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Manufacturers, Screeners, Users, and Scientists: Producing and Circulating Information and Knowledge about Equipment

Monique Lortie[1], Angel Alberto Toyos Alvarez[1], Steve Vezeau[1], Maud Gonella[2]
(1. Université du Québec à Montréal, Montréal, Qc, Canada;
2. Institut de Recherche en Santé et Sécurité du Travail, Montréal, Qc, Canada)

Abstract: This paper addresses two equipment-related issues: on the one hand, the choice of appropriate equipment, and on the other hand, the development of equipment that meets end-user needs. These issues were explored in two rather distinct cases and contexts: expensive equipment (forklifts) in medium-sized businesses, and inexpensive equipment (kneepads) in micro-businesses. The study investigates these issues through catalogues and brochures, seen here as relay tools between manufacturers and users. They provide good insight into what is understood about user needs and what is incorporated from the scientific literature. Two types of users were considered: equipment screener and equipment user. The study sheds light on the gap between the information provided by manufacturers and what screeners look for, and the gap between what is described in the catalogues and what end-users look for. It also shows the gap between the screener (as relay agent) and the end-user. The crucial role that relay tools and relay agents may play in the capture, organisation, and circulation of information is discussed.

Keywords: Forklift truck; kneepads; purchasing; catalogues; tacit knowledge; relay tool; relay agent
JEL codes: Z

1. Introduction

The development and selection of appropriate work equipment is an important issue in occupational health and safety (OHS). Proper equipment can improve efficacy and efficiency while providing health and safety protection. To this end, the proposed equipment must meet users' needs, and purchasers must make suitable choices.

On the one hand, manufacturers who want to remain competitive need to produce innovative equipment that meets or even surpasses users' needs. This implies putting in place a process that incorporates user-derived information and scientific knowledge, in particular, norms and recommendations. On the other hand, to make the

Monique Lortie, Professor, Université du Québec à Montréal; research areas/interests: ergonomics and knowledge management. E-mail: Lortie.monique@uqam.ca.
Angel Alberto Toyos Alvarez, Ph.D., Corporate Ergonomist, Université du Québec à Montréal; research areas: knowledge transfer, human machine interaction and design. E-mail: angel.alberto.toyos.alvarez@pwc.ca.
Steve Vezeau, Ph.D., Professor, Université du Québec à Montréal; research areas/interests: ergonomics, industrial design. E-mail: Vezeau.steve@uqam.ca.
Maud Gonella, M.Sc., Professional Scientific, Institut de recherche en santé et sécurité du travail; research areas/interests: ergonomics. E-mail:Gonella.maud@irsst.qc.ca.

best selection, managers must understand employees' needs (sometimes involving groups of people with different needs, for example, operators and maintenance staff) and translate these needs into technical characteristics. This requires a minimal understanding of work activities, which represents the core of research in ergonomics.

Indeed, the network of exchange may be quite complex. As shown in Figure 1, the flow of information between manufacturers and users is mostly indirect; it usually transits through diverse relays or agents, including representatives, distributors, and screeners, who by virtue of their position, develop knowledge about needs, contexts, and conditions. These agents are not professionals in knowledge transfer or management (i.e., knowledge brokers or officers), but because of their role and status, they facilitate the capture and circulation of information and knowledge (Lortie et al., 2012). They may relay information and knowledge between organisations, between manufacturers and customers, and within organizations.

Supplier, purchaser, and manufacturer representatives may be seen as typical relay agents between two organizations, and supervisors may be seen as relay agents within organisations. In this relay chain, the screener (*selectionneur* in French) can play a crucial role. In fact, it is usually not an official function, but rather, a role that may be filled temporarily by someone familiar with the equipment to be purchased. This person screens what is available on the market and suggests the most appropriate choices to the decision-maker.Screeners must interface between at least three groups: tool or equipment manufacturers (or their representatives), end users, and employees (e.g., maintenance staff) and management. To perform this role adequately, screeners need to understand and translate the characteristics offered in terms of "needs" and vice versa. In small businesses, of course, the user is generally the screener as well as the decision-maker. At the heart of the final decision is therefore the ability to connect needs, context, and technical characteristics.

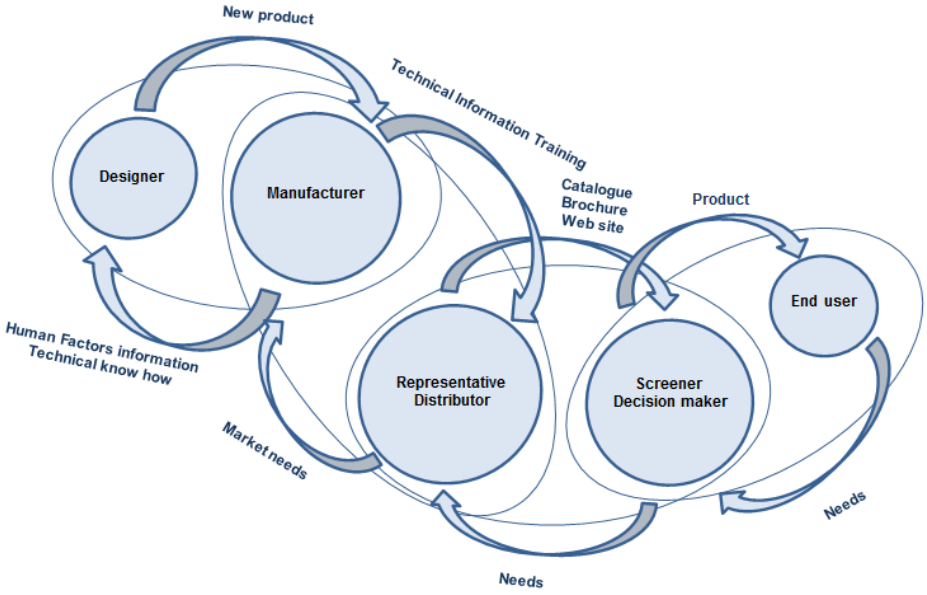

Figure 1 Flow of Information between the Manufacturer/Designer and the Screener/Decision Maker and End User
(Toyos, 2013)

For their part, manufacturers organise and transfer information about their products through catalogues and brochures. These may be seen as interface or relay tools reflecting the manufacturers' understanding of customers and end users. Interface design itself is an important area of research in terms of human factors, but, for the most

part, studies focus on computer and software interfaces and rarely on this type of interface. In addition, catalogues and brochures may be seen as relay tools between manufacturers and the scientific community; their analysis may help to understand what is incorporated from the scientific literature and how the latter is concerned by the content of catalogues and brochures.

Thus, equipment is an area in which knowledge management and transfer represent significant challenges. Brochures and catalogues may be seen as artefacts reflecting the outcome of this management and transfer activity between various relays and groups of interests. They are also significant because, in effect, they capture tacit knowledge, which is known to be difficult to capture (Grant, 2012).

The goal of our research in this area was to better understand to what extent the information provided by these relay tools meets the needs of users and screeners; what is incorporated from the scientific literature; and to what extent the scientific literature treats the implicit needs reflected through these artefacts. A secondary goal was to better understand the role of relay agents and their ability to capture and transfer information.

2. The Studied Sectors and Methodology

Our interest covers two distinct sectors (small-and medium-sized businesses), which differ considerably in terms of structure, tools involved, potential relay agents, and needs in knowledge management and transfer. In this section, we describe the main characteristics of these sectors and the contexts in which the studies were conducted.

2.1 Flexible Floor Layers and Kneepads

This construction sector is made up of a multitude of small or micro enterprises that install linoleum or fixed carpeting. The largest companies hire around 30 workers. Owners are typically floor layers themselves. Floor layers may work for several small companies. There are approximately 1,600 officially registered floor layers, who are associated in a federation; a prevention mutual group provides information and training regarding occupational health and safety issues. Floor layers can work in the commercial (mostly) or residential sectors. Most of the time, the job provider is the floor layer' seller. The work is performed 60% of the time in a kneeling position (Jensen & Friche, 2008). Musculoskeletal disorders are significant, knee disorders being what is the best documented. Studies show that about one on in six floor layers older than fifty suffer from arthritis after fifty years old (Jensen et al., 2000). In USA, 6% of all knee' injuries are reported by floor layers, which represents108 times the national average (Tanaka et al., 1982). This sector has increasing difficulty recruiting new workers and in retaining older ones despite significant salaries. The technology level used is low-level, the main equipment used being the carpet stretcher (including the knee kicker, which is activated by through knee impact). Kneepads are the main protection equipment. Workers usually purchase their own equipment. In the Montreal area, there are two specialized distributors.

The basic aim of this research-action study was to better identify difficulties encountered by floor layers to determine potential changes that would improve their work conditions. An indirect issue raised was to determine how we could improve the information flow transversally between workers and bottom up to distributors and manufacturers. The idea was to develop an assessment tool for the equipment purchased to favour the flow of information between workers but also towards manufacturers. The kneepad was chosen because of its importance and the variety of models encountered during preliminary field studies. This product has a short lifespan, and manufacturers regularly propose new models. The work activity was observed (e.g., knee posture, area of the knee

in contact with the floor, displacement on the floor, etc.; 34 workers at 13 building sites), and 31 workers were questioned about their kneepads (model, how they chose the model, and their assessment of the model).

The descriptions of 44 models proposed by ten manufacturers were collected from the Internet and visits to the two specialised stores. The information provided was classified according to technical characteristics (e.g., material used, attach system, form) and qualities emphasised (e.g., comfort, resistance).

2.2 Forklift Truck Operators

Forklifts are used in a variety of work industries, both inside and outside (e.g., lumberyards). They are seen as a significant purchases because of their high cost (±$125,000). Their use leads to the development of cumulative trauma disorders, in particular, of the back, the two main causes being vibrations and postures adopted for better views. However, safety issues draw most attention because of their potential severity (permanent disability, amputation, death; Vezeau et al., 2009). Choice of forklifts that adequately meet the needs of users and maintenance workers is thus crucial.

A first field study was conducted to document the interactions between forklift characteristics and forklift operation and safety (Vezeau et al., 2009). Information published by the five main manufacturers about their forklifts was analysed through 23 catalogues (and 5 websites). The various characteristics of forklifts were grouped into six subsystems (e.g., controls, cabin, mechanical system), covering 38 elements, which in turn were divided into 74 characteristics in order to compare proposals. These characteristics were identified from three sources: the literature, a previous field study conducted with operators, and the catalogues themselves. All written statements were collected and classified using this grid (visual data were not covered in this analysis). In the next study, nine screeners were interviewed on their selection experience, their use of catalogues, and their understanding of the information provided; they were asked to assess 37 models offered in these catalogues. Finally, 40 operators were asked to assess the last model purchased; they were also questioned on the importance of a set of forklift characteristics (for more information, see Toyos, 2013).

3. Results

The first section is related to the catalogues and brochures as interface tools between users and manufacturers. In the second section, the incorporation of scientific data in the published material is examined.

3.1 Interface between Users and Manufacturers: Catalogues and Brochures

3.1.1 Kneepads

Nineteen different materials were mentioned. The worker had the choice between flat or curved, and flexible or rigid kneepads. Kneepads could be fastened with a simple elastic band or a system of straps (1, 2, or 3) equipped or not with various types of cords. Manufactures generally mentioned three qualities (comfort, knee protection, and adaptation to the work) but usually emphasised one aspect in particular. Thus, even a not-especially-sophisticated piece of equipment such as a kneepad poses a problem of choice.

In Table 1, what floor layers workers looked for and what was offered in brochures is compared. As can be seen, there is a significant gap between both perspectives. For some items, manufacturers emphasised qualities attributed to their products, while workers emphasised problems to avoid. For example, the most significant comfort issue for workers was lack of breath ability of the kneepads. Sweat and heat build-up was a major problem for them. To improve breathability, many used only one kneepad strap, even if this reduced kneepad stability. Thus, strap adjustment peculiarities were never an issue for them. For other items, such as floor

displacement, workers referred to what they needed to do, while manufacturers referred to the type of surface. Several manufacturers emphasised the ability of the padding to protect against impact (knee kickers are activated with the knee). Any worker never raised this issue. In fact, kneepads are usually removed when knee kickers are used (to achieve the required accuracy).

Table 1 Advantages Emphasised by Manufacturers and What Floor Layers Look for

Item	Manufacturers	Floor layer installer
Comfort	Flexible, light, and soft material	Avoid humidity and heat,
Strap	Keeps kneepad well in place; adjustable	No compression
Movement	Can move on different surfaces (hard, fragile)	Allows to walk, slide, pivot, and swing on knee
Postures	Permits easy postural changes	Ditto
Protection	Against knee kicker impact and cumulative trauma disorders	Against nails

3.1.2 Forklifts

The first analysis conducted aimed to verify whether catalogues covered all the characteristics identified (and in the same way), especially by forklift operators. As shown in Table 2, the catalogues, taken together, covered 80% of the 74 characteristics identified (12 did not concern operators, e.g., maintenance staff). The 12 characteristics not mentioned by any of the 23 catalogues were pointed out by the operators because of their impact on comfort, efficiency, and safety. For example: wheel dimension was seen as important because a wider diameter absorbs shocks better (comfort issue) and allows taking shortcuts on rough terrain (when working outside; efficiency issue). Pedal dimension has an impact on efficiency and comfort: operators usually prefer bigger pedals because they can be operated more smoothly. Light size has an impact on safety: co-workers can see large lights better.

As shown in Table 2, what was treated varied considerably from one manufacturer to another. For example, in the case of electric forklifts, less than a sixth of characteristics were covered in one catalogue. In the best case, two thirds of the characteristics were covered. Nevertheless, the amount of information provided was considerable since as many as 135 different proposals were collected. Here, two descriptions were considered to be different if they led spontaneously to two different interpretations (e.g., “two-spoke steering wheel” vs. “hydraulic steering”; “spacious cabin” was considered equivalent to “roomy driver compartment”). Some catalogues covered systems extensively, while others barely covered them at all. For example, one forklift catalogue provided information about 13 control characteristics, while another provided none. The catalogues, therefore, present a vast amount of information to manage, and it is difficult for screeners to compare proposals (For more details, see Toyos, 2013).

Table 2 Coverage of Forklift Characteristics (Internal Combustion and Electric) by Manufacturers

Refers to	Internal combustion				Electric			
	# of characteristics covered			Descriptions	# of characteristics covered			Descriptions
	All manuf.	Range	Median	#	All manuf.	Range	Median	#
General	10	5 to 10	8	28	12	7 to 8	8	48
Cabin	16	4 to 13	10	38	16	0 to 8	5	35
Controls	19	4 to 13	10	37	19	0 to 13	5	31
Communication	3	0 to 3	2	6	4	0 to 2	1	7
Mechan. System	10	1 to 7	3	16	7	2 to 6	3	9
Maintenance	4	0 to 4	2	7	3	0 to 2	2	5
Total	*62*	*23 to 41*	*33*	*132*	*61*	*10 to 39*	*21*	*135*

A second analysis was conducted on 43 proposals (related to 25 characteristics) to determine the type of information provided: was it of a general (e.g., presence of the characteristic was mentioned), specific (i.e., descriptive data), or qualifying nature (e.g., good visibility)? A quarter of the proposals were qualitative (e.g., spacious, good visibility, comfortable), and a quarter were general (e.g., adjustable seat, dimensions respect norms). In these cases, one can assume that the value of the information provided was limited. In about one third of the proposals, the information could be considered as not useful enough to distinguish between two forklifts, mostly because all forklifts had this item (e.g., an adjustable seat) or the information was too difficult to interpret (e.g., 17.5º right rotation, 20º left rotation).

In the next study, nine screeners were questioned on their use of the catalogues (see Table 3). About half the time, screeners considered the information difficult to find. Nearly all screeners felt they learned little from the information (94%), and, most of the time, the information did not help them in their decisions (79%).

Table 3 Screeners' Assessment of the Information Provided in the Catalogues

Subsystem	Very important n = 54	Difficult to find n = 48*	Learned little n = 48*	Insufficient to decide n = 48*	Dominant comment
General	9	5	6	6	Incomplete: you need to talk with the representative. Visual material is missing.
Cabin	2	7	7	7	Difficult to interpret: you need to try it; a lot of photos, but lack of descriptions.
Controls	4	5	8	6	Difficult to interpret: does not tell if it does the job.
Communication	0	0	8	7	Little information, but not an important issue.
Maintenance	7	6	8	7	Incomplete: you need to talk with the representative. No information on service quality and contract terms.
Mechanical system	8	0	8	5	Incomplete: no information on reliability; difficult to interpret, too complex; no link with the actual work.
Total (%)	30 (63%)	23 (48%)	45 (94%)	38 (79%)	

Note: * One participant did not consult the catalogues

In addition, 44 proposals (related to eight characteristics) were extracted from the catalogues. For each characteristic, screeners were asked to identify the proposal(s) that were meaningful to them, the proposal they would choose, and what additional information they needed to know. For example, six proposals dealt with steering wheel adjustment (adjustable; adjustable over 38°; adjustable for height, back, and front; adjustable column, programmable, programmable for height). In this case, eight of the nine screeners identified adjustable column as meaningful, and seven identified it as being the basis of their choice. However, they would have liked to have information on the steering column position in relation to the forklift operator. Overall, only 16% of the proposals presented were considered as meaningful by at least four screeners. Finally, for five of these eight characteristics, no proposal was clearly favoured.

All screeners emphasised, at some point during the interview, the importance of representatives providing the missing information and additional information relevant to their situation. Representatives were seen as able to match the screeners' needs with the manufacturers' proposed products.

In the subsequent study, operators (n = 40) of the same companies were questioned on the last forklift purchased. These forklifts were operated in three different contexts: lumberyards, shipping, and warehouses. Overall, operators preferred their previous model over the new one, regardless of the qualities considered

(accuracy, comfort, safety, efficiency, general performance). For 23 characteristics, operators were questioned about the qualities they were looking for. For example, the operators said they wanted a control that was highly responsive (87%), had short range of motion (52%), was easily accessible (50%), and had low resistance (35%). In fact, preference varied according to the work context. For example, a short range of motion was cited as being important in lumberyards, and low resistance and accessibility were more important in shipping work. In the great majority of cases, the qualities identified by the operators were absent from the catalogues. Thus, there was a clear gap between the information provided by the catalogues and the needs expressed by the operators; several important characteristics for the operators were not covered at all, and when they were, other aspects besides those considered important by the operators were covered.

3.2 Interface between Users and the Research Community

3.2.1 Floor Layers

Fourteen solutions proposed in the literature or patented were presented to 13 active workers (n = 182 responses). The workers were asked if they had already tried the proposed solution, if they would choose it, and how it could be improved (28% had tried the proposed solution). The most frequently used solution (n = 11) involved homemade equipment for unrolling carpet or linoleum rolls, designed by the owner of a small floor layer company. Ten workers were asked to select this equipment to identify further improvements. The workers rejected previously tried solutions three times out of four. Overall, workers were open to trying new equipment (62% of the solutions chosen had never been tried). The most popular solutions involved pieces of equipment designed to support the trunk in a kneeling position (a portable trunk support) or limit the pressure on ankles when standing up (a portable thigh support). Solutions involving wheels to facilitate displacement were eliminated altogether since they were hard on the back (wheels increase the distance between the floor and the back in a bending position) and ankles (workers must constantly counteract the motion of the wheels). Workers therefore seemed quite able to infer what was useful or not in their choice of potential solutions. Indeed, it was striking that the solutions chosen by the floor layers corresponded mostly to problems that were little documented in the literature on floor layers.

3.2.2 Forklifts

For five key cabin-related characteristics (e.g., seat, pedal position), we analysed the link between what was recommended and what was described. Analysis showed that the manufacturers generally incorporated recommendations and suggested figures (e.g., adjustment range, seat back angle). However, some descriptions were little informative because they incorporated recommendations that were too general or incomplete (e.g., presence of lumbar supports and so-called “ergonomic” seat backs; however, to be effective, such supports must be positioned correctly, spine curvature varying greatly from one person to another). Also, many recommendations that were incorporated were based on studies conducted in the context of driving automobiles, which is quite different from operating forklifts. For example, the recommended adjustment ranges (front-forward: 150 mm) and angles (back reclining: 5°-15°) are based on experimental data (increasing the trunk-thigh angle reduces intra-disk pressure) combined with automobile studies regarding visibility (seeing the road ahead at three metres) and steering control requirements. With forklifts, the fork ends must be visible at a shorter distance during forklift operation; operating the controls is more demanding than it is for automobiles. In addition, a tilted seat is not recommended for situations involving vibrations and jolts (i.e., maintaining a vertical axis is preferable) which is the case for forklifts, which are often not equipped with suspension systems (Verschoore et al., 2003).

4. Discussion

Knowledge systems involve a complex network of knowledge producers and users (e.g., scientists, designers, maintenance personnel, end-users), intermediaries (e.g., marketing personnel, suppliers, buyers, users), and transfer interfaces (e.g., handbooks, catalogues, websites).In the literature on knowledge management and transfer, studies focus more on internal systems and less on the flow between two systems and the various levels and loops involved (manufacturing loop: scientists, designers, marketing staff, engineers, etc.; customer loop: screeners, suppliers, maintenance staff, end-users, etc.). In these systems, exchanges also occur at both the organisational and individual (end-user) levels. For example, organisations consider production costs, maintenance facilities, quality control, and after-sale services; end-users focus on ease-of-use and performance efficiency for a given task. The goal is to find a way to combine these needs, and equipment is a good place to start. What appears to be the main difficulty is the translation of dynamic information into static information, namely, the translation of what is needed for an activity into technical characteristics, and vice versa.

Furthermore, our study presents useful findings about relay agents. Considerable effort is currently devoted to defining and developing the function of transfer agents (mostly as brokers) or knowledge officers. The relay agent function has been far less covered in the literature, probably because it is just a function or a role rather than a professional activity. What relay agents appear to do well is understand needs within specific contexts. In the case of forklifts, two types of relay agents stood out: screeners and representatives.

Screeners clearly play an important role, despite the fact that they are not decision makers. They are a junction, an interface between decision-makers, purchasing staff, maintenance staff, supervisors, and ultimately, operators. Their recommendations can have substantial impact, although difficult to quantify. Despite this, all the screeners in our study expressed considerable difficulty interpreting catalogues and linking the information with the context of their companies. Although it was not the purpose of this research to address the selection process, one can say that the screeners also had difficulty understanding the needs of forklift operators. Screeners concentrated their attention on maintenance needs, which were perhaps easier to decode.

The second type of relay agent, the representative, was identified as important for overcoming these difficulties. Because their work involves going to many locations, the representatives are more easily able to distinguish specific needs and associate them with the various models available. Considering the difficulty fitting generic knowledge with contextual needs, this role appeared to be crucial.

In the case of flexible floor layers, the relay chain was short. The distributors we met did not know why one model was popular or not. Consequently, they could not play a relay role. The best relay agents, in fact, were small business owners who kept abreast of new developments and judged them according to their needs. Since floor layers move from one location to another, the information circulated quite quickly. At the time of the study, for example, a kneepad made with gel was introduced; several floor layers had already tried and rejected it because the gel filling was unsuitable for their needs. This information was widely and rapidly circulated. One manufacturer, however, has since developed a knee protector that seems to be greatly appreciated by floor layers. It offers a new feature that was not even considered a few years ago: an ankle support. Floor layers rapidly accepted this innovation. In such cases, a specific assessment tool, as intended at the beginning of our study, may have missed this feature.

That being said, perhaps what is needed more than relay tools is the development of a relay process that captures the information and knowledge needed to improve decision making for purchasing. In the same manner,

two-way circuits that allow information to flow freely must be put in place. While the Internet offers interesting possibilities, it is not always easy to link all the various networks together.

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