Teller's Workstation Design Project - Health and Wellbeing through Ergonomics

Rosa Ana Rizzo[1(✉)] and Luciano Gabriel Adatto[2]

[1] Postgraduate School of Ergonomics, Universidad Tecnológica Nacional, Castro Barros 91, Buenos Aires, Argentina
rosanarizzo@frba.utn.edu.ar
[2] Ergohuman Consulting Designer, E. Conesa 3970, Buenos Aires, Argentina
lucianoadatto@ergohuman.com.ar

Abstract. A workstation design and implementation project can be poured with infinite decisions. An ergonomic approach to industrial design aimed at improving health and comfort to a large workforce has the potential to materialize many ergonomic concepts and ideas and turn them tangible. A new workstation demand from a multinational company will be the project's setting, and the opportunity to wield knowledge, gathered and learned, from multiple disciplines; and to learn from our mistakes regarding the project' process. This paper will illustrate the process from demand to implementation going through the methodology, decisions and challenges.

Keywords: Design project · Activity-centered ergonomics · Participative ergonomics · Workstation design

1 Main Message

The inquiry of a money exchange multinational company to design a teller's desk prototype to be implemented countrywide aimed at improving 800 job positions, sparked this project.

The goal: To design and manufacture a workstation including the actual desk, the device's layout and accessories and to promote healthier work habits, to be carried out within time, budget, space and industrial production limitations.

A multidisciplinary team composed of an ergonomist, an architect, a production expert and an industrial designer was set up.

The team's approach was based on activity-centered ergonomics (ACE) [1–3]. A deep analysis of teller activity, historical musculoskeletal disorders (MSD) data recollection, personal interviews with the workers and applying ergonomic methodologies was essential to support future design decisions.

Calm waters and smooth sailing during the design process transformed into a thunderstorm as the transition was made from paper to reality. Every line, so deceptively easy to draw on the screen, resisted to be uplifted to the physical world.

The outcome of the project reflects the knowledge and creativity poured into the design, as well as the hardships of production and real life implementation.

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2 Context

The client's demand emanated from the desire to "improve the working conditions and productivity of their 800 tellers throughout the country through a new workstation", they'd had two previous attempts at redesigning the desk, and both failed to meet their expectations.

As for this third attempt, the company decided to hire an ergonomist to assemble and lead the entire design team, they bet for ergonomics to be up to the task and finally have a positive impact on their employees and their own bottom line.

The project was undertaken with the intent to use this mission as a lever to implement ergonomic knowledge as an essential factor in improving workers quality of life while increasing productivity.

3 Actions

Statistical data about teller's occupational diseases (OD) was collected, as Fig. 1a shows there is a growing trend of musculoskeletal disorders (MDS) over other OD. Figure 1b shows most OD are related to the spine and hands.

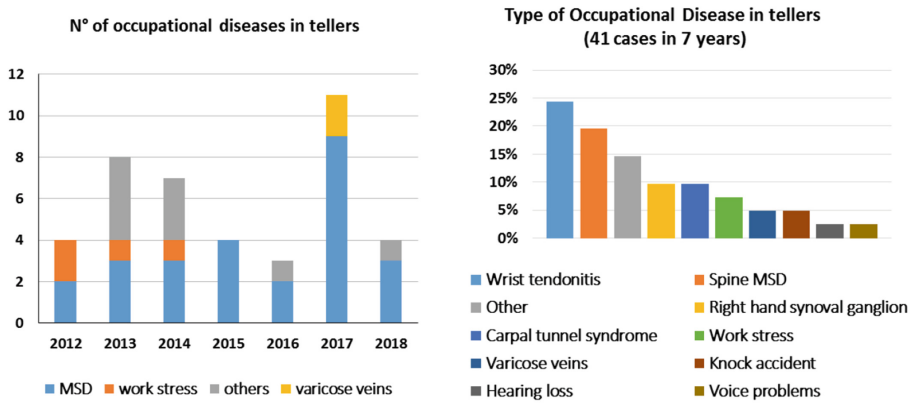

Fig. 1. a. 7 years series of Occupational Diseases; b. Percentages of OD in tellers

The Corlett Bishop physical discomfort test [4] was applied, see Fig. 2a, which revealed most tellers were suffering work related pain, mainly in the neck and lumbar area.

The HAL (Hand Activity Level) Method [5] applied to measure the risk of MSD in distal upper limb due to repetitive tasks. Figure 2b shows the results regarding two typical tasks analyzed at two different branches.

The results show that the right HAL is closer to the control zone than the left HAL; as the dominant hand in most cases, it's used more often regarding several tasks (mouse, keyboard, stapler, handling drawers, counting and sorting money, scanning barcodes, etc.).

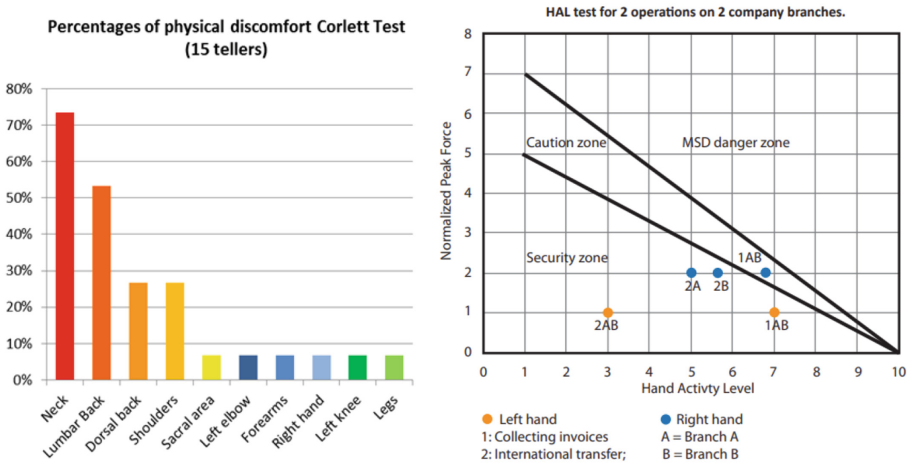

Fig. 2. a. Results of Corlett Test; b. Results of HAL Method

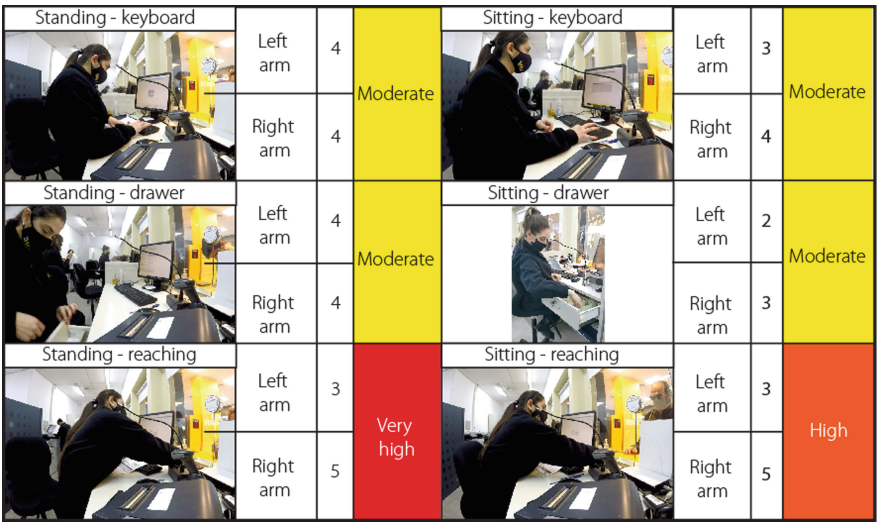

Fig. 3. Results of RULA Method in standing and sitting postures before changes

The RULA Method (Rapid Upper Limb Assessment) [6] was applied.

Figure 3 shows that some of the typical postures of tellers' work go from moderate to high or very high risk due to spinal bends outside of comfort angles, arm bends greater than 90° when they reach the customer service window, almost permanent cervical bends due to the monitor being below the horizontal line of sight.

In Fig. 4 the tellers use a soft ergonomic chair, with height adjustment and comfortable lumbar support on the backrest but the legs were kept bent, due to lack of footrest

and the knees collided with a ledge, causing contact stress. All this may result in varicose veins and leg fatigue [7].

Fig. 4. Lack of footrest causes poor leg posture

At the request of the client a productivity study was conducted [8] to have the data to compare the current situation to post redesign productivity levels. We were able to conclude that overall productivity decreased 25% compared to pre COVID-19 quarantine restrictions in Argentina, this decline was attributed to a 50% customer decrease.

Having finalized the primary data recollection phase, ergonomic observation and analysis, the old workstation problems were detected and appropriate solutions were stated, see Table 1.

The design process was aligned with the work systems' design systemic approach [2, 9, 10] based on E/FH and the PDCA (Plan, Do, Check, Act) model [2]. The process was iterative, having several presentation instances to management, their input was taken into consideration and made integral part of the final result. (Fig. 5).

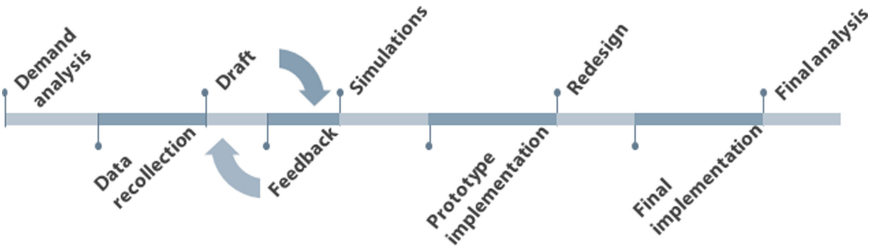

Fig. 5. Design Process

Simulations through virtual and physical models were used to test out design ideas, for example, a 1:2 wooden model of the height regulation mechanism for the footrest, several 1:1 shelves models to be attached to the desk, a full 3d virtual model of the

workstation, among others. Supervisors and tellers participated in these simulations, contributing their experience and opinions [1, 9, 10].

After a prototype model was finally approved, one was manufactured and installed at the main branch on Oct 7th of 2020.

Table 1. Issues and proposed solution

Problems found and analyzed	Design solutions
Lack of leg support	Height adjustable footrest
Contact stress on knees	Shorter tray redesign
Too much distance from the teller to the window	Desk depth shortening
Repetitive scanner use	New location and scanner's operation mode
Poor neck posture due to monitor height	Monitor lift module
Suboptimal device layout	Layout optimization and adding shelves
Lack of legroom	legroom widening
Poor cable management	Tray and cable channel standardization

The prototype was tested by the company branch population for a month, after this period, the company's production manager gave us the feedback they had collected from the tellers and some of the company's chiefs.

The results were good but some minor adjustments were necessary, mainly, there were concerns about the device layout.

All the data we'd collected wasn't enough to yield an optimal device layout design. Even though we asked tellers about their opinions on the proposed new layout, and their answers were overwhelmingly positive, the contrary could be said about their input after they tested the prototype on real conditions.

Taking into account this feedback, we presented the final workstation version to management, the main differences being, new hanging shelves, for the bill counting machine and general office supplies, freeing up more space on the desk's work plane, addressing the staff's major concern about the first prototype.

Fourteen units of the final design were commissioned to us by our client, to be installed on different branches, the central one, where the prototype was tested and a second one with certain particularities, which would force us to customize each of the five desks intended for those premises.

This request was issued on Dec. 3rd and every workstation was expected to be installed and fully operational by Dec. 30th of 2020.

In spite of the constrained time frame and the new necessary customizations, the commission was accepted.

The workstations were delivered on time, and the installation began on schedule, unfortunately, there were several production errors: Some pieces were not as designed (the height of the portable iron brackets to support the shelves), carpenters had to work at night, as not to disturb daily operations, just one day before the holidays. (See Fig. 6 and 7).

Several more visits to the aforementioned branches had to be made to correct several production and installation errors (drawer locks; footrests did not slide well, portable shelves).

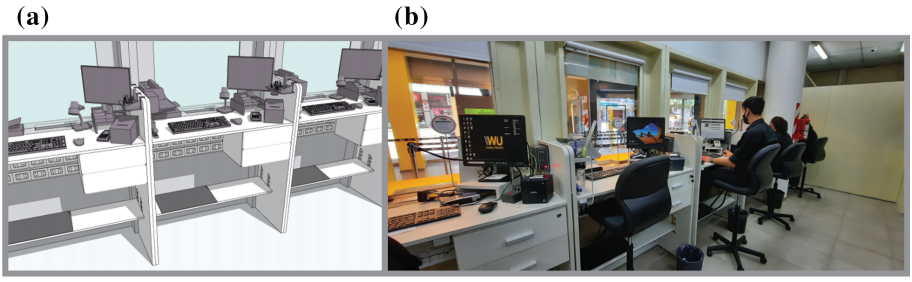

Fig. 6. a. Final design; b. Real installation

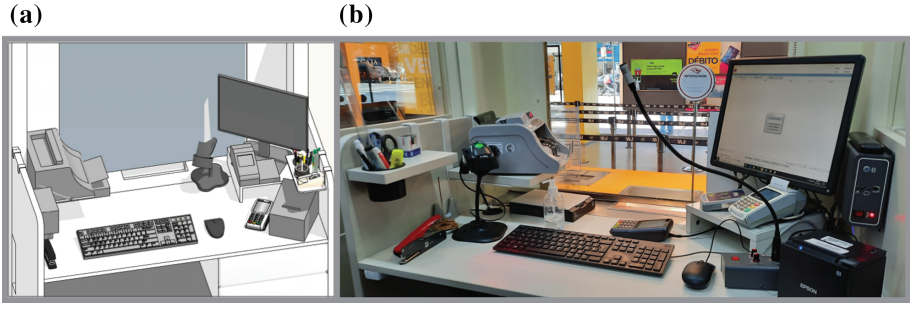

Fig. 7. a. Layout design; b. Real layout

4 Outcomes

As seen in Fig. 8 the legroom depth was extended, which lets arms to be partly supported by the desk and to get closer to the customer service window, which improves back and arm posture. The lift module raising the height of the monitor, minimizes neck tension and space on the work surface was gained thanks to portable shelves.

After installation, a survey was conducted among tellers and 100% agreed that the new furniture was very comfortable, the layout made their job much easier (43%) and that it moderately improved work (57%). 86% found it easy to adjust the height of the footrest. Regarding the discomfort that they currently felt, the answers were those shown in Fig. 9.

Fig. 8. Sitting and standing postures using the new design

The RULA method was also applied [6] to the post-installation situations. The results show that the risk indexes of postures out of comfort angles were substantially reduced in the characteristic postures of the activity (Fig. 10).

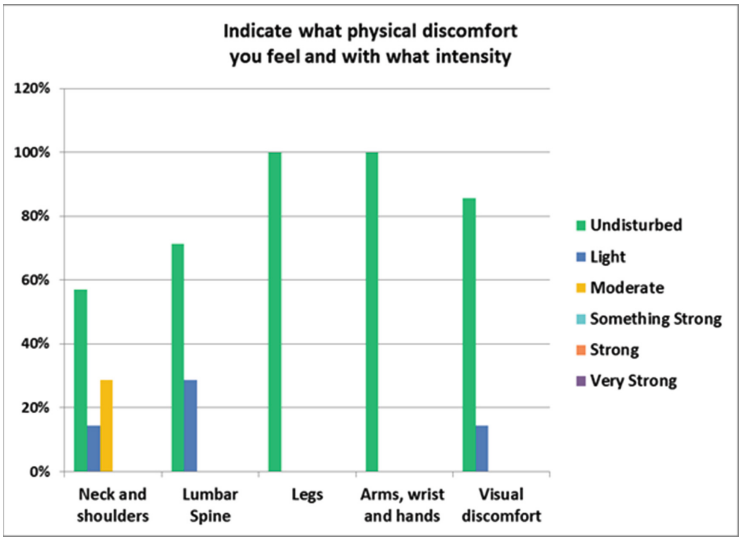

Fig. 9. Survey on physical discomfort after the change of furniture

Post installation productivity study showed there was no significant improvement despite rearranging devices to be more accessible. In any case, it would be convenient to have a broader post pandemic study.

The new design had a strong positive impact on the teller's comfort and in several ergonomic variables, and thus, this aspect of the project is considered a success by our

team and the company. However, while the desks were delivered and installed on time, and were serviceable enough as to be operational and allow the company to not pause regular operations, the workstations had to be tweaked for several days after, until they presented no issues and were 100% finished and faithful to the blueprints. Therefore, the project did not meet the stipulated installation and implementation time frames.

Charateristic postures	Arm	Risk level		Characteristic postures	Arm	Risk level	
Standing - keyboard 	Left arm	2	Low	Sitting - keyboard 	Left arm	2	Low
	Right arm	2			Right arm	2	
Standing - drawer 	Left arm	3	Moderate	Sitting - drawer 	Left arm	2	Moderate
	Right arm	3			Right arm	3	
Standing - reaching 	Left arm	2	Moderate	Sitting - reaching 	Left arm	2	Moderate
	Right arm	3			Right arm	3	

Fig. 10. Result of RULA method, post-installation

5 Discussion

The most important success factor according to the client was production and installation within budget, which was fulfilled, and the quality and impact of the desk and accessories design on employee satisfaction.

For the project team this experience showed that the ergonomists and designers can work together in all the stages of a design project with the goal of improving the working conditions of the people [1, 9, 10].

Several mistakes were made by our team regarding production and implementation:

The outsourced furniture factory hired to manufacture the workstations was located in a different province than our team, this made it impossible to visit the factory for quality control before the implementation. Hiring a local factory would have allowed us to avoid many production mistakes.

This company is used to working on construction sites, therefore, their workers' presentation and attitude (image) was out of place inside operating commercial premises full of customers and employees (they were asked to fix desks issues during working hours). Choosing a provider with the right experience would have avoided certain complaints from the client regarding this issue.

Finally, eager to embark on this project, we reluctantly accepted a small timeframe to deliver results, this implied working frantically to reach the deadline, which precipitated many errors. Being honest with ourselves and analyzing our experience and capacity to determine how much it would take to properly finish this project would have made the experience much more enjoyable.

Regarding the RULA method, we noted it only classifies stable posture and unstable posture for lower limbs. In this case the legs were supported by a pipe as a foot rest below the chair, which provided a stable but uncomfortable posture. The method could be improved by adding a 3rd. classification: Supported but uncomfortable posture.

6 Conclusion

We believe our experience is a prime example of the importance of data gathering and analysis as the foundations of any ergonomic design project. It's also an example of the importance of thinking outside theoretical ideas, and considering practical aspects such as logistics, production technology and giving yourself the margin to correct mistakes.

Dealing with a big multinational company implies dealing with bureaucracy, which means you need to communicate to your client very precise information regarding what you need from them and what you can and will deliver, since they lack the flexibility a smaller company would have to adapt to unforeseen issues you, as a provider, could have during your workflow.

As a final conclusion, a well-designed product was delivered, that met the conceptual objective of the project and that could kick start an improvement process regarding ergonomics and worker wellbeing within the company.

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