be established, which handlers learn to do with time and experience. We cannot overemphasize the importance of this information-gathering stage, which enables the handler to anticipate and prepare rather than always being in reactive mode. Although handling does not demand complex information-gathering or elaborate reasoning, it does require vigilance and an ability to process information rapidly. Decisions must be sure and based on a thorough analysis of the situation parameters: without being complex,[13] problem-solving and decision-making are important components of handling.

13. The term "difficult" seems more accurate, since information-gathering does not involve a great level of abstraction. The difficulty resides in the quantity of information and the speed with which it must be processed.

5.1.3 Rules to guide actions

Based on the information gathered, the handler will take action, which will be expressed in the form of know-how. Although handling know-how is extensive and diversified, it can be grouped into several predominant rules. We have identified eight such rules, described in Table 5-2 in random order. They will be detailed later on in individual datasheets.

Table 5-2 Eight rules of manual handling

	Rule	Note	Description
1	**Postural alignment**	The human spine is designed and adapted for working in alignment.	Refers to the best spinal postures to adopt during effort. It is important to respect the natural curvature of the spine, without excessive forward bending, and to work symmetrically.
2	**Load/body distance**	Greater distance from the load means greater effort.	The lower back is already subjected to considerable effort to support the upper body; now a load is added, and the farther it is from the person holding it, the greater its weight. The load should therefore be held as close to the body as possible.
3	**Weight bearing**	The less time is spent holding the load, the less the effort.	The phase in which the load is entirely supported is the most demanding: this should be reduced to a minimum.
4	**Load use**	The load can be used to work in one's favour.	It is preferable to work WITH the load rather than against it, using its position in space or its inherent properties.
5	**Body balance**	Being in balance and ready to react to avoid unpleasant surprises.	The addition of an external load influences balance, as does the floor surface. Having to recover from loss of balance or from an unforeseen event requires sudden and brusque movements, which are unnecessary and harmful and should be avoided.
6	**Body use**	The body can be used to reduce effort.	The body can be used in handling activities. Body use consists first and foremost in the use of the lower limbs, which do most of the work.
7	**Transfer from pickup to delivery**	The handler must choose how to cover the space between pickup and delivery.	The route selected for going from pickup to delivery has a major influence on how long the load has to be supported. The most appropriate form of transfer must be selected.
8	**Rhythm of movement**	Pattern and quality of movement.	Speed and fluidity have an impact on back stress and on how long the load must be supported. The handler must know how to choose the appropriate rhythm and avoid jerky movements.

We would like to offer a few comments for better understanding before we present the rules in detail.

5.1.3.1 One rule, several know-hows

The rules are goals for the handler. Depending on the context and the possibilities open to him, he must decide on the best way to apply them. It is this openness to adaptation to the context, or this flexibility, that makes the handling rules interesting. Following are some examples of know-how (n=4) typically associated with the “weight bearing” rule (Table 5-3). This rule says that the handler should try to hold the load in his hands as little as possible. In handling, the greatest effort occurs when the load is entirely supported. In addition to increasing the effort needed for each load, the cumulative effect of many handling operations can lead to fatigue, which should be avoided. The less time the handler spends with the load in his hands, the less effort is expended.

Table 5-3 Examples of know-how for minimizing load-holding time

Know-how	Description
Wait until the last minute before pickup, and/or deposit as soon as possible	For example, during pickup, the handler will slide the load until it loses contact with the surface. Upon delivery, he will set it down as quickly as possible and then reposition it as needed. In this way, he reduces the time during which he has the load fully supported in his hands. The gains may seem minimal for one load but can be appreciable over the course of a day or a week, after thousands of handling operations.
Keep the load in contact with the surface floor during transfer	For some loads, it is possible to avoid lifting by sliding or rolling; for example, tires, beer kegs, barrels, etc. Large objects that are difficult to pick up can also be handled in this way.
Choose the most appropriate deposit method	The way of depositing the load can have a significant impact on the duration of load-holding. The idea is to avoid holding the load until the end wherever possible, for example, by dropping or throwing it. Depending on the handler’s skill and/or the context, it may have to be repositioned after it is thrown or dropped.
Have pickup and delivery locations closer together	Minimizing distances to reduce carry time wherever possible.

No doubt there are other techniques used by handlers in specific contexts to reduce load-holding time. This list is not exhaustive and could be added to. Our goal is not to provide a complete list but to point out the intention underlying this rule, which makes it possible to interpret new techniques that have never been inventoried. This is why we emphasize rules rather than know-how.

5.1.3.2 One know-how, several rules

When the load is on the ground, gripping it can be more difficult. To get a good grip, the handler must sometimes bend down. To avoid pronounced bending, handlers will tilt the load on one corner or edge to lift it (Figure 5-2). Gripping without too much bending is then easier. But this technique—tilting the load—can be associated with other rules such as balance or body/load distance. It has a positive effect on balance since the handler's upper body is less inclined, and also on load/body distance since the load is closer to his body. The observed technique can therefore be interpreted according to various viewpoints, which the trainer should understand before passing judgment on whether or not it is appropriate for the situation.

Figure 5-2 Load-tilting can be seen as application of more than one handling rule: postural alignment, load/body distance and balance

This shows that the handling rules are all interrelated. A handler's work cannot be divided into little compartments called balance, leverage and rhythm. **All handling movements involve most of these rules to varying degrees.** In this document we have made the choice to take a distance from concrete reality in order to facilitate understanding: this is why the rules exist. As trainers provide more training sessions, they will naturally combine these notions with experience and field situations, to eventually yield a coherent whole in the analysis of handling methods.

5.1.3.3 Contradictory rules: A matter of compromise

This training approach gives precedence to rules over know-hows to the extent that the latter, to be interpreted, must be reduced to one or more rules which they aim to achieve. This analysis must be conducted with a broad perspective that takes into account the fact that the handler wishes either to maintain his balance, use his body weight to reduce effort, or get as close as possible to the load, depending on the situation. All of the rules must be considered. But often the handler is confronted with a choice, and compromises must be made; this is where the notion of competence takes on its meaning.

Imagine a case where, in order to get closer to the load, the handler must place one foot on a wooden pallet (Figure 5-3**A**). It is entirely possible that the pallet, depending on its condition, might give under the handler's weight and he could be injured (sprained ankle, scratches, etc.). This is the compromise the handler is faced with: should he stay farther from the load and take the stress on his back—thus contravening the load/body distance rule—or take the risk and put his foot on the pallet, knowing that the probability that it will give way is very low since he looked at it beforehand?

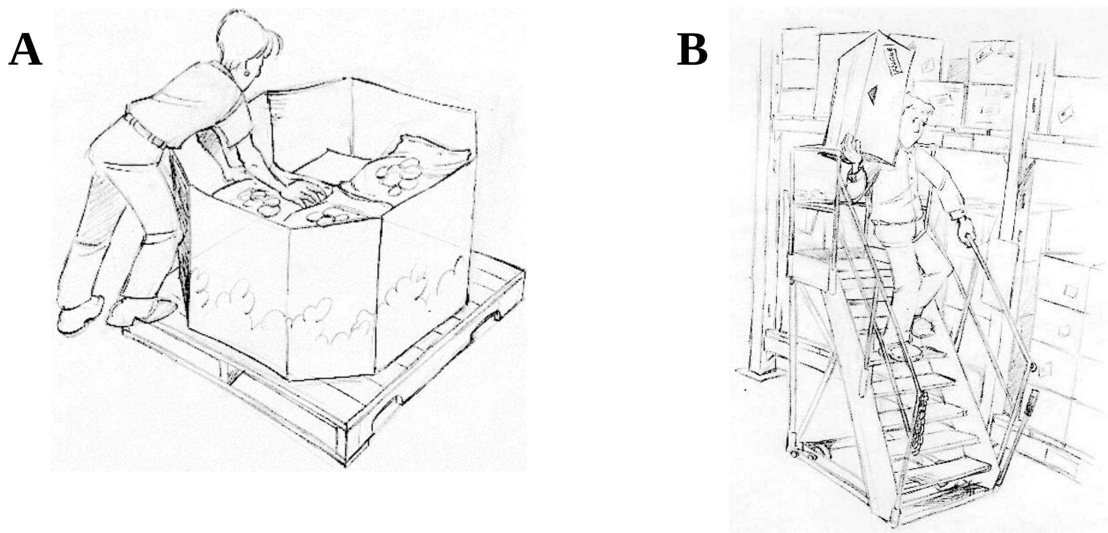


Figure 5-3 Know-how is often a result of compromise that can be analyzed using the rules

In using a ladder, the handler has emphasized balance by using the three-point support technique (Figure 5-3**B**). Moreover, this seems to reduce load/body distance since the load is almost all superimposed on the body. But because he has to use one hand to hold the handrail, compromises are necessary: the grip on the load is more precarious and the effort is asymmetric (i.e., concentrated on one side of the body). In this case, the rules are in contradiction: balance and load/body distance interfere with postural alignment and symmetry of effort.

How can one be chosen over the other? Prohibit all handlers from climbing onto pallets, force them to hold the handrail when using stairs… are these acceptable solutions? Probably not, since the idea is to evaluate the choices available and make the best decision in the context. The current state of research does not enable us to establish priorities in the application of rules: is it more important to have good back alignment or to have good balance? In fact, is it even possible to decide such things? **Our perspective is that it is the situation that determines the priorities, and each situation must be analyzed in order to determine what rules should be prioritized**. This may be an opportunity for interesting exchanges with handlers in order to bring home the idea of compromise and discuss the potential consequences.

To summarize this section on manual handling rules, here is a table that will help distinguish between the rules and know-hows.

Table 5-4 Correspondence between rules and know-hows

Principles…	Know-hows…
Are not prescriptions, but objectives to attain.	Can be specified in the form of procedures for simple handling tasks with little variability.
Are eight in number and non-contextual. They can be generalized and used in a variety of contexts.	Number in the dozens and are very diversified, but those with similarities can be grouped into rules. They can be associated with a context.
Provide guidance for action.	Are interpreted through the rules.
Can be contradictory in a given situation and therefore require compromise and decision-making by the handler.	Often present both advantages and disadvantages. There is no “best” know-how, but know-hows adapted to each situation.
Allow operators some leeway as to the best way of achieving them; freedom of choice.	Enable the handler to apply several rules at once.

5.1.3.4 The eight rules of manual handling

Here we present a detailed description of each handling principle, in the same order as in Table 5-3, where they were outlined. Each section contains the following four headings:

- **What does this rule mean?** Here we give a brief definition.
- **Why is this rule important?** Here we explain the importance of considering this rule, often describing the impacts it can have in terms of stresses or difficulties.
- **How to observe this rule?** A non-exhaustive list of know-hows is presented that led to identification of this rule. The know-hows are listed along with advantages, disadvantages and limitations.
- **What do the studies say about this rule?** Here we present the results of the validation study from the literature. The reader is referred to the appendix and to the pages where the complete results of this validation study are presented.

Each datasheet is meant to be self-sufficient; however, as mentioned earlier, the rules are interrelated. It can therefore happen that we refer to other related rules. In addition, the level of language may be different from the rest of the report, as we have made an effort to simplify in order to facilitate comprehension. We are aware that the addition of pictures and videos at the appropriate places—especially in the section on know-hows (How to observe this rule?)—would have been very useful in facilitating understanding. We plan to make such additions in a later stage, when pedagogical material will be developed for this purpose. The priority, in this report, was on stating the theoretical foundations of our proposals.

Postural alignment

What does this rule mean?

It means maintaining the best postures for the back—especially the lower back—at the time of maximum effort. This rule states that an aligned spine is less exposed to stress. Timing between posture and effort is key.

Why is this rule important?

This rule, one of the best-known in handling, contains three concepts. The first involves ***natural curvatures***. The spine has three curvatures, the lordosis being the most critical in handling. The back's natural position is best for supporting loads; one should attempt to preserve this position during handling, that is, maintain the natural curvatures of the spine. The second concept is ***trunk bending***. During the lift, one must avoid bending over too far, since it is at this critical point that the stresses on the back are at their maximum. Keeping the back straight will ensure uniform distribution of forces on the back and will favour compression force, the force for which the back is best adapted. The trunk itself is a large mass that has to be held up. Inclining it means greater effort is required just to support it. The other advantage of a straight back is that it limits the shear force and, in the case of pronounced bending (> 45°), transfers the stress to passive structures such as ligaments. In fact, laboratory studies have recently shown that experienced handlers do less lumbar bending than novices. Lastly, when one turns to the side but the feet do not follow, the spine is twisted. The feet anchor the pelvis, which is then not in the same axis as the shoulders; the result is ***asymmetry***. This posture, combined with forward bending, is a major risk factor for back injury. The stresses are concentrated on a smaller portion of the structures, in particular the ligaments and intervertebral discs, which can lead to damage and wear. When the additional stress of the load is added to this posture, the demands on the back become quite significant. The spinal column can be compared to a shoe sole that wears down more on one side than the other, because you are bearing more weight on that side. Hence the importance of applying force as uniformly and symmetrically as possible.

How to observe this rule?

Control pelvis angle: The pelvis must be positioned so as to allow the spine to maintain its natural curvatures. Avoid stooping, i.e., rounded lower back and/or shoulders curved forward (cat position). By experimenting with the pelvis—tilting it backward and forward—one can align the spine to work better. However, maintaining the spine's curvatures (or having a straight back) does not mean that the back must remain vertical: one can maintain the curvatures even when bending forward by positioning the pelvis, for example, when reaching for a load and bringing it closer.

Tilt the load: One effective way to reduce bending, especially in the case of a low-lying load, is to tilt the load on one of its edges or corners to allow for a higher grip. The back then remains more or less vertical and in natural position. If the load is not a box, the idea is to leave part of it in contact with the ground while tilting another part up in order to grasp it. Then the handler does not have the entire load in his hands, which facilitates the operation. This can also be applied when depositing the load; do not set it down flat, so as to avoid too much bending.

Align body and load: Before lifting, make sure the load is not overly off-centre with respect to the body. At the start of the lift, the effort must follow the axis of the feet, i.e., the feet must point in the same direction as the effort.

Face the load: The feet must be pointed toward the load. The load is centred in relation to the two supports and should ideally be within the base of support. The handler adjusts his position in relation to the load and his initial position: everything is thought out as a function of the pickup location.

Orient the load in relation to the base of support: The initial foot position can sometimes be open toward the delivery location to ensure a more direct transfer. The load is oriented toward the delivery location to be placed along the same axis as the feet. The load is often a little off-centre in relation to the stance, but not much. This slight off-centredness is desirable for giving acceleration to the load.

Turn the feet toward the delivery location: After lifting the load with the feet pointing toward the pickup location, turn the feet toward the delivery location. The feet must do the work in order to avoid twisting the back.

Position the base of support in the direction of the effort, i.e., the direction in which the load will be moved: Continue the movement in the same position as that adopted initially: feet open toward the delivery location, load pointed in the same direction. The idea is to have the effort following the same axis as the feet, to avoid turning the back. Small adjustments to the base of support are possible to adjust to movement of the load (pivoting, shuffling).

Tilt the load: Especially during carry, playing with the load by tilting it laterally will re-centre its C.G. if it was not already centred. This simple action will avoid having to force too much on one side and will ensure better distribution and balancing of effort. It is very rare to see experienced handlers carry a load flat.

As can be seen from these know-hows, **the role of the feet is key** in ensuring good postural alignment during handling.

What do the studies tell us about this rule?

See Appendix 1, pp. 105 to 109.

Load/body distance

What does this rule mean?

The distance of the load from the handler's body (lower back).

Why is this rule important?

Although a load has a fixed weight, the effort needed to lift it can vary. The farther the load is from the body, the more effort is required from the lower back muscles and the greater the stress. Furthermore, a distant load will have a negative effect on balance. Load/body distance is influenced by a number of factors that may have a combinatory effect on the stresses felt by the handler, namely:

i. Load volume: the larger the load, the farther away it will be from the body.
ii. The centre of gravity (C.G.) of the load: it is not always in the middle. Even if a load is held close to the body, its C.G. (its weight) may or may not be close to the body.
iii. Load position in relation to handler's body: the weight of a load held far from the body (> 60 cm) can be multiplied by a factor of 10: a 10-kg load held at arm's length is equivalent to 100 kg for the lower back. And if the trunk is bent, there is even more stress, since the weight of the upper body—trunk, head and arms—account for nearly 70% of body weight.

How to apply this rule?

Superimpose C.G.s of body and load: The load must be brought within the base of support so that its C.G. is superimposed on that of the handler. This forces the handler to lift vertically, since horizontal movements will be more difficult with the load between the legs. However, the more voluminous the load, the harder this is to apply.

Bring the load as close as possible: Tilt or slide the load as close to the body as possible without jeopardizing freedom of movement. Loads are almost never lifted purely vertically but rather with a horizontal component; this is why its freedom of movement must not be constricted.

Get close to the load: If the handler cannot bring the load closer, he may choose to get closer to the load. This spares the effort of bringing the load closer, but may involve climbing, straddling, bending, etc.

Tilt the load and/or lean it on the body: Tilting can help bring the load closer to the body, especially if the load's C.G. is off-centre and the handler wants to bring it closer. By tilting the load, he can get it to lean on his body, which can be an advantage. This might not be a good approach to use with loads that are contaminated or dirty.

What do the studies say about this rule?

See Appendix 1, pp. 110 and 111.

Weight bearing

What does this rule mean?

It refers to the time during which the load is totally borne by the handler. More time spent bearing the weight equals more effort.

Why is this rule important?

In handling, the greatest effort occurs when the load is entirely supported. In addition to increasing the effort for each load, the cumulative effect of many handling operations can lead to fatigue, which should be avoided. Three categories of effort can be distinguished:

i. The influence of the weight is minimal: These are operations that can be performed on the load before lifting or after setting it down, that is, pre-lifting and post-delivery manoeuvres (pulling, pushing, tilting, etc.). They are small movements in which the load is supported by the surface, and handlers should try to use them as much as possible.
ii. The influence of the weight must be considered: Here the load is moved over a greater distance, but is still in contact with a surface; e.g., through pivoting, sliding or rolling. Such efforts are more demanding than the first category, since they involve controlling and guiding the load. In addition, the handler must move along with the load and therefore coordinate his own movement with that of the load. This requires more skill and is more demanding.
iii. The influence of the weight is critical: At this time, the load is completely supported by the handler. This category of effort must be delayed and minimized as much as possible.

How to apply this rule?

Wait until the last minute before lifting, and deposit the load as soon as possible: By waiting until the last minute before lifting (delayed lift) and/or by setting the load down as quickly as possible (early deposit), the handler is using the first category of effort. The savings in load-holding time may seem insignificant for only one load; however, over a day or a week, after thousands of handling operations, they can become appreciable.

Keep the load in contact with the ground during transfer: In some cases, handlers can avoid lifting loads by moving them while keeping them in contact with the floor or other surface (second category of effort). This can be applied to objects such as tires, beer kegs, barrels, etc. More voluminous objects which are difficult to lift can also be handled in this way. Usually one cannot avoid the moment when the load must be fully lifted. Yet it can still be supported on another part of the body (lower abdomen, hip, shoulder, etc.).

Choose the most appropriate method of deposit: The way a load is deposited can have a major impact on load-holding time. Wherever possible, the handler should avoid working right to the end. Here are three deposit methods with their pros and cons:

Full deposit: This is the most demanding, since the handler must expend effort right to the end. The load is usually deposited flat on the ground, and the hands accompany the load until its final destination. This requires a high level of control and precision, which means greater additional effort (greater muscular contraction). Full deposits sometimes involve eccentric efforts from the lower back, which should be avoided. They are sometimes necessary, as in the case of a very fragile load, or when the delivery space is very tight.

Partial or early deposit: The idea is to set down the load as soon as a surface is encountered. Instead of carrying the load to its final destination, the handler sets it down as soon as possible and then moves it into position through supported post-deposit manoeuvres. This is greatly facilitated when the surface makes for easy sliding (little friction). One load can be used to push another, e.g., toward the back of a pallet or deep shelf.

Throwing/dropping: The load leaves the handler's hands before touching the ground; in other words, the hands do not accompany the load to the final destination. Depending on the handler's skill and/or the context, this may require post-deposit adjustments. Here there are two main variations: the handler may throw the load, or let it fall or slide.

Bring the pickup and delivery points closer together: Reduce carry time by minimizing the distance. The idea is to reduce the horizontal route, i.e., the distance between the pickup and delivery points.

What do the studies say about this rule?

See Appendix 1, pp. 112 and 113.

Load use

What does this rule mean?

It means capitalizing on certain characteristics of the load: taking advantage of its physical properties—shape, material and centre of gravity—or its position in space.

Why is this rule important?

The force used to lift a load is produced by the handler's muscle strength (internal force) and is largely dependent on the load weight and the distance of load from body (external force). Instead of forcing *against* the load, experienced handlers learn to use certain characteristics of the load to facilitate the task: they work *with* the load, i.e., in the same direction. The load can sometimes become an ally in making the task less demanding. The same rule is applied in combat sports such as judo and karate, where you use the opponent's force to your advantage. In handling, one concern is the direction of effort in relation to gravitational force, i.e., weight. Schematically, there are three directions:

i. Opposing gravity: A typical example is a load that is on the ground and has to be placed on top of a pile. The effort is upward, and therefore against gravity. This is the most demanding situation.
ii. Parallel to gravity: The pickup and deposit locations are at similar heights. This is what handlers call working in the same lift region. The effort is mainly horizontal and much less than in the first category. Experienced handlers will often try to work in the same lift region, for example by using step-wise pallet unloading. The ideal lift region is at hip height.
iii. With gravity: This is the ideal situation for using the potential energy of a load that is higher than its delivery location. However, knowing how to make effective use of the load's energy is not easy, and requires skill.

How to apply this rule?

Use the load's potential energy: A load at the top of a pile is not a problem but an opportunity for someone who knows how to handle it. The potential energy inherent in the load's high-lying position can be transformed into kinetic energy, and the handler then has only to guide the load toward the delivery location. The load's potential energy is like money in the bank that must be made to yield profits. If the handler impedes the load's movement instead of guiding it, the action is not profitable: the energy must then be absorbed and cannot be exploited. This is what handlers call working against the load. Continuity of movement is therefore essential.

Use the load's properties: Loads have certain properties that can be used advantageously:

Shape: A round or cylindrical load can be rolled along the ground instead of lifted.

Elasticity: Some loads have elastic properties that enable them to be stretched and resume their original shape. An elastic band can be stretched and propelled over a considerable distance. The effort needed for the stretching is largely compensated by the energy return. Elastic bags and tires are loads whose elastic properties can be put to use. However, care must be exercised, because if the load is stretched too much it can rupture.

Centre of gravity (C.G.): A load with unequally distributed weight can be a problem, but the handler can either fight it or use it to his advantage. If you place a 30-cm ruler on one finger, it will stay balanced if your finger is at the centre. The **C.G.** is the point where the weight is balanced on all sides. If you move the ruler, say to the 10-cm line, it will pivot around your finger without the least effort on your part. This action of turning around an axis is called a **moment**. An off-centre or asymmetrical C.G. thus represents a “moment” that can be exploited. Some loads have a stable C.G., while others, such as containers filled with liquid, do not. An unstable C.G. can pose a problem if the handler is unaware of it. During lifting, for example, if the handler has not done any pre-lifting manoeuvres, he can be caught off-guard and lose balance, lose control or have to exert more effort to regain balance.

What do the studies say about this rule?

See Appendix 1, pp. 114 and 115.

Body balance

What does this rule mean?

This rule refers to the handler's ability to maintain his stability and react to unforeseen factors. It also refers to body control.

Why is this rule important?

In terms of stability: Handling involves adding an external mass to one's own body mass. This sets up a system: load + handler. The addition affects the handler's balance. The first instant in which the load is completely supported is a key moment for being aware of balance. Although loss of balance can occur in other handling phases, it is at the pickup that the system is created and that certain load characteristics (e.g., weight, position of C.G.) are most likely to affect balance. The delivery phase, too, must be considered since that is when the system is disrupted. If the handler loses balance, he may suffer an impact or have to make sudden movements to recover.

In terms of ability to react or recover: Since handling often involves unforeseeable incidents, the handler should avoid putting himself at risk by always providing for a certain amount of leeway for reacting to unforeseen factors and recovering his balance. The movements that are potentially most injurious for the back are sudden and unanticipated movements. This is why it is critical to ensure mobility of the feet for balance recovery.

How to apply this rule?

The two main factors are static balance and dynamic balance.

Static balance: Maximum stability should be sought.

> ***Uniform weight distribution***: The weight should be uniformly distributed between the feet to ensure stability. When the handler moves, one foot has to be relieved of its weight. The more solid the stance, the less able the handler is to move or react rapidly. When both feet are on the ground, too much increase in the support surface does not improve balance. In fact, although side-to-side distance between the feet promotes balance, the opposite has been observed for the sagittal plane. Handlers have affirmed that an overly pronounced step stance is detrimental to balance.
>
> ***Additional supports***: This is also referred to as having three support points, i.e., always having three body parts in contact with a surface (e.g., the floor plus a handrail).
>
> ***Lowering the C.G. of the handler + load system***: This can be achieved by lowering the C.G. of the handler or of the load.

Dynamic balance (or controlled imbalance) and reaction capability: Here stability is more precarious but there is greater freedom of movement and ability to react.

> ***Use of a primary support***: Often one support bears more of the weight: this is called the primary support. In general, when one foot is in front of the other, the forward foot bears most of the weight. In some situations, it can be advantageous to play with one's C.G. to facilitate movement

by weight transfer, which is possible only when the weight is not uniformly distributed. Another advantage of having one primary support (and another, more mobile support) is the ability to react more rapidly. When you are standing with your weight on both feet, if you want to move, you have to take the weight off one foot and push with the other to initiate the movement. If you have one primary support, you save a step: you only have to push with the primary support. Of course, if most of the weight is on only one foot, balance is more precarious. But this is offset by greater mobility and greater ease of moving and using the body to one's advantage.

Ability to move the feet freely / maintaining mobility of the feet: Experienced handlers say you should never have your feet stuck to the floor. It's important to maintain foot mobility in order to avoid or rapidly remove oneself from an unforeseen situation. Handlers must therefore avoid finding themselves stuck between structures that prevent foot movement. However, even when there seems to be freedom of movement, if the space is too constricted (such as on a stepladder), it will be difficult to recover from loss of balance.

Do not take long steps: A large stance means stability. But when you have to move, it's another matter. Then the priority is being able to recover rapidly when something happens. It is important to keep the gravity line at the centre of the base of support while keeping the base of support as small as possible, which enables the handler to initiate a rapid response in one direction or another. This reduction of the base of support optimizes reaction speed. During load handling, this can mean taking small steps so as to ensure better possibility of recovery.

What do the studies say about this rule?

See Appendix 1, pp. 116 to 118.

Body use

What does this rule mean?

Using the entire body (the handler's main tool) to reduce the amount of effort.

Why is this rule important?

To avoid over-solicitation of small muscle masses in the arms and lower back, for example. The handler's body may be used in three different ways, making it possible to adapt to variable situations and also to alternate the body structures being solicited. First, the handler may want to use his ***body weight***, which is usually greater than the load weight. The use of weight transfers will be favoured here. Second, by using the ***large muscle masses***, i.e., the legs; bending the knees during the lift is a perfect example of this. Lastly, the handler may want to use ***postural compensations*** through counterweight actions to adjust to the addition of an external weight to the body. In this last case in particular, connections should be made with the body balance rule.

How to apply this rule?

Bend the knees when lifting: The recommendation is to bend the knees while avoiding pronounced curving of the lower back, and to lift the load vertically. The feet should be pointed toward the load to avoid asymmetry. Using the legs increases the contribution of the large muscle masses, which are the strongest, and reduces the contribution of the back. The legs are doing the work. However, this leads to increased energy expenditure, since the handler must lift his own body weight each time. It can also compromise balance, because bending the knees can sometimes require having the weight on the toes as well.

Transfer weight from one foot to the other: This makes for a more dynamic movement and reduces the effort needed to get the load moving. While knee-bending means that the movement is vertical and powered by the legs, the weight transfer technique makes use of the legs as well, but more horizontally. The weight is transferred from side to side or from front to back, from the foot closer to the pickup location to the foot closer to the deposit location. The body weight here becomes an ally, rather than a constraint as in the knee-bending technique.

Pelvic counterweight: Here the idea is to use the pelvis as a counterweight to the load. The posterior is extended (in relation to the base of support) to offset the weight of the load, which is in front. The farther back the posterior is, the more it offsets the load. Think of a see-saw with a child at either end: the pelvis at one end and the load at the other. This technique can be effective in cases where the load cannot fit into the base of support: it provides an alternative to the technique of superimposition. When the handler is using his pelvis as a counterweight, the load can only be lifted vertically (upward). A danger with this technique is when the handler's connection with the load is broken: he will then be thrown backward with a force proportional to the counterweight he is using. He will have trouble regaining his balance and could fall on his buttocks or have to take small steps backward to recover. Note that the counterweight technique is in opposition to the load/body distance rule.

Back leg counterweight: Sometimes a handler will keep the weight off one leg and let it trail behind, thus providing a counterweight to the load in front. This technique is also used to offset trunk bending. The compensation comes from the free leg (segment compensation) and from the distance between that leg and the support foot, i.e., the foot bearing all or most of the body weight. The farther behind the leg is, and the higher it is held, the greater the counterweight; however, if the handler needs to move quickly to recover balance, it will be more difficult, and both balance and the capacity to react are compromised.

What do the studies say about this rule?

See Appendix 1, pp. 119 and 120.

Transition from pickup to deposit

What does this rule mean?

It refers to the way of covering the space between the pickup location and the deposit location. In handling, a lot of emphasis is placed on lifting. But handling also involves moving a load from point A to point B; this is what is meant by "transition."

Why is this rule important?

The route from pickup to deposit will largely determine the load-holding time and is thus related to the weight-bearing rule. Both of these two rules are aimed at reducing the duration of effort associated with the phase in which the load is entirely supported by the handler. The transfer rule is especially concerned with the route and with continuity of movement.

How to apply this rule?

Transfer in stages: Transfer most commonly occurs in clearly identified stages. First the handler lifts the load with his feet pointed toward it. Then, taking small steps, he points himself toward the delivery location and moves in that direction. Lastly, he lowers the load while facing the delivery location. Throughout this process, the load moves along with the handler and follows a route shaped like an upside-down "U": it is lifted vertically, carried horizontally and deposited vertically. Compared with other transfer modes, this one lengthens the load-holding time but is not as demanding in terms of skill.

Continuous transfer: The advantage of this type of transfer is that it reduces holding time by choosing the most ***direct route*** between pickup and deposit and by ensuring ***continuous movement*** of the load. Once the load has been set into movement by the initial effort, why stop the movement if it can be continued and if the load can be guided toward its delivery location? Any interruption in the movement (such as deceleration or change in direction) will require additional effort; it is important to avoid working against the load. Contrary to transfer in stages, here the focus is on delivery; right from the beginning of the transfer, the handler is preparing for the deposit. The hands and feet must be properly positioned for this.

Feet pointed toward delivery location: To facilitate this direct and continuous movement, foot positioning is critical. Having the feet open toward the delivery location, or even pointed right at it, facilitates this continuity and ensures a harmonious passage between pickup and deposit, without too much interruption. Handlers therefore prefer to extend their stance in the direction of the effort, so as to be able to transfer their weight while following the movement of the load. This makes it easier for the body to go along with the load, since it is not thrown off course by the movement. This foot position becomes all the more critical if the load is accelerated at the start: it enables the handler to make use of the momentum generated. This action is connected to the biomechanical rule of movement conservation. The greater the initial impulse given to the load, the greater the ensuing movement. So it is logical that the handler—who is initiating the impulse—should want to gain as much as possible from it by not impeding the movement.

Flexible grip: One can draw an analogy between the role of the feet, as described above, and that of the grip. The feet ensure a compromise between body balance and ability to move. They play a central role in the continuity of movement. The grip, too, ensures a compromise between load balance and the ability to move the load. Similarly, it will have a role to play in the continuity of movement. It is pointless to adopt a position that facilitates movement if the load is unable to follow. This is what happens when the handler must interrupt the movement in order to change his grip. In box handling, the diagonal grip is very popular, precisely because of its flexibility. Each hand plays a different but complementary role. The lower hand is the one doing the carrying as well as most of the lifting and lowering. The upper hand (diagonal to the lower one) ensures horizontal stability and guides the load in the desired direction.

What do the studies say about this rule?

See Appendix 1, pp. 121 to 123.

Rhythm of movement

What does this rule mean?

This rule refers to the quality of movement during lifting and carrying. Two aspects should be considered: the need to achieve a steady, flowing movement—this aspect is called ***fluidity***—and the need to maintain the appropriate ***speed***.

Why is this rule important?

In terms of fluidity: When a movement is lacking in fluidity, it has an impact on the next movement in the sequence, and so on. The overall impression is that the effort is increased and there seem to be useless “parasite” contractions. Most importantly, there is a lack of control, as though the movement were not yet mastered. A handler who is still learning a movement may lack fluidity and control, and is therefore more at risk.

In terms of speed: The speed at which a load is handled will influence the internal forces that act on the lumbar structures. The faster the movement, the more it will increase these internal forces. There are situations where the loads can be accelerated and ways to achieve this acceleration without overly increasing the stresses.

How to apply this rule?

Here it is not so much a matter of listing know-hows as of giving instructions for applying this principle.

To achieve fluidity: The handler must find a rhythm that enables him to maintain a smooth sequence of movements and avoid sudden acceleration or deceleration, jerking, hesitation and pauses, especially when he has to change direction.

To maintain the appropriate speed: There are two main scenarios:

> ***Slow and steady movement****:* If the handler is unfamiliar with the loads, if they are heavy or if the feet are on a slippery surface or in a constricted space, a slow and steady speed is preferable. A smooth, constant motion is easier to control and less likely to result in a loss of balance or other disruption. The downside is that the load must be supported longer.
>
> ***Give momentum to the load and follow it***: One technique frequently observed in experienced handlers is to accelerate the load at the beginning of the lift and then take advantage of the momentum by simply guiding the load and interfering as little as possible with its motion: this is the acceleration/guiding technique. The acceleration is progressive rather than brusque, and is achieved through a coordinated movement. This action is closely related to the rule of body use through weight transfer. The initial acceleration must not be achieved solely by forcing with the arms or back, but by the entire body through the use of body weight. It is only under these conditions that the load acceleration will not lead to an increase in internal forces. In this respect, the technique is similar to the snatch in weight lifting. Although the intention and the force of movement are quite different, the principle is the same: accelerate the load and then take advantage of its momentum. While the weight lifter will lunge underneath the bar to lift it

overhead until it is at arm’s length, the handler will guide the load to its delivery location with a minimum of effort; in fact, he is only following the load in its movement. Of course, acceleration is not as brusque or intense in handling as it is weight lifting. Unlike a weight lifter, the handler does not want to generate maximum power but only as much as is necessary for the context. This technique is typically used in load throwing.

What do the studies say about this rule?

See Appendix 1, pp. 124 to 126.

5.1.4 Situation types: An attempt at categorization

The literature on competency development makes frequent reference to situation types or classes. We mentioned these in our description of our theoretical framework (p.18, Section 3.2.3). They are useful in that they can point the operator toward a course of action appropriate for the situation type in which he finds himself. Although their importance is acknowledged, it is rare to find examples of situation types for work activities (Chenu, 2004), so it is not surprising that manual handling research is silent on the subject. Nonetheless, we have attempted to categorize handling operations into situation types. It should be noted that this is a proposal and has not been validated in any way. Although it still needs fine-tuning, we are nevertheless presenting it here in order to give an idea of about what could constitute a situation type and to initiate a discussion on this topic. Our intention is primarily to lay the groundwork.

We chose to identify types based on the **difficulty** and **complexity of the motor tasks required**. This categorization is a preliminary response to the question of what motor skills and aptitudes are needed to perform handling tasks. We wanted to counterbalance the importance placed on the combination of effort and posture in handling. This combination is certainly key and will be taken into account in the categorization, but has already received a lot of attention at the expense of other factors such as body balance and rhythm of movement. There are connections to be made between these types and the handling rules described earlier, but such connections are embryonic for the time being. For instance, we will see that when a handling aid is introduced in order to reduce the effort involved in a task, that task can actually become more difficult in terms of motor skills, in that it may require more coordination, balance or control.

Our strategy was to place body movement or non-movement in parallel with that of the load. Thus body movement—ensured by the feet—and load movement—ensured by the upper limbs—are analyzed in relation to each other. More specifically, a parallel is established between upper and lower body movements. This association is informed by research on motor learning in a sports context, which states that "having to coordinate the movements of different body parts or coordinate manual movements with locomotion control increases task difficulty, at least in the initial learning phases. The same applies when the task involves rhythm, since the nature of the rhythm to produce increases task difficulty." (Temprado, 1992)(our translation) Without getting into details, the most difficult task is one where the upper body and lower body are moving independently of each. In sports, a good example of this is tennis.

Regarding body movement, there are two main scenarios in manual handling: handling with **transfer** and handling with **carrying**. In transfer, the goal is to move an object from point A to point B in a single, relatively continuous movement, while carrying corresponds to situations where the handler must move with the load over a variable distance. Transfers can be divided into **pure transfers**, where both feet remain in one place, and **pivoting transfers**, where one foot is stationary and the other moves freely. Transfers therefore involve little or no body movement. Let us nuance that statement. Although there is no visible movement of the body through space (i.e., locomotion) during a transfer, the transfer of weight from one foot to the other gives a movement to the body that is similar to that of a balance wheel. As for **carrying**, it can be over a **shorter** or **longer** distance. According to ISO 11228-1 (2003), the recommended tonnage limit is 10,000 kg/8 h for moves of less than 10 metres. In the case of a longer distance—10 to 20 metres—the limit is reduced by nearly half, to 6,000 kg / 8 h. Ten metres thus seems to be the dividing point between short and long carry distances.

As for movement of the load, two dominant patterns have been identified: **free** movement and **constrained** movement. In free movement, the load does not have an imposed route but is free to move as the handler desires, in any direction. Of course, moving it can be made more complicated by the context or certain load characteristics (e.g., voluminous or unwieldy load, restricted delivery space), but the movement is still entirely controlled by the handler. This category includes handling operations where the hands are in direct contact with the load, as well as those where the load is moved by a tool—a shovel or spade, for example—which then becomes an extension of the hands, as for instance in shovelling snow. Constrained movement, on the other hand, is when the load's route is totally or partially imposed on the handler. This is the case when a handling aid is involved. In this category are cases where the load is **supported** (e.g., on a dolly, cart or hand pallet truck) or **suspended** (as from a hoist, gantry or boom truck). The route is determined by the characteristics of the environment and equipment. The movement is constrained by the degrees of freedom of the rotating axes (articulated arm, stationary wheels or guiderails) or by the presence of obstacles to be bypassed. This forces the handler to use routes that are usually longer and less natural compared to human movement (i.e., free movement). Another type of supported handling, besides those involving handling aids, would be movement where the load is kept in contact with a surface (for example, rolling a beer keg). Team handling (buddy system) also belongs to this category.

In the specific case of constrained movement, the handler is required to perform two types of activity: guiding and piloting. Guiding consists in assessing the movement and speed of the load—and thus of the equipment involved—in relation to its final destination, and producing the effort needed to realign or redirect it. The handler may be the only one controlling the load (by using a hand pallet truck, sliding a load on the floor, etc.) or may depend on another operator (someone operating a gantry crane or boom truck, or a partner in team handling). Changes in route to position the load therefore require effort. In the case of piloting, the handler uses the equipment controls, and changes in route are made with no direct manual effort.

Table 5-5 presents certain characteristics of the four types of movement just described. We have tried to highlight the dominant traits of each movement—the ones that characterize it the most—and to link them to the most relevant or applicable handling rules.

Table 5-5 Characteristics of body and load movements

Movement…	Characteristics	Handling rules
… of the body		
Transfer	**Continuity** between pickup and deposit: avoid interrupting the movement Quality of movement in terms of **fluidity**: avoid jerking Importance of good **rhythm**, appropriate speed **Foot position**: adequate room for feet, plus some extra for recovering lost balance	Rhythm (fluidity) Transfer (direct) Balance Body use Alignment (asymmetry)
Carrying	Considerations about the **load route**: condition of surfaces, obstacles, sloping, distance… Concern for **loss of balance** Minimize **carry time (duration)**	Weight-bearing Balance Transfer (in stages)
… of the load		
Free	Efforts mainly against **gravity:** whenever possible, work with instead of against gravity Efforts by handler alone: try to reduce their **duration** **Quality of grip**: hand/load or hand/tool/load interface. In the latter case, tool design is important (e.g., handle diameter, texture)	Load use Weight-bearing Balance (control)
Constrained	Efforts mainly against **inertia**, which opposes movement: the equipment, given its mass and speed, can have repercussions on the effort needed to initiate or stop the movement **Efforts shared** by both equipment and handler: however, the weight and/or volume of the combination is often greater **Volume of equipment** vs environment: provide for adequate room and circulating areas	Alignment Balance Transfer (route)

These elements, taken separately, already have an intrinsic interest; however, it is when they are correlated that there is value added. The association between body movement (horizontal axis) and load movement (vertical axis) is illustrated in Figure 5-4. The correlation of the axes reveals four main situation types, numbered one to four. On each axis we have added the subcategories described previously, but solely for information purposes. Given where we are in our process, we will not make them separate categories, although this would be a possible option (e.g., distinction between guiding and piloting discussed above). It should be noted that a task can be in more than one category; for instance, it is not uncommon for a task to involve both transferring and carrying a load. It may be supposed that a task that requires going from one category to another will be more demanding in terms of skills to master. Below, let’s see the dominant motor skills for each of the four main situation types.

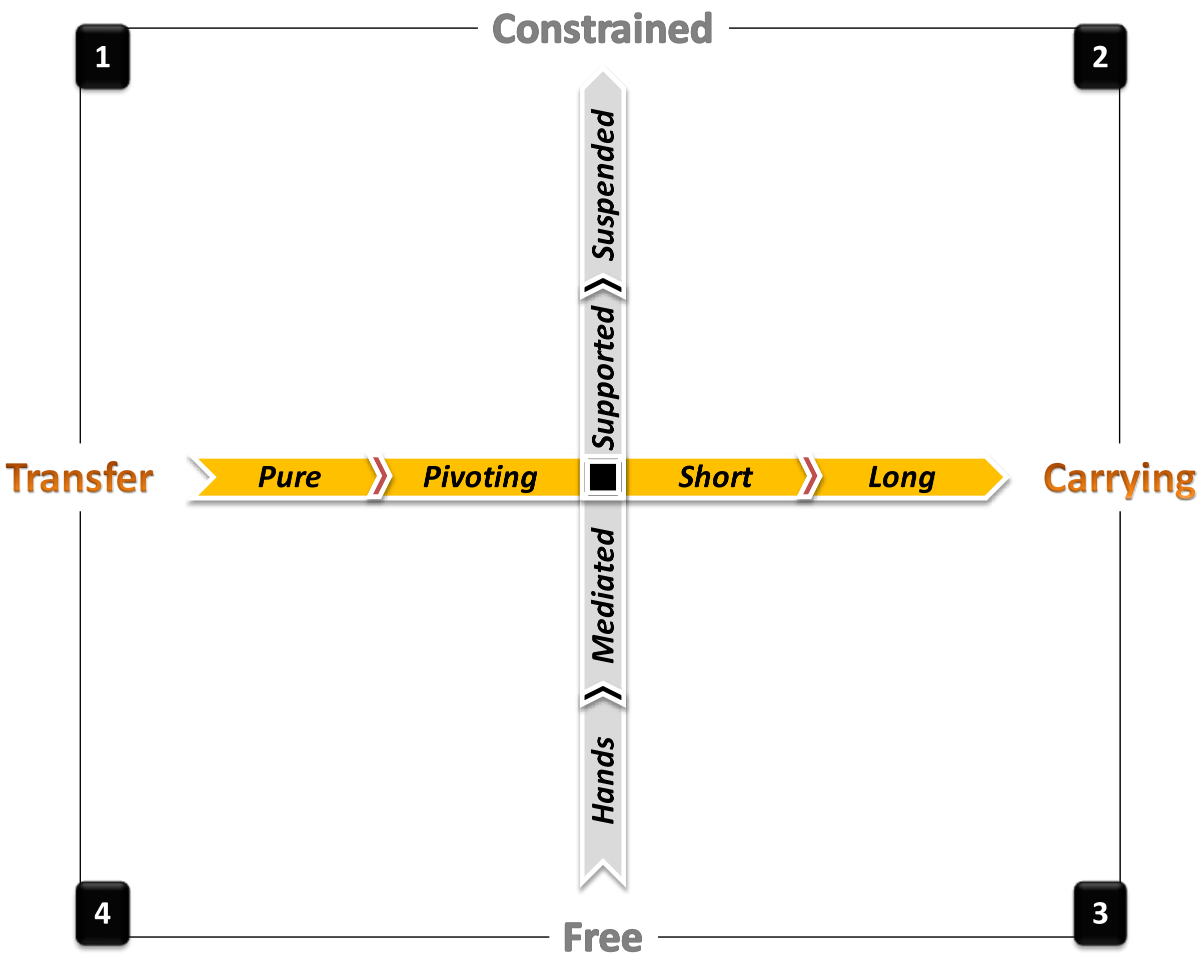


Figure 5-4 Four main situation types in handling

1 Transfers with constrained load movement

This type seems the least demanding in terms of motor effort, mainly because the handler does not move. There are not many examples of handling operations in this category. Although the load movement is imposed, it does not require much effort since it is partially assumed by the equipment or by the fact that the load is resting on a surface. As in all cases of load transfer, it's important that the feet have enough room to avoid asymmetry. This is especially true when load movement is independent of foot movement, as is the case here.

2 Carrying with constrained load movement

This situation presents challenges in terms of motor skills. It is not always easy to move while controlling a load, since it requires coordination of independent arm and leg movements. The handler must direct the load while moving his body; spatial representation is thus very important.

He must look where he is going while keeping visual contact with the load. Changes in grip are frequent, and the handler may have to compromise his posture (e.g., bending the back) in order to reach and direct the load, especially if it is on the ground. The handler must sometimes anticipate the load movement—which is not always completely under his control—and move his feet accordingly. If he fails to anticipate and is instead in reaction mode, there is more risk of asymmetry and sudden effort.

3 Carrying with free load movement

Like those in Type 1, these handling operations seem to involve a low level of motor difficulty. The load does not move in relation to the body but forms a single system with it. The handler's attention is on the movement he has to make and not on the relation between load movement and body movement, since they are one and the same. However, the load's position—not its movement—can present difficulties (e.g., load carried on one side of the body). And the effort required can still be significant and can be the main concern, along with energy expenditure.

4 Transfer with free load movement

The challenge here is to synchronize or coordinate the weight transfer with the load movement. As in the previous situation type, it is difficult to speak of a body/load system here, but there is nonetheless movement of one in relation to the other, which the handler tries to make as smooth as possible. The timing between leg movement and arm movement determines the quality of the movement. This is the situation type where rhythm is most important. If a tool is involved and it is poorly designed, this will increase the difficulty level. Here are some examples of handling tasks that fit into Type 4 (Figure 5-5).

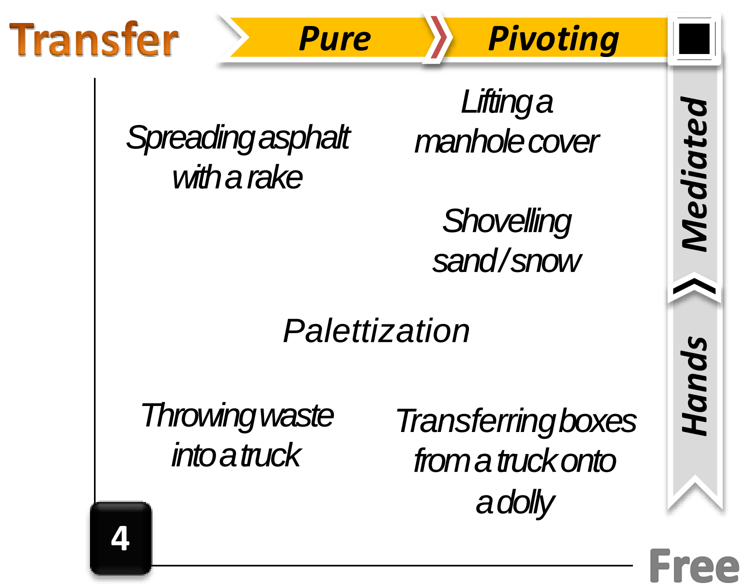


Figure 5-5 Examples of Type 4 handling tasks

5.2 Competency # 2: Organize the work

This second competency is more comprehensive and addresses the way the handler organizes his work, establishes priorities, determines a task sequence, etc. It does not directly concern the action of handling loads, but is more macroscopic in nature. It refers to the ability to plan and organize the work as efficiently as possible for a given cycle, for the day or for the week. Optimum organization saves effort and prevents having to work under pressure, which is often the cause of accidents. Darvogne and Noyé (2000) emphasize the growing importance of organizational know-how, i.e., the art of self-organization. As we have seen in our theoretical discussion (3.2.6, p. 21), although it is useful to plan one's work at the start of the day, it is often necessary to review the plan as the work situation changes, so as not to find oneself in reactive mode.

Figure 5-6 The ability to organize one's work is important in handling

The tangible expression that this competency takes is very specific to the context: there are as many different forms and methods of work organization are there are different handling contexts. However, just as we did for the first competency, we were able to identify rules (n=5) that guide work organization, and we have listed them in Section 5.2.1. These rules are less clearly defined than the handling rules, since there has been little research on the topic. To compensate for this lack, we provide examples describing the work organization strategies used in various sectors (5.2.2).

5.2.1 Work organization rules

Table 5-6 presents the five rules of work organization in manual handling. The idea for the handler is to avoid excess work and finding himself operating under pressure with less and less flexibility. Concretely, the rules can translate into better time management, which will prevent rushes where the handler has to work under pressure, or into a reduction of needless re-handling operations, optimization of movements and better distribution of the work throughout the day. Keeping a regular work rhythm is also a major concern that means managing work effectively to avoid interrupting the rhythm.

Table 5-6 Five rules of work organization

	Rule	Note	Description
1	**Re-handling**	Additional, unnecessary handling operations require more effort.	Ideally, a load should be handled only once. Any extra handling can be regarded as unnecessary since it requires added effort, which should be avoided.
2	**Flexibility**	Having to react rapidly in an emergency limits the possible courses of action.	The handler must be able to react to situations, especially when they involve risk or unforeseen incidents. Working under pressure reduces flexibility and forces the handler to take the most rapid course of action, which is not always best. The handler should allow enough time so as not to rush.
3	**Rhythm**	Interruptions in rhythm result in reduced efficiency. A regular and constant rhythm should be sought.	The handler should seek a regular and constant work rhythm. This is especially true for dynamic tasks. Continuous movement is often preferred, hence the importance of synchronization.
4	**Movement and route**	Moving can be costly in time and energy.	Carrying can be a major source of fatigue. The handler should plan optimal routes—ones that avoid problems such as wasted time. The best routes are not always the shortest. A worker may want to reduce the distance to cover (by positioning himself closer to the delivery point) or choose the easiest route.
5	**Distribution of effort**	During rushes, effort is concentrated into a short time. This should be avoided as it prevents muscle tissue recovery.	Effort should be distributed over the entire shift and there should be recovery periods; that is, work should be interspersed with formal and informal breaks (mini-breaks). Experienced handlers spread their work out over the entire shift and do not try to “get it over with” as quickly as possible. Distribution can greatly influence the resulting workload.

5.2.2 Concrete examples of work organization

The following table contains examples of work organization in various contexts and/or for various tasks, along with the source.

Table 5-7 Work organization strategies in various contexts

Context / Task	Work organization strategy	Source
Re-handling		
Trailer loading	During trailer loading, items already loaded often have to be re-arranged to make more room. By waiting to know the entire load content, or finding it out in advance, the handler will have less re-arranging to do.	Lortie and Pelletier, 1996; Lortie, 2002
Receiving	Good planning of the space on a receiving dock obviates the need to move pallets that are blocking the way when a trailer comes in for unloading.	St-Vincent et al., 2005
Delivery	Customers who want to check the content of boxes delivered will sometimes request intermediate deposit. The quality of customer relations and the delivery approach will influence these deposits.	Lortie, 2003 (field data)
Palletization	Loads can be placed on pallets in such a way as to facilitate checking, thus obviating the need to move them for checking.	Couture and Lortie, 1999; Couture, 2000
Batch unloading and sorting	The sequence of loads and the use of carts can reduce re-handling operations for finding and positioning loads.	Lortie and Pelletier, 1996
Flexibility		
Warehouse store	To prepare for the arrival of new merchandise, a placer frees up space in the bins so that items can be displayed quickly, thus avoiding a rush at the end of the shift.	St-Vincent et al., 2005
Peak hours and customers	Customers usually want their delivery to be done quickly, especially if they have to attend to it. Some customers like to concentrate all their deliveries into one day, which can lead to a lot of activity at once and reduce flexibility.	Lortie, 2002
Difficult environment	For deliveries in low basements, refrigerated areas or tight spaces (e.g. cubbyholes, low deep shelves), time can become a handicap. Taking one’s time can become very tiring.	Lortie, 2002
Rhythm		
Palletization	Certain palletization and depalletization methods (e.g step-wise) make it possible to work in the same height region or use similar routes.	Lortie and Baril-Gingras, 1998
Delivery	Deliverymen arrange their deliveries based on their knowledge of the other road users. They have identified critical periods of the day when a given street or area is too congested, based on rush-hour traffic or on bus or garbage pickup schedules.	Chomez, 2008

Garbage collection	When a garbage collector is faced with a pile of garbage bags and other waste, he will throw the items in random order regardless of their characteristics. Thus heavier bags, which should perhaps be carried and placed in the hopper, will also be thrown in order to avoid interrupting the rhythm.	Denis et al., 2007
Movement and route		
Warehouses and pallet trucks	When driving double pallet jacks, some operators choose to go in a zig-zag to be able to get the cart closer to the pallet and thus save a few steps.	Couture and Lortie, 1999
Carpet carrying	The shortest route can also be the hardest and riskiest (e.g., obstacles, debris). Carpet layers will then choose to take the long route.	Gonella, 2007
Warehouses and hand pallet trucks	Knowing the warehouse and where merchandise is located helps the handler determine a good order-picking sequence.	Couture, 2000
Garbage collection	Garbage collectors make intermediate piles of bags. This is the same rule as in distribution centres that operate by hubs. It reduces the carry time and makes for better coordination of carry-transfer passages.	Denis et al., 2007
Distribution of effort		
Hospitals	Female orderlies wash their patients in the bed, alone, then work in teams of two to do the transfer operations. Male orderlies prefer to do the transfers and wash the patients at the same time. In the first strategy, the effort is broken down into more manageable units, with the greater efforts being handled by teams of two.	Lortie, 1987
Delivery	The organization of delivery sequences is critical. A good sequence will not only reduce driving time but also distribute loads efficiently. For example, starting with the difficult deliveries will result in too much fatigue. Keeping them for the end of the day, when fatigue has already been accumulated, is not a good choice either. Alternating types of difficulty is one way of distributing loads. Not only the quantities but also the difficulties are thus spread out.	Lortie, 2002

6. CHAPTER 6: RECOMMENDATIONS ON TRAINING IMPLEMENTATION

The approach presented in this report for training in the workplace tries to set itself apart from conventional lecture-style training in which an expert comes and tells operators what they need to know and shows them "the right way" to do things. This teaching model is based on the transmission of knowledge, with the trainer explaining as clearly as possible while the trainee listens. Although economical in terms of time and resources, this model does not seem well suited to the learning of know-how, which is typical of handling activities.

A more recent trend, that of social constructivism,[14] places the trainee at the centre of the learning process. Social constructivism is "an approach to education that emphasizes the learner's active role in the construction of knowledge based on perceptions, experience and prior knowledge."[15] (our translation) This definition highlights two particular characteristics of this approach, which we would like to stress. The first is the active role that the learner must play in the learning process. People learn by doing. This holds especially true when one considers that handling involves a large proportion of physical know-how: the notion of motor skills is central. This topic is largely documented in the teaching of sports and other physical activities, where the different phases for learning a motor skill are considered (Schmidt and Lee, 2005), but little or none of this knowledge has been transferred to the workplace (Ouellet, 2009). Whether in sports or in the workplace, people do not learn a movement by listening to someone describe it, but by doing it, according to a planned progression of the level of difficulty. The more complex the movement, the more time it takes to learn.

The second characteristic emphasizes the central role of what is already in the learners' minds, which influences how they receive and assimilate the new knowledge. The learner is not an empty receptacle to be filled. In knowledge acquisition, the information received is filtered through the learner's experience and prior knowledge, which are generally designated as constructs or preconceptions (Giordan, 2002). This is important in handling training, since many handlers are manual labourers who have already had to handle loads in their work or outside activities. They already have some opinions—right or wrong—about the proper way to handle loads. As a result, they sometimes question the training offered to them, viewing it as disconnected from their reality or from their usual way of doing things.

6.1 Proposed approach for setting up a workplace training program

The proposed approach is a combination of conventional ergonomics (Guérin et al., 1997)—especially participatory ergonomics (St-Vincent et al., 2000) —with more specifically training-oriented approaches such as action learning and participatory learning. It involves a large portion of active worker participation. It should be seen in the same way as a more conventional intervention, for example, an intervention on technical facilities (i.e., equipment or premises).

14. Piaget developed the cognitive aspect of this approach—i.e., the rules of assimilation, accommodation and equilibration—while Vygotsky emphasized the social aspect and the importance of interpersonal relations between learners and their environment, which contributes to their learning.
15. Grand Dictionnaire Terminologique.

This is not just a few hours of break for presenting pre-packaged knowledge: we are proposing training that can last several days in which preliminary analyses are conducted, work groups are formed and action follow-ups are organized. Consequently, the approach must be presented in such a way as to negotiate more training time. The critical matter of the time allotted to training will be discussed at the end of this section.

As we have seen, handling can take a wide variety of forms; moreover, there are many organizations that have limited resources and face special challenges. Because of this diversity, we need an approach that can be adapted to each context. Beyond training, there can be problems of a technical nature (e.g., physical layout, handling aids) or organizational nature (e.g., stability of teams, workload requirements) whose solution requires the collaboration and participation of many actors. The most realistic and sustainable approach should emphasize the involvement of operators assigned to handling tasks and possibly other actors in the production system in the search for solutions adapted to their environment. It aims to achieve experiential co-learning of operators through coaching by a coach-trainer[16] who will lead group exchanges directly at the work stations. This process offers operators and other actors the opportunity to discover, learn and innovate together.

6.1.1 A three-phase approach: Preliminary analyses, participatory training and post-training follow-up

Table 6-1 gives an overview of the three-phase approach. For each phase, actions are indicated. This table does not mention the analysis of the request needed for any ergonomic intervention, but only the subsequent actions once the training mandate has been approved. The request analysis is a prime opportunity to explain the training needs and to have the training time increased. In the following paragraphs we will review each phase and the actions they involve so as to explain a little more about how they take place and the important aspects to consider, along with any variants in the way of implementing them. The reader should be aware that these actions are flexible and can be modified, as the success of the training often rests on the quality of adaptation to context; the general philosophy of the approach is important to preserve, but not so much the structure. For example, although we suggest setting up a training follow-up committee, the OHS officer is free to determine whether this is appropriate, depending on the context.

6.1.1.1 Phase 1: Preliminary analyses

Follow-up committee

To guide the training and to report on the actions carried out, we recommend setting up a follow-up committee made up of handlers, employer and union representatives, and any other person who may be involved in training matters (e.g., HR officers). The frequency of meetings depends on the duration of the implementation and on the role assigned to the committee. Short meetings

16. The terms “coach” and “facilitator” are also used in the literature. We prefer the term "coach-trainer" to emphasize the double role of training as well as intervening in other factors that can influence constraints experienced by operators.

at the end of each day may be the chosen arrangement. We see this as playing an important role in addressing issues that go beyond training but have an impact on it. Though it cannot be denied that there are training needs, in some cases operators may simply be up against inadequate conditions. Giving training in a poorly designed workplace will often cause frustration for the learners, because they are being taught responsibility for prevention when the source of the problems lies elsewhere (Figure 6-1).

Figure 6-1 Training cannot compensate for inadequate conditions, such as object locations that are too high or too low, or severe space constraints

Table 6-1 Three phases for implementing workplace training and consequent actions

Phase and action	Description	Objectives
Phase 1: Preliminary analyses		
Set up a follow-up committee	Get various employees to sit on the committee charged with following up on activities set up by the trainer	Regularly report on the progress of the intervention and obtain opinions or validate the orientations to be used Request that certain actions be taken to facilitate the intervention Address issues that go beyond training but have an impact on its success, i.e., other factors such as layout, equipment and work organization
Analyze the context	Using the analysis grid, analyze the context in which the handling activities take place and for which training is requested	Get a better idea of the particular characteristics of handling activities in order to adapt the training Identify other factors that could influence constraints Evaluate the extent to which responsibility for OHS is assumed and thus evaluate the capacity of the workplace to receive training Provide the trainer with arguments for negotiating a training program that is as well-adapted to the context as possible
Target a handling task	Based on the results of the previous step, identify a handling task to begin the training	Start the training with one task rather than with handling as a whole Go from the relatively simple to the increasingly complex in order to ensure success Enable the trainer and the actors to become familiar with the training approach
Analyze local work methods	Using the observation grid, get an idea of how operators handle the loads	Become familiar with the work methods in place so as to facilitate discussion during training Get an idea of which work methods are promising, which ones are not in line with manual handling rules, and which ones are unconventional and merit particular attention (e.g., workarounds, tricks of the trade)
Phase 2: Participatory training		
Set up a working group	Based on training needs, set up a working group that includes operators	Have a representational group of operators to ensure optimum impact and to make sure the proposals are suitable for the largest possible number of operators Selection of operators can lead to the training of in-house trainers
Lead group meetings	Central portion of the approach, where exchanges and discussions are planned to debate work methods directly at the work station	Promote training that is • self-critiquing, i.e., the operators analyze themselves • based on local know-how already in use • active, i.e., practising in actual work situations is encouraged • social – in groups – emphasizing sharing of viewpoints based on experience
Phase 3: Post-training follow-up		
Follow up on actions	After a defined period, follow up on the actions implemented to evaluate the results	Evaluate the effectiveness of the approach implemented and its sustainability Propose improvements and/or adjustments if needed

Training then becomes a good pretext for bringing up such factors, and constitutes a springboard for acting on the entire set of factors influencing handling conditions. The follow-up committee meetings, too, are a good opportunity to change certain perceptions about various issues such as training and its dynamics, what is involved in handling, and its importance in the company. Rather than adding another structure, it is preferable to have the follow-up done by a joint body that already exists in the company (e.g., the OHS committee).

Analyzing the context

To help trainers familiarize themselves with the workplace and adapt the training, a practical tool is proposed: a grid for analyzing handling contexts (Appendix 2). It contains three main sections, each in the form of simple questions to answer. The necessary information is obtained by means of short interviews complemented by observation. The grid should take two or three hours to complete. Each section corresponds to a specific objective of the grid. The first section is for describing the workplace and context and for targeting the handling situations found there. Specifically, the user will enter information about the size of the company, its sector of activity, its financial resources, the characteristics of its workforce, and the prevention activities already in place, along with other details such as its objectives with regard to training. This will yield a better understanding of the environment in which the trainer will be intervening, in order to better prepare and adapt the training implementation strategy. The grid will then help the trainer to inventory the main handling situations found in the workplace. In the second section, the user describes the characteristics of these handling situations in order to understand them better and adapt the training content to them. Each handling situation is described according to three main aspects: the degree of variability, the challenges it poses, and its particular characteristics. This information will be useful for targeting a specific handling task and for justifying this choice (Step 3 in the proposed approach). Lastly, in the third section, the user analyzes the various factors influencing the handling situation. This means analyzing the possible problems in terms of equipment, layout and socio-organizational aspects such as stock management, flexibility, workload and teams. The goal is to identify the aspects where corrective action will be contemplated in parallel with the training.

There are four summary datasheets where the user can enter the information to be gathered: three for the sections described above and one more for a plan of action. The action plan contains the avenues identified for training, as well as those for orienting preventive action on the other factors. In particular, major avenues for prevention are suggested to ensure correspondence between the characteristics of the handling activities studied and the training components to implement. For example, the greater the variability, the more the training will emphasize planning and organization. Similarly, the more difficulties there are, the more important it will be to develop the handlers' ability to analyze situations.

Targeting a handling task

It may happen that the company has various handling activities but wants a general training program. However, we feel it is preferable to distinguish between handling activities and to conduct training on just one of them, or at least on activities that have similarities. In other words, the training must be repeated as many times as there are different handling activities. In the case of a simple handling job of a cyclical nature, with little variability, the job as a whole can be addressed in the training. But for a job involving several tasks with a significant level of variability, it is preferable to target one or two tasks, that is, only a portion of the job. Observation, along with consultation of operators and foremen (Step 2), will point to certain tasks that are more problematic or difficult, or even tasks that are more frequent or typical. Although it is probable that some of the training can be transferred to other tasks, this targeted approach is especially useful for ensuring the success of the training. Depending on the trainer's level of experience, knowledge of handling and the workplace in which he is intervening, it may be difficult to tackle a wide range of handling activities all at once. In such a case, it is preferable to go at it progressively by breaking the job down into segments for training purposes. Nevertheless, an experienced trainer may decide to address a job in its entirety, provided there is sufficient training time (see 6.2).

Analyzing local work methods

Given that this approach does not seek to impose ways of doing things but only to add value to what is already being done in the workplace, observation of operator activity is very necessary. Preliminary observations must be made in preparation for this. To help the trainer with this, we have designed an observation grid based on the handling rules described earlier, to be used for the task targeted in the previous step. The reader may refer to Appendix 3 for a more complete description of this grid. The observation made be done *in situ* since it is only a matter of having an initial assessment, not a systematic survey of techniques. But video recordings are also an interesting possibility—not so much to facilitate observation as to use the clips during the training to show and comment on the work methods used. The interest, of course, is being able to observe the handling techniques used and to comment on their pros and cons. This will help the trainer to establish a dialogue with the operators, provided that his knowledge of the work methods used gives him certain credibility with the trainees. Experience has shown to what extent a good knowledge of working reality is critical to the success of a training program.

6.1.1.2 Phase 2: Participatory training

Establishing a working group

At this stage, the trainer should have sufficient knowledge of the workplace and work methods to delve into the proposed approach. We suggest setting up a working group composed solely of the operators who will receive the training. Here the trainer has various options for selecting the operators. The first criterion is the number of operators assigned to the targeted handling activity: to ensure dynamic exchanges where everyone has a chance to express themselves, there should be no more than seven people in the group (Boudreault, 2002). It should be an odd number, to prevent a tie in the event of a vote. Depending on the problems identified in the previous steps and on the population of handlers to be trained, operators with various levels of experience and a range of anthropometric profiles (e.g., taller and shorter) may be included, along with workers who have been injured in the past. A certain level of heterogeneity can yield a wider variety of viewpoints and needs, although it will also mean that managing the group will be more complicated.

It is always good to have at least one or two experienced operators so that everyone can learn from their tricks of the trade, developed over time. In fact, it is not unusual to have, as trainees, handlers with several months or even years of experience, who are being asked to refresh their knowledge. One last aspect to mention concerns the possibility of training in-house trainers, who may take up the task of providing certain training needs after the trainer leaves. If this option is contemplated, operators who are interested in playing this role and who have the necessary skills (motivation, communication skills, sufficient experience, etc.) must be recruited. The training of in-house trainers is one more argument that can be put to management when negotiating the length of the training.

Facilitating working group meetings

For these meetings, we propose discussions between the handlers in training and the trainer based on the usual work methods in place, directly at the work station. The operator is the primary expert on his workplace and the tasks to be done. The idea is to start from actual work situations and existing methods, rather than imposing methods from outside (Figure 6-2). **Any improvements should therefore be based on the know-how already in place**. This know-how should be analyzed and discussed before any improvements or alternatives are proposed. In this connection, the trainer should refer to the handling rules and work organization rules to interpret the know-how: for example, he should question whether—given the situation to be handled—the transfer methods are the best, whether they minimize load/body distance, whether moving strategies are optimal or loads are often re-handled, etc. He may approach the handlers about these matters and ask them to explain their choices. In this way, know-how is negotiated in an exchange that involves the trainer and the handlers in a co-construction of professional know-how. The goal is to use the complementarity of knowledge to find a common ground on the best work methods.

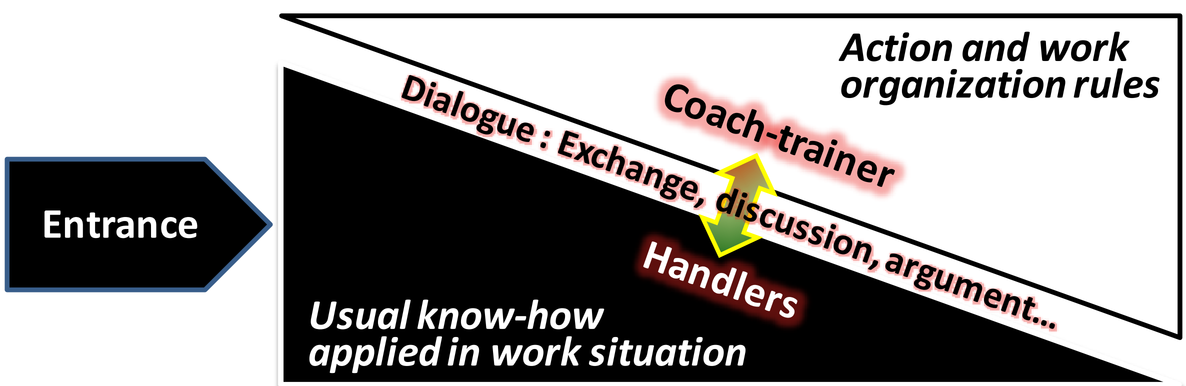


Figure 6-2 Complementarity between workplace experts and theoretical experts

The number of meetings will be directly related to the complexity of the selected handling task, the variety in the participants' profiles and the correspondence of other factors. Meetings may be held daily on consecutive days, which would be a practical option. However, to maximize the effects, we strongly recommend meetings spread over a longer period—once a week—and interspersed with times when the handlers can go back to their jobs and try what they have learned. Alternating work with training will yield richer discussions during subsequent meetings, since the handlers will have had a chance to try the methods discussed. These meetings are at the heart of this approach, and they are designed to promote the following:

- **Self-analysis of work methods**: Operators are placed in a position where they must analyze their own handling methods. They find problems and difficulties, and look for new ways to improve. Instead of imposing a solution, coach-trainers help operators find other work methods on their own. For example, the trainer might ask whether balance is important in a given situation, or whether there's a way to reduce the length of time that the load is supported. Are these work methods suitable for handlers with back pain, for handlers of short stature, in areas with space constraints, etc.?

- **Learning through action:** The approach is designed to stimulate operators to experiment concretely and make their own discoveries. They must learn through practice. In this way, it is hoped, they will assimilate the learning better and make more lasting changes. Rather than having discussions in a classroom far removed from the shop floor, operators learn directly at their workstation—or, if this is not feasible, at a station that resembles their workstation as closely as possible.

- **Social learning:** Operators learn in a group for a period of time determined by the trainer. The trainer leads sessions in which operators are encouraged to exchange ideas and discuss different ways of doing things, the pros and cons, etc. This group approach stimulates learning through sharing and exchanging viewpoints based on practical experience. The group's heterogeneity will give the participants a chance to consider various viewpoints and thus discover more than one way of doing things. A climate of trust and respect is essential for stimulating this type of exchange.

- **Self-learning**: Given the limited duration of the training and the fact that the trainer will not necessarily be present after it is over—thus limiting the possibility of receiving feedback during normal work shifts—the novice handlers should be made autonomous in their learning. We are looking for long-lasting effects that will continue beyond the official training period. The idea is to make them aware of the need to gather information about the results of their actions in order to make any necessary adjustments; they have to be able to learn from their actions. By being more aware of what they are doing, of the sought-after effects and of the possible consequences, handlers can gain experience more rapidly by learning to correct themselves. In addition, watching co-workers in action can be an effective learning device.

These meetings are also an opportunity to talk with operators and see what in their environment is preventing them from applying the methods discussed: pickup locations too high, severe space constraints, etc. It is then possible to discuss avenues for improvement and to refer these matters to the follow-up committee. The previous analysis of the context should make it possible to identify a few of these irritants. Although it is important for the practical portion to account for most of the training time (~75 to 80%), more theoretical portions could also be considered; however, they must complement the rest of the content. Conventional teachings on lumbar structures (i.e., vertebrae, ligaments, discs), risk factors, etc. can be planned, although we think it is wiser to deal, for example, with the handling rules or work organization rules by discussing the importance of balance, how to make the load work in one's favour, or how to make use of one's own body weight. The use of video clips is recommended here. We think that this knowledge can be more useful to the handlers' concrete action, as handlers are always concerned with the "how-to."

6.1.1.3 Phase 3: Post-training follow-up

After a few weeks, it is interesting to conduct a follow-up on the company and on the trained handlers to check the impact of the actions carried out and to make any necessary adjustments. The sustainability of the training approach should be evaluated. This is an opportunity for the trainer to see what is working well and what needs improvement, and to modify his strategies for future training sessions. It is always possible to reinforce the training of operators who are not applying the know-how discussed; however, it is more constructive to try to understand why they are not applying it. In cases where in-house trainers have been trained, one could start by finding out what training they have given and how it was received.

6.2 Estimated duration and sequence of actions

We estimate that the entire process should take three to five days (Figure 6-3); anything short of that will not yield any real benefit. Except for Phase 3, which is a follow-up, the actions may be conducted on consecutive or non-consecutive days. Action 1 takes place in parallel, and the frequency of the follow-up committee meetings can vary. Realistically, the preliminary analyses (actions 2, 3 and 4) can be expected to take up the equivalent of one work day. Actions 5 and 6 account for most of the training time. The length of training time is influenced by the number of workers to train and whether it is necessary to train in-house trainers, for example. It should be remembered that the training time is especially dependent on the type of handling activity. Repetitious work with little variability may require only one day—ideally two half-days, one week apart—whereas more complex work will require two to three days. Even in the case of more complex work, only one or at most two tasks should be addressed, not all of them. In our opinion, the development of handler skills takes much longer, on the order of several weeks or even months.

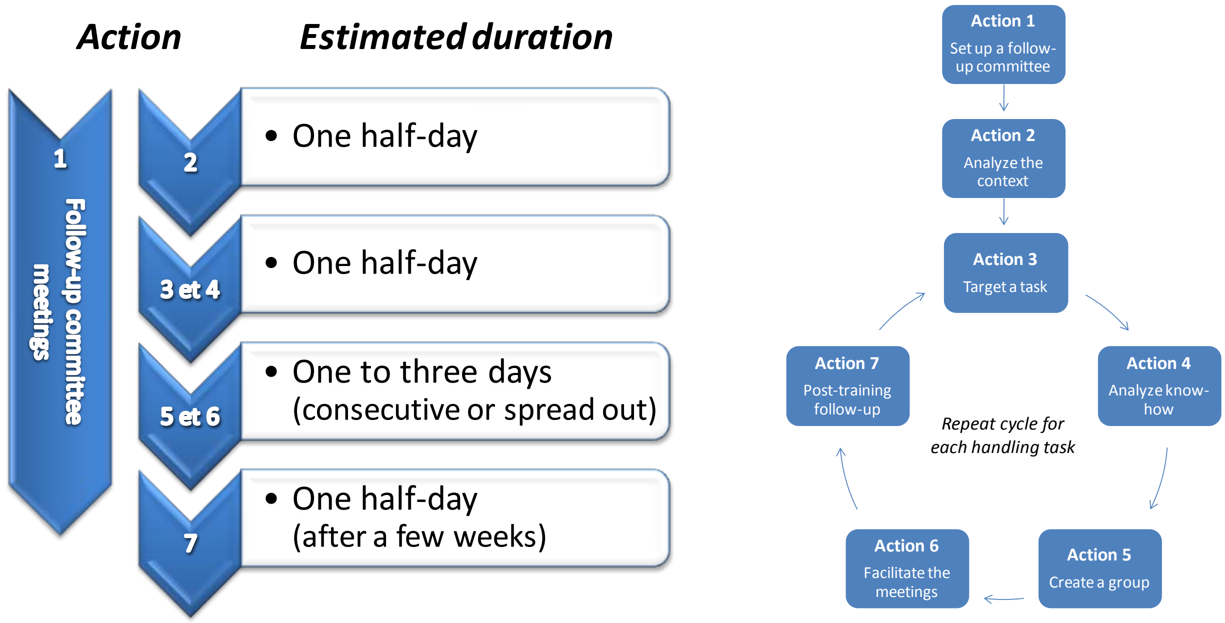


Figure 6-3 Estimated duration for each action and their sequence

It is therefore up to each trainer to evaluate and determine a training time compatible with the objectives sought. The data gathered in the preliminary analyses, especially the context analysis, can be used to justify the need for more training time. This estimate does not take into account the possibility of addressing other factors. Where only quick fixes are needed, the amount of time needed should be negligible. The same is not true of transformations, which require additional effort that should be planned for. Table 6-2 shows certain aspects of the process and the advantages to present to employers when negotiating training time.

Table 6-2 Training time: Arguments to present to employers

Aspect of the process	Potential advantages
Conduct ***preliminary analyses*** on the context and the various handling activities	Having data that describes handling activities and their implications will help when justifying training time. The time needed for these analyses will be compensated by the fact that the training will be better adapted to the workers' realities.
Start from situation-based ***local know-how*** and improve it through group exchanges	This will make the training more specific to the learners' real context and will ensure a higher level of buy-in and more lasting effects through workers' participation in the process. The training will be in line with the needs of organizations seeking to meet immediate requirements.
Break up training time and promote ***alternation between work and training***	Training can be dispensed over a longer period rather than in one block. Practical application of training content makes it possible to rapidly test the feasibility of the proposals and to make any necessary corrections. On-the-fly adjustments are possible.
Train ***in-house trainers***	Gives the employer the possibility of possessing in-house training skills instead of always being dependent on outside resources. Opens the way to more effective forms of coaching.
Train workers in ***specific tasks*** identified as relevant	Since on-the-job training can take more time overall, the strategy is to break down the activity and identify critical, problematic or representative tasks to which training efforts can be devoted. Transfer of knowledge is then possible.
Intervene in other aspects of the job: layout, equipment, etc.	Any task is part of a larger system that involves constraints but also offers resources—so-called external resources—for the operator. The operator's performance does not depend solely on him but is in part determined by this set of interacting factors. Acting on these factors will contribute to the application of skills.
Conduct a post-training ***follow-up***	Ensures long-term quality of the process by seeking long-lasting training actions, which are otherwise limited to a relatively short time. Allows for analysis of the effects beyond the training period and opens the way to making adjustments.

7. ISSUES AND PERSPECTIVES

This section is divided into three parts. First, we come back to the central question of manual handling rules. We then discuss the two main challenges posed by this training approach, i.e., the time to invest in it and the expected competency of the trainers. Last, we will discuss the limitations of this study.

7.1 The usefulness of rules in manual handling training

7.1.1 Handling rules: General but context-specific

The handling rules were developed on the basis of know-hows identified by research on the activities of various groups of handlers. The process involved taking various know-hows or techniques used in specific contexts—but with similar end results—removing them from their original context and associating them with a principle: in this way, we decontextualized know-hows to bring them from the specific to the general. A trainer who wishes to use the rules will have to do the opposite. Based on the rules, the trainer will be able to interpret know-hows used in a context very different from the one that led to the development of the principle: the trainer will take a general principle and recontextualize it in order to identify or evaluate specific know-hows. This is the primary advantage of rules: they can be generalized to various contexts that go beyond the context in which the research took place.

7.1.2 Handling rules: Between all and nothing

The rules are a grid for reading and interpreting handling know-how. They do not tell handlers what to do, but set out a goal or an objective to reach. It is up to each handler to choose how to implement the rules and even to determine which ones are important, according to his working conditions and physical profile. The more static the context (e.g., always the same load to handle at the same workstation), the better he will be able to determine a best practice that can be reproduced. But the more changing and dynamic the context (e.g., a garbage collector or a mover), the more important it will be to adapt and to choose the best method according to the context at any given moment. However, it is important to understand that having a choice does not mean being able to do things any which-way. This is why we are setting out rules to guide the handler's decisions. Unlike a prescription defining *a priori* how to do something, the rules provide a framework for the handler's actions while leaving him some leeway for deciding on the best way to do the job.

Let's use the example of balance. Balance is a critical factor in handling: as in any activity involving movement, load handling cannot be done without balance. Briefly, balance is based on the distribution of body weight (i.e., the position of the centre of gravity) over the base of support. If you want maximum stability, you must distribute your weight evenly between your feet and widen your stance while lowering your centre of gravity. This is the equilibrium referred to in traditional training (static equilibrium). Being more stable is desirable when on slippery surfaces, where there is little room for moving your feet, when you need to regain your footing after suddenly losing your balance or when the load is heavy and liable to throw you off balance.

However, it is not always best to have maximum balance in certain situations that can more easily be resolved through a certain degree of controlled imbalance (dynamic equilibrium) with a view to facilitating movement. In terms of dynamic equilibrium, body weight is rarely distributed evenly; more of the weight is often borne by one of the feet, called the "primary support." Obviously, if a large part of the weight is on one foot, balance is more precarious. However, less balance and stability also means more mobility, more ease of movement. In some situations, it can be advantageous to play with one's centre of gravity to facilitate movement, for example by transferring weight between the primary support and the support carrying less weight (i.e. by using one's own body weight). Unequal distribution of weight also enables one of the feet to be quite mobile, provided that the distance between the feet is not too large. The foot bearing less weight is easier to move: it can be turned, moved to adjust your stance, etc. Then you can exert counterweight with the free leg or position the back foot toward the delivery location to ensure continuity of movement between lift and deposit (the transition rule). In our view, this foot can also play a role in minimizing asymmetry by allowing freedom of hip movement. The advantages are many, but they can be evaluated according to the characteristics of the work situation and how much operating flexibility the handler wants. The principle states that balance and the ability to recover it are essential in handling, but the handler may choose how to proceed in light of his analysis of the context: Is my balance threatened? Do I have enough room to move my feet and regain balance in the event of a sudden upset? Would a transfer of weight facilitate the moving of this load? These questions will guide the handler in choosing actions that will ensure his balance and will be appropriate for the situation.

7.1.3 Handling rules: A junction point in research

Our study of the literature revealed that it is not obvious to identify any coherent or concerted effort in research on handling. A large portion of the results are from laboratory experiments in occupational biomechanics. Besides this dominant area—which also includes research in physiology and psychophysiology—there are a multitude of research studies of an applied nature (e.g., case studies, research, interventions and action) dealing with various topics related to handling. With few exceptions, such studies are conducted in parallel and do not "talk" to each other. As a result, it is difficult to establish links between them or to perceive how they might complement each other. For example, while field studies show the important role of the feet in handling, very few experimental studies have examined this aspect (Delisle et al., 1996) or, on the contrary, will intentionally limit the movement of the feet for technical considerations (such as the size of force platform). Examples of disparities and even contradictions abound. And yet, applied and experimental research teams have every interest in working together, because it would yield more complete results from their respective contributions (Plamondon and Denis, 2008). As in any interdisciplinary undertaking, the challenges are many. We believe that the handling rules can serve as a common ground between field and laboratory studies. It should be mentioned that most of the rules have not been validated through experimental studies to determine their effectiveness in reducing musculoskeletal stress. This question of validation will be addressed later on.

7.2 Challenges in implementing the training approach

7.2.1 Training of adequate duration: From what perspective?

Most of the OHS officers to whom this training approach was presented had positive comments about the orientations proposed. They saw this revamping as necessary, relevant and realistic with respect to the requirements of handling work as perceived in their practices. However, one central question kept coming up: How can I fit all this content into the time normally allotted to me for training? This was their first reaction, followed by wondering whether the length of current training sessions was realistic. At the same time, they wonder how to persuade management of the need to have training sessions lasting several days, instead of a few hours as is generally the case.

To our knowledge, only one study has examined the dynamics of learning a task on the job—in this case, in an automotive assembly plant (Vézina et al., 2003). Although this task required little or no load handling, we feel it would be useful to describe it, since it is general in scope and could be applied to other jobs.[17] The authors identified three main stages or levels (Figure 7-1). First, the workers must learn the various operations and familiarize themselves with the company's expectations in terms of production (quantity and quality) as well as their co-workers' expectations. They also learn about the means and conditions offered for completing the task. Emphasis is on "what needs to be done" and on recognized standard practice. According to the workers, this stage lasts only a few days. This is often the only time when they can get help from a resource person. Ironically, this first stage is the easiest in terms of learning.

At the second level, the workers strive to become comfortable with the job. They try to find their own methods for doing things and to discover workarounds: they learn how to "do it their way." Here the emphasis is on exploring what are the best techniques for them as individuals. Apparently this stage can take weeks. The quality of this learning stage will depend on work conditions: must the worker keep pace with the others? Does he have easy access to help when he needs it? Is he required to perform a variety of different tasks?

It is only at the third level that the worker will be able to deal with variability—unforeseen incidents and events. Although he is at ease with a certain way of doing things, he will adapt when faced with the unexpected. This is a kind of creativity: inventing ways of making things work. Workers mentioned that they are able to remain "in control" of a situation and complete their tasks despite the various difficulties encountered. Depending on conditions, it can take months or even years to reach this level. This last stage seems to be the one that corresponds most closely to the notion of competence, as described in our theoretical framework: it is at this stage that know-how develops and is refined. This study, along with most of the literature on motor learning (Famose, 1990; Schmidt and Lee, 2005), thus suggests that learning takes time and is progressive.

17. Similar results have been obtained with a population of seamstresses (Vézina et al., 1998). A recent thesis by Ouellet (2009) partially discusses these issues of manual task learning.

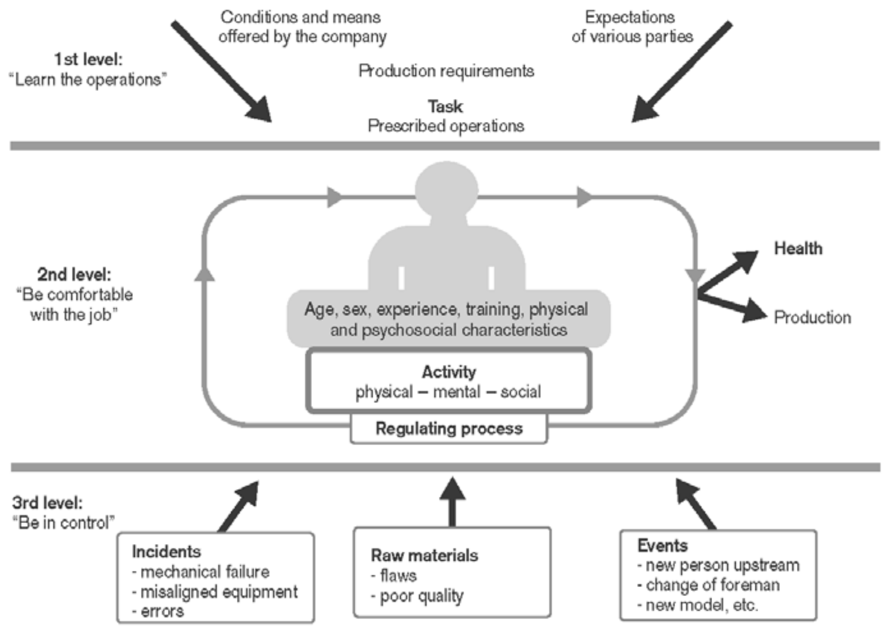


Figure 7-1 Levels of on-the-job learning: An ergonomic perspective (from Vézina et al., 2003: p. 79)

In the world of handling, training of insufficient duration has been identified by Hale and Mason (1986) as the main obstacle to the effective transfer of knowledge and skills. The authors made this observation following the evaluation of a five-day training, which largely exceeds the average duration of training for industrial operators. In the case of a training in patient handling, three days were not enough—according to the trainers and participants—to properly learn the techniques being taught (Dietz and Baumann, 2000).

Employers generate much demand for training programs in handling. They would like their employees to adopt proper working techniques that are safe for their backs and for their health in general. But they also do not want training sessions to interfere with expected production levels. This strong demand from employers can be explained in part by the fact that worker training—in its current form—is among the least expensive activities for a company if it is not part of a broader framework of prevention activities covering other aspects of working conditions (Baril-Gingras et al., 2006). Training then implies only an occasional investment of time, generally accompanied by training leave for employees and sometimes a shutdown of operations for a few hours.

Between what is suggested by the research on learning, the concerns of OHS officers and industry challenges (competition, cost-cutting, the need for more multi-skilled workers…), it appears difficult to prescribe a duration that would suit everyone. We believe that our proposed approach offers a compromise between the necessary learning time and the constraints of organizations and OHS officers. The efforts needed to implement this approach already constitute a minor revolution and a step forward, although we have learned with certainty that handling skills can take several years to perfect. It bears repeating that the challenge for a handler is not moving a load from point A to point B; seen from this angle, anyone can do the job in a few hours. No, the real challenge is to move thousands, even hundreds of thousands of loads, while meeting production standards and maintaining one's own bodily health. Until the need to set up handling training schools and to ensure post-hiring follow-up is recognized, implementing this approach in the workplace seems an acceptable compromise.

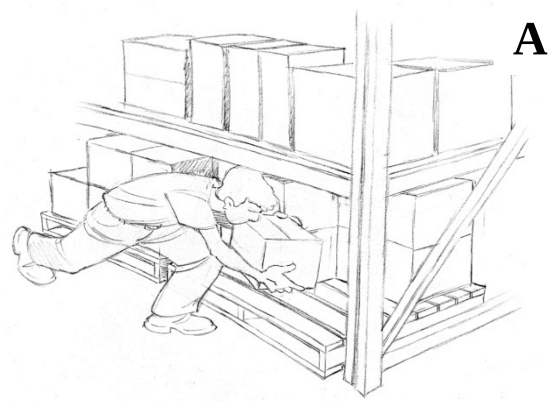
7.2.2 Developing trainer skills

The implementation—and in large part the success—of this approach is in the hands of the trainer. The proposed approach implies a change of perspective that requires a special new skillset. The position of expert trainer seems more comfortable than the coach role required by the approach presented in this report. The transmission of already-formatted content has a reassuring quality since the expert trainer is familiar with it and has learned it over time and repeated training sessions, even though there are always unforeseen factors and some aspects needing adaptation. Having to analyze and adapt the content to the context based on existing know-how and to respond on-the-spot to trainees' comments places the trainer less in a position of control with known material and more in the position of an actor where the script is being written as the play is being acted out… a kind of planned improvisation. The trainer must constantly adapt, react and develop a tolerance for uncertainty. Trainees' closeness to the job and to real conditions gives them more confidence for getting involved and expressing themselves than when in their usual role, which often places them in a position of inferiority in relation to the expert trainer and the content presented (e.g., back structures, risk factors). The idea that there is not just one way of doing things—going back to the notion of compromise—is an important challenge: to a large extent, it is the situation that determines the proper course of action. There are no absolute truths; only relative truths that may be validated in the context of an actual work situation.

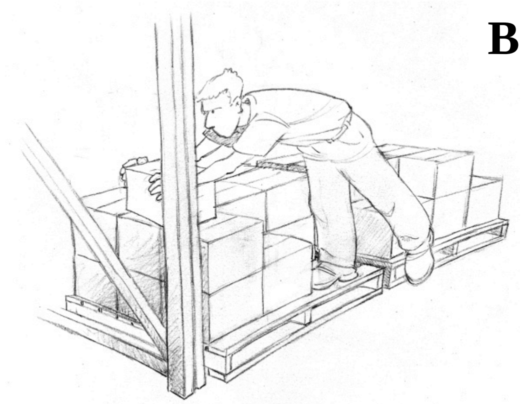
In addition, the emphasis in handling training so far has been placed on posture. The rule of **postural alignment** is focused specifically on questions of unsafe postures and their consequences. Without neglecting this aspect, seven other rules have been identified, all of which address legitimate concerns of handlers. And that's without considering work organization rules. This broader perspective on handling activities constitutes an additional challenge for trainers. On top of the conventional notions of posture and effort, there are now questions of balance, ability to react, duration of load holding, speed and fluidity of movement, the contribution of body weight, etc.

Even in cases where attention is paid to posture, sometimes people lose sight of the goal and judgments are made using a reference standard—the "right" posture or the "right" movement—without taking into account the work situation. Let's take the example of trunk bending: there are two ways of bending: from the hip and from the lower back (stooping). Bending from the lower back can place an additional load on the lumbar structures, especially the passive ones (ligaments). The stress on the back will be lessened if one lifts with the back bent at the hip, as shown in Figure 7-2: the back is bent, but mainly from the hip. Handlers should therefore avoid stooping from the lower back, especially during lifting, since that is when stress on the back is at its maximum (Plamondon et al., 2010a; 2010b).

Posture becomes a concern when great effort must be exerted, as is the case in the initial moments of lifting. The timing between posture and effort must be considered. The two sketches in Figure 7-2 show differences in timing between the posture and the type of effort deployed. In the first case (Figure 7-2**A**), bending is almost maximum when the handler begins lifting the load. Although the handler is bending mainly from the hip, the stress on the lower back is significant. Space restrictions here are a determining factor in the choice of method.



The handler lifts the load using a low forward bend



The handler bends forward in order to pull the load closer before lifting

Figure 7-2 Timing between posture and effort in evaluating the effects of forward bending

The same does not apply to the trunk bend seen in Figure 7-2**B**, which is nevertheless similar in amplitude. One of the reasons for bending is to reach a load and pull it closer. Often this bending will be accompanied by a backward extension of one leg in an effort to offset the weight of the forward torso: the leg counterbalances the effect, or moment, of the torso. This action corresponds to the body use rule and will allow the handler to reach a load and bring it closer before lifting. The back leg will even act as a counterweight and contribute to the effort to pull the load closer. It is also probable that this method will help maintain balance. In our opinion, this bending is very positive and remains within the acceptable safety margin. Moving a load takes less effort when it is still in contact with a surface than when its weight is totally supported by the handler. The advantage of bringing the load closer before lifting it more than makes up for the required trunk bend.

In other words, trunk bending cannot **always** be interpreted in the same way: one must first seek to understand why a posture has been adopted, before judging whether it is good or bad. Interpretation is based on the work situation and on the nature of the efforts deployed. Our proposed training approach, which combines the trainer’s expertise with the trainees’ knowledge of the work situation, is the best way of avoiding errors in interpretation. In the case shown in Figure 7-2**A**, a group could talk about the inadequate stocking arrangement and its impact on work methods. For the situation in Figure 7-2**B**, the worker’s strategy could be discussed. Is the trunk bend harmful or helpful in this situation? Beyond the back posture, note that the worker seems to be adopting a top-down unloading strategy since he is not taking the loads that are closest to him. Is he trying to work at the same height as the pallet truck where he intends to deposit the load? Is he trying to ensure continuity of movement between load pickup and deposit? Does the fact that he is tall have to do with his choice of method? Discussing these matters with the worker will lead to greater understanding of his work methods so that he can be advised about ways to improve them, if need be. This approach seems to be the most effective way of ensuring long-term benefits from training. It is not a matter of imposing an expert's view but of starting from the actual work situation and seeing how it can be improved.

7.3 Limitations of the study

There are four limitations to this study. The first limitation concerns the evaluation of learning after training. As rightly mentioned by Tardif (2006), the competency-based approach calls for adapted evaluation practices that pose new challenges. Competence does not depend on what the operator knows but on how he uses what he knows. A conventional evaluation of learning based on an evaluation of knowledge therefore cannot do justice to the competent operator. No doubt it would have been interesting and useful to examine this aspect in greater detail. But since a follow-up on workplace implementation is planned, the question of evaluation of competencies developed by handlers can receive more attention at that time. This will provide an opportunity to develop indicators that will provide information about the level of competency development.

Already, we have used the rules to observe various populations of handlers; new and seasoned employees were compared in the performance of the same task. We can state that the rules make it possible to distinguish the levels of experience in the handlers observed. The preliminary results indicate that experienced handlers adhere to the rules more often and show more adaptability in their work methods than do beginners. The beginners often stick to the same work methods and rarely change them. In light of these initial results, we may surmise that the rules can serve as indicators of the level of development of handling competencies (i.e. expertise) and can be useful for monitoring their rhythm and sequence of acquisition. In fact, a paper has been presented on this topic (Gonella et al., 2010).

On this same topic, let us emphasize that the rules have not been subjected to specific validation in the laboratory. Apart from the more conventional rules, such as postural alignment and load/body distance, which are widely documented, we are advancing hypotheses regarding the usefulness of the other rules in the prevention of handling accidents, but their efficacy in reducing the mechanical loads on structures—and thus in preventing injuries—has yet to be demonstrated. However, the validation of these rules is more complex than it may seem at first glance. We know that the handling conditions studied in the laboratory are very different from those in the field, and the impact that this artificial environment can have on study participants is little understood and difficult to evaluate. A more realistic solution would be to develop on-site measurement methods that would make it possible to validate the rules under real work conditions. Our research team has been working towards this goal for a number of years.

The second limitation deals with learning after the training period. Given that the learning period is long and that competencies are developed over the long term, it is necessary to ensure that the conditions conducive to such learning are present. After the brief three- to five-day training period, learning continues and will be facilitated by favourable organizational conditions (Darvogne and Noyé, 2000; Fernagu Oudet, 2006). Learning is not limited to the training period;

it also takes place before and after (De Corte, 1992). This report has made little or no mention of these important issues. Besides the follow-up stage that closes the intervention and the recommendation to extend meetings with handlers over several weeks, there has been little thought given to this aspect. Again, we intend to evaluate this training; such matters may therefore be brought up with more insistence at that time.

The third limitation is in connection with the collective aspect of the work activity, which has not been considered here. Due to the circulation of products, handling plays a key role in organizations. Many departments and players are therefore involved; handlers rarely act alone but collaborate to varying degrees with other parties. Typologies for collective work through types of interactions have been proposed (Pueyo and Gaudart, 2000; Barthe, 2003) and show the wealth and complexity of the possible forms of collaboration. This is an interesting question that merits special discussion, which would have been difficult to include in this already ambitious study. It is not due to a lack of awareness of the importance of this aspect that we have ignored it, but for practical and methodological considerations.

The fourth and last limitation is the degree to which the proposals advanced in this study can be implemented. We have presented an overview of the implementation approach without going into a level of detail that would enable a trainer to grasp all the subtleties and master it completely. A pedagogical material development stage to facilitate the use of the notions presented in this report is upcoming, along with training sessions for potential users.

8. CONCLUSION

The training approach proposed in this report constitutes a paradigm shift that is significant and not without impact. Although it may be tempting to simply rework the existing approach, it is also legitimate to question the notions that require a change in perspective, in particular the time investment and the idea that “one-size-fits-all” training is not a viable option. The additional time and effort needed to adapt training to the context each time brings up an interesting contradiction: it is the most interesting part of the approach we are proposing, and yet is liable to raise the most objections. Yet if people can be persuaded of the importance of taking time to adjust certain technical or organizational factors, why should we not work toward better recognition of the fact that training, too, requires long-term effort? We will soon have answers to these questions, because the next stage in our research program involves implementing the approach and evaluating its impacts.

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APPENDIX 1 – RESULTS OF VALIDATION OF HANDLING RULES

Postural Alignment

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Keep your back straight Use your knees, not your back Avoid combinations of back postures (twisting, bending, sideways bending) Protect your lower back above all Maintain the natural curvatures of the spine Stabilize your spine Use your feet to move around Keep the shoulders parallel to the ground Maintain symmetry	Pivoting of the feet Rotation of the body toward the load delivery location Asymmetries used frequently in terms of: - direction of effort of upper limbs - position of hands on the load - twisting Sagittal bending of over 45° in 2/3 of handling operations Twisting is rarely isolated: very often combined, very common [E/N] Experts: Often have the back bent and knees locked; reduction of vertical movement Bent back and locked knees frequently observed “Natural” handling: between a stoop and a squat Conventional handling (bent knees / straight back) rarely used, except for heavy loads

Effects / impacts of guidelines	Effects of observed or reported elements
Role of the feet	
Moving the feet reduces bending and twisting moments	[E/N] Pivoting by expert handlers: reduction of large turning movements
Feet pointed toward pickup location: less asymmetry during pickup Feet close to pickup location: less asymmetry during pickup	Foot mobility: lumbar load transferred to knees
Squatting is good for voluminous loads When it is impossible to spread the feet, stooping is good for reducing compression on the lower back	Pivoting: reduction of asymmetries in trunk posture and effort, reduction of twisting moments and muscular effort, safer trunk position, increase in extension moments
	Anticipation of deposit location (foot positioning): increases back symmetry in terms of posture and effort When the feet are not aligned with the load, there is increased asymmetry Step stance causes asymmetry
Back postures	
Non-neutral trunk posture increases the risk of back MSDs Twisting without load-holding does not increase risk	Intra-abdominal pressure is greater in straight position than in bent position [E/N] Expert handlers keep their backs straighter and do less bending in the lumbar area

Awkward trunk postures (twisting > 45°, pronounced bending or turning): increase in risk of MSDs	
Bending, twisting, compression: increase in lumbar instability and risk of back pain	
Gripping with both hands: greater compression on the spine Resultant L_4/L_5 moments are smaller in vertical position than in bent position	
Very bent trunk: increase in risk of back pain (increase in trunk moments and decrease in strength)	
Bending and large moments cause risk of loading on structures	
Twisting not implicated in disc degeneration	
Bent knees / straight back	
Bent knees / straight back: less compression, less tension in ligaments and reduced effort	[E/N] Expert handlers are seen to bend knees only slightly: reduced back effort, less asymmetry of effort and reduced energy expenditure
Straight back: reduces disc compression, reduces lumbosacral compression, reduces stress on L_5/S_1 Trunk bending: shearing force due to body weight	Knees slightly bent: reduces L_5/S_1 moment, increases bending moments on knees and causes greater instability Knees slightly bent: reduces asymmetrical effort on the back, reduces energy expenditure and asymmetry on the knees, and causes greater instability
Knees slightly bent: reduces back moments, reduces effort exerted by upper limbs	
Bent knees / straight back / load between feet / body close to load: reduces loading values	
Lifting with the legs, not the back: reduces pressure on L_5/S_1 Lifting with the back: higher peak compression	
Intra-abdominal pressure is less when the back is almost vertical Free-style handling (free back posture): less energy expenditure, less fatigue Muscles and ligaments: strong enough to support body weight in bent position	
Fatigue, energy expenditure, perceived effort	
Repeated full turns: fatigue and cartilage degeneration	[E/N] Expert handlers: less asymmetry in the trunk, less energy expenditure
Squatting is more demanding than stooping in terms of oxygen consumption and energy expenditure	Reported easier to lift a load with the back slightly bent
Squatting is perceived as more tiring Squatting: less risk due to fatigue, less risk of injury to active and passive tissues	

Bending and twisting: increased fatigue Asymmetrical handling (or handling of asymmetrical objects) perceived as more physically demanding; increases cardiac rhythm	
Symmetrical work	
Weight distributed over both hands: less asymmetrical effort Shoulders parallel to ground: less asymmetry in effort and posture	Reduction of asymmetries when depositing load: increased stability Varying the grip and the trunk angle: reduces asymmetry of effort

What do we know about the differences between expert and novice handlers [E/N]?

Novices use their back muscles less efficiently (higher level of oxygenation): they are not as well adapted as expert handlers and run a greater risk of injury.
Experienced handlers have lower peak moments and do not subject their L_4/L_5 to as much stress.
Experienced handlers show greater variability in moments.
Novices subject their spines to greater loading.

What are the main conclusions to be drawn from the studies?

The range of techniques observed or reported goes well beyond the range found in the guidelines.
In terms of the use of twisting or extreme postures, a significant divergence from the guidelines is reported.
The guidelines are mainly concerned with protecting the back; however, workers are observed to seek a balanced contribution from not only the knees but also the back when generating movements.
Contradicting statements about the effects of keeping the knees slightly bent.
There is more information about the guidelines than about the effects of the observed / reported elements.
Studies comparing expert or experienced handlers with novice handlers are often used to document the effects of the alignment rule.
Should alignment be a concern only at the time of peak effort?
Expert handlers are concerned about other factors besides protecting the spine.

Details on the literature consulted

The literature on this rule comes mainly from biomechanical studies (n=27) or studies combining biomechanics with another discipline or methodology (n=4). However, various documents were compiled, including secondary research studies and articles on *in vivo* or field studies.

Studies by our research group: 19/53

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Graveling, Melrose, Hanson	2003	Summary, consultation of experts	-	-
2	Leskinen, Stalhammar, Kuorinka	1983	Laboratory study, biomechanics	Subjects	20
3	Randall	2003	Training guide	-	-
4	Sedgwick, Gormley,	1989	Secondary research	-	-

	Smith				
5	Straker	2003	Secondary research	-	-
Effects / impacts of guidelines					
6	Adams et Hutton	1981	Laboratory study, dissection	Ligaments	-
7	Anderson, Chaffin	1986	Modeling	-	-
8	Bazrgari, Shirazi-Adl	2007	Laboratory study, in vivo	-	-
9	Burgess-Limerick	2006	Secondary research	-	-
10	Delisle, Gagnon, Desjardins	1995	Laboratory study, biomechanics	Novice subjects	14
11	Ekholm, Arborelius, Németh	1982	Laboratory study, biomechanics	Subjects	15
12	Farfan	1975	Secondary research	-	-
13	Gagnon	2005	Secondary research	-	-
14	Gagnon, Plamondon, Gravel, Lortie	1996	Laboratory study, biomechanics	Expert and novice handlers	11
15	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
16	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
17	Gallagher, Marras, Litsky, Burr, Landoll, Matkovic	2007	Laboratory study, in vivo	-	-
18	Garg, Banaag	1988	Laboratory study, biomechanics	Male subjects	8
19	Garg, Saxena	1979	Laboratory study, biomechanics	Male subjects	6
20	Goel, Voo, Weinstein, Okuma, Njus	1987	Laboratory study, in vivo	-	-
21	Hart, Stobbe, Jaraiedi	1987	Laboratory study, biomechanics	Workers	20
22	Hughes, Silverstein, Evanoff	1997	Field study, ergonomics, observations, questionnaires	Aluminum smelter workers	104
23	Kumar	1984	Laboratory study, biomechanics	Male and female subjects	12
24	Lorenz, Lavender, Andersson	2002	Training, laboratory study, biomechanics	Distribution centre handlers	955
25	Mairiaux, Malchaire	1988	Laboratory study, biomechanics	Male subjects	15
26	Marras, Davis	1998	Laboratory study, biomechanics	Subjects	10
27	Marras, Mirka	1989	Laboratory study, biomechanics	Subjects	44
28	Mital, Fard	1986	Laboratory study, biomechanics	Male subjects	18
29	Park et Chaffin	1974	Modeling	-	-
30	Plamondon, Delisle, Trimble, Desjardins, Rickwood	2006	Laboratory study, biomechanics	Experienced mining operators	11
31	Punnet, Fine, Keyserling, Herrin, Chaffin	1991	Field study, ergonomics, observations, interviews	Auto industry workers	95
32	Schultz, Andersson, Haderspeck, Ötergren, Nordin, Björk	1982	Laboratory study, biomechanics	Subjects	10
33	Shin, Mirka	2004	Laboratory study, biomechanics	Male and female subjects	11
34	Troup, Leskinen, Stalhammar, Kuorinka	1983	Laboratory study, biomechanics	Male subjects	10
Elements observed or reported					
35	Authier, Lortie, Gagnon	1996	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12

36	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12
37	Baril-Gingras, Lortie	1990	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
38	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
39	Delisle, Gagnon, Desjardins	1999	Laboratory study, biomechanics	Male subjects	8
40	Denis, St-Vincent, Gonella, Couturier, Trudeau	2007	Field study, ergonomics, observations	Garbage collectors with varying levels of expertise	13
41	Lortie, Baril-Gingras	1998	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
Impacts / effects of observed or reported elements					
42	Authier, Lortie	1993	Field study, ergonomics, interviews	Expert handlers	28
43	Delisle, Gagnon, Desjardins	1995	Laboratory study, biomechanics	Novice subjects	14
44	Delisle, Gagnon, Desjardins	1996	Laboratory study, biomechanics	Novice subjects	14
45	Gagnon	2003	Laboratory study, biomechanics	Novice handlers	10
46	Gagnon	2006	Secondary research	-	-
47	Gagnon	2005	Secondary research	-	-
48	Gagnon, Plamondon, Gravel, Lortie	1996	Laboratory study, biomechanics	Expert and novice handlers	11
49	Gagnon, Plamondon, Gravel	1993	Laboratory study, biomechanics	Novice subjects	9
50	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
51	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
52	Mairiaux, Malchaire	1988	Laboratory study, biomechanics	Male subjects	15
53	Marras, Joynt, King	1985	Laboratory study, biomechanics	Male and female subjects	20
54	Plamondon, Denis, Bellefeuille, Delisle, Gonella, Salazar, Gagnon, Larrivière, St-Vincent, Nastasia (upcoming)	2010	Laboratory study, ergonomics, biomechanics, observations	Male handlers, expert and novice	30
55	Yeung, Genaidy, Deddens, Leung	2003	Field study, questionnaires	Male workers	217
[E / N]					
56	Chany, Parakkat, Yang, Burr, Marras	2006	Laboratory study, biomechanics	Experienced and novice handlers	24
57	Granata, Marras, Davis	1999	Laboratory study, biomechanics	Experienced and novice handlers	12
58	Patterson, Congleton, Koppa, Huchingson	1987	Laboratory study, biomechanics	Experienced handlers and novice subjects	40
59	Yang, Chany, Parakkat, Burr, Marras	2007	Laboratory study, physiology	Experienced handlers and novice subjects	10

Load/Body Distance

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Stand near the load or position the load near you, with the load's centre of gravity near your spine Superimpose centres of gravity	Light boxes can be held farther away [E/N] Expert handlers minimize the distance between body and load for all weights; novices do so mainly for heavy loads Box in contact with the body for a short duration Movements far from body more common than movements bringing load closer to body [E/N] Distance between box and L_5/S_1 shorter for expert handlers than for novices Load tilting: brings centre of gravity closer Tilting, pre-lifting manoeuvres: different ways of bringing the centre of mass closer

Effects / impacts of guidelines	Effects of observed or reported elements
Distance between body and load	
Holding the load close reduces twisting and bending moments L_5/S_1 moment increases as a function of load/body distance	[E/N] Experienced handlers can carry loads farther using shoulder strength: higher peak moments on trunk and greater lumbar loading
Load close to hips: less effort Increased distance between load and body: increase (non linear) in peak moment	[E/N] Expert handlers: shorter distance between the load and the lumbosacral joint
Holding the load close reduces compression on the L_5/S_1 disc Shorter load/body distance: advantageous for the trunk (reduces back moments) Distance between load and body: an indicator of spinal loading	
Characteristics and work on the load	
	Factors having an impact on load/body distance: handling method, location and characteristics of the load Load tilting: reduces mechanical work on the load and total extension effort because the load is closer and higher
Work postures	
Work along the axis of the shoulders: the load's centre of mass is closer to the body	Trunk bending: shorter distance between the lumbosacral discs and the load

What are the main conclusions to be drawn from the studies?

The descriptions of the methods or know-how employed are richer than what is recommended in the programs: greater diversity is reported.
Expert handlers are better than novices at reducing leverage effect.
Fairly clear, few contradictions.
Should the reduction of load/body distance be considered solely or mainly at the moment of peak effort, as is postural alignment?

Details on the literature consulted

The literature deals mainly with laboratory studies conducted on populations of handlers with varying levels of expertise or on subjects with no handling experience.

Studies by our research group: 7/20

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Dotte	2003	Training program, secondary research	-	-
2	Graveling, Melrose, Hanson	2003	Secondary research, consultation experts	-	-
3	Randall	2003	Training guide	-	-
4	Sedgwick, Gormley, Smith	1989	Secondary research	-	-
5	Straker	2003	Secondary research	-	-
Effects / impacts of guidelines					
6	Albert, Wrigley, McLean	2008	Laboratory study, biomechanics	Male and female subjects	34
7	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
8	Ekholm, Arborelius, Németh	1982	Laboratory study, biomechanics	Subjects	15
9	Lorenz, Lavender, Andersson	2002	Training, laboratory study, biomechanics	Distribution centre handlers	955
10	Marras	2006	Secondary research, reference manual	-	-
11	Park, Chaffin	1974	Modeling	-	-
12	Schipplein, Reinsel, Andersson, Lavender	1995	Laboratory study, biomechanics	Male subjects	12
Elements observed or reported					
13	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12
14	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
15	Davis, Marras	2005	Laboratory study, biomechanics	Subjects	15
16	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
17	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
18	Lortie, Baril-Gingras	1998	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
19	Lortie	2002	Secondary research	-	-

Impacts / effects of observed or reported elements					
20	Authier, Lortie	1991	Secondary research	-	-
21	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
22	Granata, Marras, Davis	1999	Laboratory study, biomechanics	Experienced and novice handlers	12
23	Park, Chaffin	1974	Modeling	-	-

Weight-bearing

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Do not carry objects needlessly or more than necessary: instead, roll them, slide them, pivot them, etc.	Transferring loads is preferable to carrying them [E/N] Experts do little carrying of loads and tend to throw them from a distance, while novices carry the loads farther and throw them from less far The handler’s positioning is important for reducing the duration of the effort [E/N] Experienced handlers take less time than novices to complete a task Mostly, instead of being carried, the object is supported as it is slid, pivoted, turned, rolled or lowered [E/N] Experienced handlers will more often keep the load in contact with the ground if it is heavy A portion of the load is dropped: not accompanied to the end

Effects / impacts of guidelines	Effects of observed or reported elements
Role of the feet Taking steps is more time-consuming	Pivoting reduces the length and duration of the load carry (optimization), but also increases the overall duration of the operation
Duration of load-holding	Free-style handling: shorter, with greater accelerations and speeds Taking one’s time: goes against the objective of reducing the duration of effort [E/N] Experts: movement time is longer, but duration of complete load support is shorter than for novices Load tilting: reduces load-holding time & distance, reduces trunk moments and mechanical work on the load, earlier release
Throwing	Throwing: very dynamic task, a good alternative for high-frequency tasks

Other relevant information

When a high degree of precision is required for deposit, the load is entirely supported for a longer time, resulting in greater stress on the spine.

What are the main conclusions to be drawn from the studies?

This rule receives little attention in training programs.
A major concern for expert handlers.
Description of advantageous methods and techniques for reducing weight-bearing.
The only effects documented are those concerning the reduction of distance to travel; very little information about effects on structures.
Certain guidelines seem to go against this rule (proceed slowly, work in stages, etc.).

Details on the literature consulted

The literature surveyed is mainly from laboratory studies, although there were a few field studies.

Studies by our research group: 11/15

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Graveling, Melrose, Hanson	2003	Secondary research, consultation of experts	-	-
Effects / impacts of guidelines					
2	Lavender, Lorenz, Andersson	2002	Training	Distribution centre handlers	265
Elements observed or reported					
3	Authier, Lortie, Gagnon	1996	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12
4	Baril-Gingras, Lortie	1990	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
5	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
6	Denis, St-Vincent, Gonella, Couturier, Trudeau	2007	Field study, ergonomics, observations	Garbage collectors with varying levels of expertise	13
7	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
8	Lortie, Baril-Gingras	1998	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
9	Lortie	2002	Secondary research	-	-
10	Smith	1982	Laboratory study, biomechanics	Female subjects	11
Impacts / effects of elements observed or reported					
11	Delisle, Gagnon	1995	Laboratory study, biomechanics	Subjects	5
12	Delisle, Gagnon, Desjardins	1999	Laboratory study, biomechanics	Male subjects	8
13	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
14	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
15	Lortie	2002	Secondary research	-	-

16	Plamondon, Delisle, Trimble, Desjardins, Rickwood	2006	Laboratory study, biomechanics	Experienced mining operators	11
Other relevant information					
17	Beach, Coke, Callaghan	2006	Laboratory study, biomechanics	Male subjects	9

Load Use

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Place loads in boxes or containers	Bringing the load closer
Divide the load into smaller loads	Transfers are mainly in same height region, rare in areas with large height differentials
Use the handles Use the load response	[E /N] Experts: the more high-lying the load, the greater its acceleration
	Unlike the pickup height, there is some leeway in the height of the deposit Working at heights above the shoulder is rare [E /N] Novices tend to tilt heavy loads more Handles: both are rarely used [E /N] Experienced handlers make use of the load's momentum

Effects / impacts of guidelines	Effects of elements observed or reported
Hands, handles	
Handles and symmetrical grip: not good for all contexts	Use of handles leads to problems in controlling and handling the load
Handles reduce shear forces on the spine and reduce loading in general	
Horizontal handles require more force than vertical ones Handles at the edges of a load face are more awkward than handles in the middle Handle position has an impact on the force needed to maintain load balance Non-use of handles: increased stress on the spine	
Use of handles: shear forces and peaks are higher but briefer	
Load position	
	Box position and height have an influence on shear forces and forces exerted on the spine
	Boxes placed at back of shelf: increased compression on the spine Loads placed on a low shelf have the greatest impact on spinal loading Bringing the load closer: decrease in duration of effort

Pre-lifting manoeuvres

Tilting: reduces mechanical work and back effort, reduces the load-holding time and the distance to be covered by the load and the handler

What are the main conclusions to be drawn from the studies?

Description of various techniques for using the load to one's advantage.
The impacts of using handles are not clear.
Pickup and delivery positions make it possible to use to the load's energy potential.

Details on the literature consulted

The literature surveyed comes from field ergonomic studies and laboratory biomechanical studies. The studies were conducted on populations of handlers, often with a high level of experience.

Studies by our research group: 9/15.

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Ayoub	1982	Secondary research	-	-
2	Dotte	2003	Training program, secondary research	-	-
3	Graveling, Melrose, Hanson	2003	Secondary research, consultation of experts	-	-
Effects / impacts of guidelines					
4	Coury, Drury	1982	Laboratory study, biomechanics	Male and female subjects	30
5	Lortie	2002	Secondary research	-	-
6	Marras, Granata, Davis, Allread, Jorgensen	1999	Laboratory study, biomechanics	Experienced handlers	10
7	Mital, Kromodihardjo	1986	Laboratory study, biomechanics	Subjects	12
Elements observed or reported					
8	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observation	Expert handlers and novice subjects	12
9	Baril-Gingras, Lortie	1990	Field study, ergonomics, observation	Experienced and novice warehouse handlers	31
10	Baril-Gingras, Lortie	1995	Field study, ergonomics, observation	Experienced and novice warehouse handlers	31
11	Lortie, Baril-Gingras	1998	Field study, ergonomics, observation	Experienced and novice warehouse handlers	31
12	Lortie	2002	Secondary research	-	-
Impacts / effects of observed or reported elements					
13	Baril-Gingras, Lortie	1995	Field study, ergonomics, observation	Experienced and novice warehouse handlers	31
14	Couture, Lortie	1999	Field study, ergonomics, observation	Warehouse handlers	8
15	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
16	Gagnon	2005	Secondary research	-	-
17	Marras, Granata, Davis, Allread, Jorgensen	1999	Laboratory study, biomechanics	Experienced handlers	10

Balance

What does the literature tell us about this rule?

Guidelines	Elements observed or reported
Stand near the load (centre of gravity near the load), feet firmly planted and stable but flexible Move in a balanced and fluid way: move the feet to maintain balance and stability Use your feet to feel for a base of support?: establish a wide and stable base of support Use the load response Have a firm grip on the load	Balance: as important as protecting the back [E/N] Experts avoid bending or extending the knees (this helps maintain balance) [E/N] Experts tolerate some loss of balance when it is possible to recover [E/N] Experts take foot position and gait into account when evaluating balance [E/N] Experts: feet on the floor during pickup and deposit, load kept low, take small steps [E/N] Experts: bases of support are few but wide [E/N] Experts try to find flexible techniques for rapid adjustment when balanced is threatened

Effects / impacts of guidelines	Effects of elements observed or reported
Back and knees	
Using the back makes for better balance compared with using the legs Using the knees: greater stability Asymmetrical postures: trunk moments, creating instability in muscular effort	Reducing asymmetry at load deposit (often the most hazardous stage): greater stability [E/N] Experts do less mechanical work and expend less energy than novices because they do less bending and extending Little bending in the knees: instability (greater knee moments), less energy expenditure Load tilting combined with little bending in the knees: reduces distance to travel, reduces energy expenditure and back effort, but increases instability
Base of support and role of the feet	
Narrow base of support: balance less stable Keeping foot contact with the ground as long as possible helps prevent falls on slippery floors Pivoting with the load: reduces muscular effort and risk of losing balance	Working on one foot: possibility of imbalance but also provides a counterweight and possibly reduces the amount of forward bending Precarious balance: raises the centre of mass Choice of way of moving feet: combat load inertia and limit the risk of losing balance
Work on the load	
	Lowering the load’s centre of mass: increases stability during dynamic movements Varying grips and bends: increases stability

Other relevant information

Balance may be affected by fatigue, whether general or more localized in the muscles. Impacts on the spine and on system stability are reported.
Vertical handling poses more of a challenge to maintaining balance.
Insufficient or erroneous information about the load creates risks for balance.
Balance is more precarious during load deposit.

What are the main conclusions to be drawn from the studies?

Training programs recommend maintaining stability; however, imbalances arising from a certain dynamism are observed.
Balance is a primary rule for handlers, and it is central to several other rules (body use, rhythm, transfer, etc.).
Experts tolerate or even seek imbalance, as long as they are able to recover in the case of an incident.
Studies comparing expert or experienced handlers with novices are often used to document the effects of this rule.
There is a significant correlation between balance and fatigue / energy expenditure.

Details on the literature consulted

The literature dealing with balance is primarily made up of laboratory studies on biomechanics. Participants are either handlers – recognized as experts, experienced or novices – or subject not familiar with handling.

Studies by our research group: 14/24.

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Dotte	2003	Training program, secondary research	-	-
2	Graveling, Melrose, Hanson	2003	Secondary research, consultation of experts	-	-
3	Randall	2003	Training guide	-	-
4	Sedgwick, Gormley	1998	Secondary research, consultation of experts	-	-
5	Straker	2003	Secondary research	-	-
Effects / impacts of guidelines					
6	Commissaris, Toussaint	1997	Laboratory study, biomechanics	Male subjects	8/25
7	Gagnon	2006	Secondary research	-	-
8	Gagnon, Plamondon, Gravel	1993	Laboratory study, biomechanics	Novice subjects	9
9	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
Elements observed or reported					
10	Authier, Lortie, Gagnon	1996	Laboratory study, ergonomics, biomechanics, observation	Expert handlers and novice subjects	12
11	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observation	Expert handlers and novice subjects	12
12	Authier, Lortie	1997	Field study, ergonomics, interviews	Expert handlers	28
13	Delisle, Gagnon, Desjardins	1995	Laboratory study, biomechanics	Novice subjects	14

14	Delisle, Lortie, Authier	1997	Field study, ergonomics, interviews	Expert handlers	28/5
15	Gagnon	2006	Secondary research	-	-
16	Gagnon, Plamondon, Gravel, Lortie	1996	Laboratory study, biomechanics	Expert and novice handlers	11
17	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
18	Lortie	2002	Secondary research	-	-
Impacts / effects of reported or observed elements					
19	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observation	Expert handlers and novice subjects	12
20	Couture, Lortie	1999	Field study, ergonomics, observation	Warehouse handlers	8
21	Delisle, Gagnon, Desjardins	1998	Laboratory study, biomechanics	Male subjects	14
22	Delisle, Gagnon, Desjardins	1999	Laboratory study, biomechanics	Male subjects	8
23	Delisle, Gagnon, Desjardins	1996	Laboratory study, biomechanics	Novice subjects	14
24	Gagnon	2006	Secondary research	-	-
25	Gagnon, Plamondon, Gravel, Lortie	1996	Laboratory study, biomechanics	Expert and novice handlers	11
26	Gagnon, Plamondon, Gravel	1993	Laboratory study, biomechanics	Novice subjects	9
27	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
Other relevant information					
28	Commissaris, Toussaint	1997	Laboratory study, biomechanics	Male subjects	8/25
29	Delisle, Gagnon, Desjardins	1998	Laboratory study, biomechanics	Male subjects	14
30	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
31	Granata, Slota, Wilson	2004	Laboratory study, biomechanics	Subjects	21
32	Pan, Chiou, Hendricks	2002	Laboratory study, biomechanics	Construction workers	60
33	Sparto, Parnianpour, Reinsel, Simon	1997	Laboratory study, biomechanics	Male subjects	16
34	Van Der Bur, Van Dieën, Toussaint	2000	Laboratory study, biomechanics	Subjects	9

Body Use

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Emphasize lower limbs: work with your legs and knees Bend your knees	Pronounced bending is rare, avoided Weight is mostly on one foot: useful for initiating movement by taking advantage of body weight and load momentum Lower limbs rarely used [E/N] Experts keep their legs straighter and move their knees less than novices Knee-bending is reduced through load tilting and keeping the centre of gravity close during placement [E/N] Experts: less knee-bending, load/body centre of gravity ahead of knees, back bent, on one foot High boxes: weight transferred to back foot: use of body weight [E/N] Novices: use of thighs, hips and lower back to control movement [E/N] Experts use their free back leg as a counterweight

Effects / impacts of guidelines	Effects of elements observed or reported
Working with the legs Working with the legs: more power generated, increase in energy potential, less compression on the back Knees bent at beginning of movement: less muscular effort required ***Back posture*** Stooping reduces energy expenditure Squatting requires less oxygen than stooping	[E/N] Experts minimize knee-bending: reduces mechanical work, asymmetry of effort and back effort; increases knee effort (flexors) Bent knees: not certain whether this reduces back loading

What are the main conclusions to be drawn from the studies?

There is little information about the effects.
The concept of body use is expanded: from working with the legs, to bending the knees, to using body weight, counterweights or weight transfers.

Details on the literature consulted

The literature consists mainly of laboratory studies using biomechanical or ergonomic methodologies. There are also a few field studies.

Studies by our research group: 10/18.

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Dotte	2003	Training program, secondary research	-	-
2	Graveling, Melrose, Hanson	2003	Secondary research, consultation of experts	-	-
Effects / impacts of guidelines					
3	Burgess-Limerick	2006	Secondary research	-	-
4	Chen	2000	Laboratory study, biomechanics	Male subjects	22
5	Hagen, Harms-Ringdahl, Hallen	1994	Laboratory study, physiology	Forestry workers	10
6	Leskinen, Stalhammar, Kuorinka	1983	Laboratory study, biomechanics	Subjects	20
7	Troup, Leskinen, Stalhammar, Kuorinka	1983	Laboratory study, biomechanics	Male subjects	10
Elements observed or reported					
8	Authier, Lortie, Gagnon	1996	Laboratory study, ergonomics, biomechanics, observation	Expert handlers and novice subjects	12
9	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observation	Expert handlers and novice subjects	12
10	Baril-Gingras, Lortie	1990	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
11	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
12	Gagnon, Plamondon, Gravel, Lortie	1996	Laboratory study, biomechanics	Expert and novice handlers	11
13	Gagnon, Delisle, Desjardins	2002	Laboratory study, biomechanics	Novice handlers	10
14	Lortie, Baril-Gingras	1998	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
15	Patterson, Congleton, Koppa, Huchingson	1987	Laboratory study, biomechanics	Experienced handlers and novice subjects	40
Impacts / effects of observed or reported elements					
16	Delisle, Gagnon, Desjardins	1995	Laboratory study, biomechanics	Novice subjects	14
17	Gagnon	2005	Secondary research	-	-
18	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21

Transition from Pickup to Deposit

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Move fluidly; make sure your feet are pointed in the right direction and are mobile Lift the load and then turn Face the delivery location Distribute the weight between both feet Anticipate / visualize: path of travel, space, environment and delivery location Hold the load with both hands and a full grip, using handles if possible Use a firm and symmetrical grip; do not change your grip while moving	[E/N] Experts: body turned toward plant foot, weight rarely on both feet, counterweight / weight transfer sequence to ensure continuity; small steps [E/N] Experts: feet and hips turned toward delivery location, variation in number of feet in contact with the ground and in type of grip depending on pickup height [E/N] Experts break the task down into several stages: pre-pickup, transfer, delivery / post-delivery (pre-lifting and post-delivery manoeuvres) Step stance during pickup Work on one foot, then transfer to the other foot; ensure smooth movement [E/N] Expert grip: usually asymmetrical and diagonal, varied (but unchanging throughout a given movement) [E/N] Experts' grips are different from those of novices [E/N] Experts: diagonal / asymmetrical grip improves load control and stability, stability being a critical factor Hand position on load: rarely flat, asymmetric No type of grip is universally adopted: grip is influenced by context, and handlers must show flexibility in adapting to changing contexts Variations in the type of grip are very common, especially when transferring downward Boxes are in constant movement and follow a multitude of paths Movements take place in various planes, not just the sagittal plane Handlers seek continuity in the overall movement: they do not see it as a series of stages but as a whole

Effects / impacts of guidelines	Effects of elements observed or reported
Role of the feet Taking more steps: advantageous from a biomechanical viewpoint, but increases the duration One foot closer to delivery location: reduces moments	Feet and load oriented toward delivery location: reduces mechanical work and back effort [E/N] Experts point their feet toward delivery location: reduces distance to be traveled by load The way of moving the feet affects posture asymmetry Having one foot closer to the delivery location helps reduce effort and promotes fluidity and smoothness of movement

Hands and grips	
One-hand grip can have advantages if the hand is on the same side as the asymmetrical load	Use of one or two hands to push and pull: no significant effect on maximum compressions Load testing is done with one hand and then transferred to the other hand Fine motor tasks can be done just as well with either hand An asymmetric grip does not necessarily mean asymmetric effort
Phases and continuity	Continuous movement: use of the load's momentum while walking; reduces effort needed

What do we know about the differences between experts/experienced handlers and novices [E/N]?

Handlers are concerned with energy expenditure: they would rather work in a more difficult position than take more steps.

What are the main conclusions that can be drawn from the studies?

Discrepancies between guidelines and observations:
- Using stable, symmetrical grips is recommended, while greater diversity and asymmetry are observed
- Working in phases or blocks is recommended, while a preference for rhythmic and continuous movement is observed

The effects of the elements observed are well documented.
Transitions are associated with fatigue and energy expenditure.
Expert handlers differ widely from what is recommended: they seek to maintain rhythmic, continuous movement.
Studies comparing expert or experienced handlers with novices are often used to document the effects of this rule.

Details on the literature consulted

Studies related to the transition rule have been conducted mainly in laboratories, but there are also secondary research studies as well as information gleaned from training programs or field studies. The data gathered are related to both handlers and subjects not familiar with handling.

Studies by our research group: 13/23

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Dotte	2003	Training program, secondary research	-	-
2	Graveling, Melrose, Hanson	2003	Secondary research, consultation experts	-	-
3	Randall	2003	Training guide	-	-
4	Sedgwick, Gormley, Smith	1989	Secondary research	-	-

Effects / impacts of guidelines					
5	Ekholm, Arborelius, Németh	1982	Laboratory study, biomechanics	Subjects	15
6	Gagnon, Smyth	1992	Laboratory study, biomechanics	Experienced handlers	5
7	Lavender, Lorenz, Andersson	2002	Training	Distribution centre handlers	265
8	Marras, Davis	1998	Laboratory study, biomechanics	Subjects	10
Elements observed or reported					
9	Authier, Lortie, Gagnon	1996	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12
10	Authier, Gagnon, Lortie	1995	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12
11	Authier, Lortie, Gagnon	1994	Laboratory study, ergonomics, interviews	Expert handlers	28
12	Baril-Gingras, Lortie	1990	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
13	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
14	Denis, St-Vincent, Gonella, Couturier, Trudeau	2007	Field study, ergonomics, observations	Garbage collectors with varying levels of expertise	13
15	Lortie	2002	Secondary research	-	-
16	Lortie, Baril-Gingras	1998	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
Impacts / effects of observed or reported elements					
17	Authier, Lortie, Gagnon	1996	Laboratory study, ergonomics, biomechanics, observations	Expert handlers and novice subjects	12
18	Baril-Gingras, Lortie	1995	Field study, ergonomics, observations	Experienced and novice warehouse handlers	31
19	Delisle, Gagnon, Desjardins	1999	Laboratory study, biomechanics	Male subjects	8
20	Gagnon	2003	Laboratory study, biomechanics	Novice handlers	10
21	Gagnon	2005	Secondary research	-	-
22	Gagnon, Delisle	1997	Laboratory study, biomechanics	Novice subjects	21
23	Gordon, Forssberg, Iwasaki	1994	Laboratory study, neurophysiology	Subjects – men, children, patients	61
24	Hoozemans, Kuiler, Kingma, Van Dieën, De Vries, Van Der Woude, Veeger, Van Der Beek, Frings-Dresen	2004	Laboratory study, biomechanics	Handlers	7
25	Lortie	2002	Secondary research	-	-
Other relevant information					
26	Drury, Deeb, Hartman, Wooley, Drury, Gallagher	1989	Laboratory study, physiology	Male and female industrial workers	30

Rhythm

What does the literature tell us about this rule?

Guidelines	Other elements observed or reported
Keep movement slow, smooth and fluid	Marked accelerations with heavy loads
Do not throw or accelerate the load	An initial acceleration is advantageous for placing the load high up
Do not rush	
Adopt a moderate and fluid pace	Throwing is the delivery method most used for bags
Acceleration is both an advantage and a difficulty	
An adequate rhythm is a determining factor	There are various kinds of throwing: wide variety
	Development of strategies for achieving a steady rhythm: handlers try to maintain a steady rhythm
	Rapidity is preferred when conditions allow
	[E/N] Fluidity is achieved more often, and to a greater degree, by experienced handlers compared with novices
	Peak acceleration occurs at the beginning of the movement

Effects / impacts of guidelines	Effects of observed or reported elements
Back stress	
Factors that increase risk of injury (effects on internal forces): peak acceleration, number of accelerations, muscle length/force ratio during peak acceleration, trunk moments and load moments on L_5/S_1 during acceleration	[E/N] Experienced handlers generate greater trunk acceleration compared to novices
	During acceleration: increase in speed and acceleration of the box, reduction in amplitude of angular displacement, no impact on L_5/S_1 moments during lifting
Acceleration: increase in lumbar stress	High speed: reduction of lumbar loading and muscle activity
High acceleration: angular peak in the sagittal plane	
Speed influences lumbar stress and maximum force; the task and the type of contraction are factors that determine speed	
Task done slowly: speed and acceleration are lower in value but last longer, thus resulting in increased lumbar loading and eventually more serious effects on the muscles	
Requiring a slower work pace: will possibly reduce compression but will require the development of new training techniques	
Slow movement does not involve a constant angular speed around the lumbar spine	
Low speed: reduction of capacity for eccentric force, increased risk of overloading, especially at the beginning and end of the movement	
Compression / decompression of spine due to acceleration: progressive deterioration of intervertebral discs and other back tissue, cumulative risk over a prolonged period	

Energy expenditure	
	Acceleration: effort shorter in duration, less work required, possible energy savings
	During acceleration: reduction in distance traveled by box's centre of gravity and in the length of time during which it is held up Throwing: possible energy savings (fatigue), reduction in travel, less risk
	Fast handling: less bodily work and effort, but requires a high degree of coordination
Load characteristics	
	Load weight: important factor in fluidity of movement
	Acceleration: reduces friction of load on surfaces
Path / phases of movement	
Smooth path: less risk for balance, less stress on joints	Acceleration should be avoided during placement as it generates maximum moments on L_5/S_1 close to this phase

Other relevant information

An increase in speed leads to a higher trunk peak acceleration, while a reduction in speed leads to a greater number of peaks: it is difficult to propose an optimum speed.

What are the main conclusions that can be drawn from the studies?

Discrepancy between recommended slowness of movement and the observed/reported tendency toward speed and acceleration.
There is information about the direct effects on structures and more long-term effects in terms of fatigue and energy expenditure.
When properly executed, acceleration and speed can reduce risk, energy expenditure and fatigue.
There is no one rhythm that suits everyone: context plays an important role.

Details on the literature consulted

The literature consulted deals mainly with load acceleration and speed. It consists largely of biomechanical studies conducted in laboratories, along with a few field ergonomic studies.

Studies by our research group: 6/15

#	Authors	Year	Type of study	Population / Context	n
Guidelines					
1	Denis, St-Vincent, Gonella, Couturier, Trudeau	2007	Field study, ergonomics, observations	Garbage collectors with varying levels of expertise	13

2	Dotte	2003	Training program, secondary research	-	-
3	Graveling, Melrose, Hanson	2003	Secondary research, consultation experts	-	-
4	Lin, Bernard, Ayoub	1999	Laboratory study, biomechanics	Male subjects	5
5	Straker	2003	Secondary research	-	-
Effects / impacts of guidelines					
6	Authier and Lortie	1991	Secondary research	-	-
7	Gagnon, Chehade, Kemp, Lortie	1987	Laboratory study, biomechanics	Nurses	15
8	Marras, Mirka	1989	Laboratory study, biomechanics	Subjects	44
9	Mirka et Marras	1990	Laboratory study, biomechanics	Subjects	16
10	Scholz, McMillan	1995	Laboratory study, biomechanics	Subjects	12
Elements observed or reported					
11	Authier and Lortie	1991	Secondary research	-	-
12	Couture	2000	Field study, ergonomics, observations	Warehouse handlers	8
13	Denis, St-Vincent, Gonella, Couturier, Trudeau	2007	Field study, ergonomics, observations	Garbage collectors with varying levels of expertise	13
14	Gagnon, Chehade, Kemp, Lortie	1987	Laboratory study, biomechanics	Nurses	15
15	Gagnon, Smyth	1992	Laboratory study, biomechanics	Experienced handlers	5
16	Splitoesser, Yang, Knapik, Trippany, Hoyle, Lahoti, Korkmaz, Sommerich, Lavender, Marras	2007	Laboratory study, biomechanics	Male subjects	12
Impacts / effects of observed or reported elements					
17	Authier and Lortie	1991	Secondary research	-	-
18	Delisle, Gagnon, Desjardins	1996	Laboratory study, biomechanics	Subjects	8
19	Denis, St-Vincent, Gonella, Couturier, Trudeau	2007	Field study, ergonomics, observations	Garbage collectors with varying levels of expertise	13
20	Gagnon, Chehade, Kemp, Lortie	1987	Laboratory study, biomechanics	Nurses	15
21	Granata, Marras, Davis	1999	Laboratory study, biomechanics	Experienced and novice handlers	12
22	Lin, Bernard, Ayoub	1999	Laboratory study, biomechanics	Male subjects	5
Other relevant information					
23	Authier and Lortie	1991	Secondary research	-	-
24	Mirka and Marras	1990	Laboratory study, biomechanics	Subjects	16

APPENDIX 2 – ANALYSIS GRID FOR MANUAL HANDLING CONTEXTS

BACKGROUND

As mentioned in the report, this grid was developed to accompany the implementation of the new handling training program. It was designed to broaden prevention activities to include the entire work situation. Concretely, it has three objectives: to help better characterize the handling situations for which training is desired, to help adapt the training to handling situations, and to open up avenues for improvement of handling situations.

The grid as such does not allow analysis of the handling activity, which is a highly complex process, but it can be used to gather information useful for prevention. It its current form, it is designed for practitioners and trainers who have competencies in handling and ergonomics. The grid is easy to fill out and can be completed in half a day. The document first explains what information is to be obtained; then it presents detachable datasheets which the user must fill out. These datasheets summarize, in the form of short questions, the information to be obtained.

This document is in the development phase, but it can already be used by practitioners having the competencies mentioned above. The grid has been validated by 14 practitioners, who used it in their daily activities. According to them, even if it does not offer any completely new elements, it is still useful. It provides a way to organize the information and place it in a hierarchy. In addition, it is a useful tool for communicating with people in the company. Improvements were also suggested and have already been taken into account; for example, clarifying some of the definitions. It its current form, the grid is not completely adapted to people in the company.

An activity is planned to improve the grid, especially by improving the form and ensuring better correspondence between training and handling situations. A version will also be produced for people in the company. The grid is found at the end of this report. We invite you to use it and send us your comments.

APPENDIX 3 – OBSERVATION GRID FOR MANUAL HANDLING TECHNIQUES

Checklist: Observation grid for evaluating manual handling techniques — **Denys Denis © 2010**

#	Predominant technique used			Inappropriate?	Quality of performance			Possible to do more	
	Continuous	Hybrid	In stages		Good	Acceptable	Poor	No	Yes
1 2 3 4 n	After watching a handler a few times, one can make out patterns that may be preferences. Or the handler may use a wide range of techniques with no patterns, which could mean an ability to adapt to context.			Indication of judgment in choice of technique according to context	After watching a handler a few times, one may be able to identify certain difficulties. These can be related to the handler but also to conditions that make the work more difficult. It is important to identify the real cause.			Decisions to use certain methods can vary widely. This is not easy to observe; it must be validated and discussed with the handler.	
	Transition				*Load/body distance, thythm, alignment, balance*			*Weight bearing, load use, body use*	

Using this grid, you are asked to judge four variables: (1) the predominant handling technique used, (2) its appropriateness for the handling situation, (3) the quality of performance, and (4) whether other options were available to the handler. You should observe the handler's actions in light of 8 handling rules, which are listed below the table.

(1) Predominant technique used: Identify the handler's preferred method. This is an initial overall picture of how the handler goes about moving a load. It is focused on the positioning and movement of the feet and is thus an incomplete picture (since handling involves much more than moving the feet). You must therefore refer to the transition rule, in which the role of the feet is explained. Please choose one of the following techniques:

TECHNIQUE

Continuous : The handler seeks the most direct path from pickup to delivery. Feet are open toward the delivery location. The idea is to move as continuously as possible between pickup and delivery so as to keep the load-holding time to a minimum. There is a great deal of overlap between the individual stages (pickup – transfer – deposit).

Hybrid : The feet are open toward the delivery location, but not completely; or the feet are pointed toward the pickup location, but the back foot will pivot so that the body can be quickly turned to face the delivery location. Work in stages can also be observed, but only at pickup or deposit. In other words, the handler is not in purely continuous mode but neither is he working in clearly identifiable stages.

In stages : Throughout the operation, the feet are pointed toward the load. The 3 typical stages in a handling operation can be observed: pickup (including lifting), transfer or carry, and deposit. This is usually described as "safe" technique.

(2) Inappropriate? Here you will pass judgment on whether the technique used is fitting for the context. Check this box only if the technique does not seem appropriate. The "in stages" technique is better for situations where risks are present, such as loads that are heavy, voluminous or difficult to pick up, or a floor that is sloping or slippery, or where there is limited room for the feet. In the absence of such risks, the handler is justified in using the other techniques. The "continuous" technique is suitable when there is a high volume of loads to move (high tonnage) and/or the handler himself does not have to move much.

(3) Quality of performance: Using a specific technique does not guarantee that the job will be done well. In addition, as we have mentioned, a technique is not limited to the role of the feet. Therefore you must judge the quality of the handler's use of the selected technique by broadening the parameters: the following 4 questions cover 6 of the handling rules:

a.	Does the handler seem to be working at arm's length? Does the load seem far from his body, especially at pickup and deposit? Refer to the **load/body distance** rule.
b.	Do the movements flow? This is often the first thing that strikes an observer. Do the movements seem to lack rhythm? Are they jerky, rushed or hesitant? Are there inexplicable changes in speed? Is the handler working against the load? Refer to the **rhythm** rule.
c.	Does the handler work in extreme or awkward positions? Notice especially the lower back: does he often adopt potentially harmful postures (stooping, twisting); does he bend over too far? Does he seem to be overexerting his spine? Refer to the **alignment** rule.
d.	Does the handler seem to be in control and ready to react? Does he seem balanced, in control of the load and ready to react to a sudden contingency? Or does he seem to be pulled along by the load rather than controlling it; does he seem at the limit of his capacities, or heavy-footed? If something happened, would he be able to react? Refer to the **balance** rule. There are three possible answers:
QUALITY	Good : Nothing to note; or, one of the above aspects could be improved, but nothing major.
	Acceptable : Performance of the task is problematic in one or two respects; for example, lack of fluidity, or load too far from body, or too much stooping.
	Poor : Performance is problematic in two or three respects; there are obvious shortcomings in the handler's work methods.

(4) Possible to do more? There are many ways of handling a load. Here you should state whether the handler, in this situation, could have used other techniques or methods that would have been more efficient. Do not focus on what he actually did, since this was covered in the three previous points, but rather on whether he could have done more. Your judgment should be based on one or more of the following considerations:

a.	Did the handler try to avoid load-holding, i.e., did he try to have the load supported in his hands as little as possible? Could he have used other deposit methods, or moved the load while keeping it supported on a surface? Refer to the **weight-bearing** rule.
b.	Did he try to make the load work for him? For example, could he have made use of its position in space or of some of its properties? Refer to the **load use** rule.
c.	Did he try to use his body weight? Perhaps he could have made better use of it, or used it in another way. Refer to the **body use** rule. There are two possible answers:
PLUS	No (or not much): Nothing to add; or, a handling rule could have been applied better, but the change would not have been significant.
	Yes : It is clear that one or more rules could have been applied better.