VIVELAB ERGO CASE STUDY

REDESIGN OF A PRE-ASSEMLY LINE TO REDUCE WORK CYCLE TIME AND INCREASE THE LEVEL OF OCCUPATIONAL SAFETY

PROJECT OBJECTIVE:

Production process optimization in order to increase efficiency and to reduce workload

● Reduced workload ● Faster production ● Fewer employees ● Smaller space requirement

The ergonomics and engineering experts of ViveLab Ergo Ltd. have been commissioned by Secret Hungary Ltd. to conduct a survey at their production line and to optimize the production process. The client had to grapple with constantly high fluctuation rates and the production process was slower than expected. The aim was to detect and eliminate bottlenecks and at the same time to check workloads in order to secure compliance with the standard MSZ EN 1005-4: 2005 + A1: 2009. In the course of the project, we reviewed the work instructions, monitored workflows, and measured the cycle time for each operation. Further, we inspected the intensity of workloads and checked whether suitable tools were available. We examined whether the material flow between different parts of the production line supported optimal production conditions. **The results of the survey and our optimization recommendations have been simulated and analyzed with the ViveLab Ergo software allowing us to compare the original and the planned work processes. Thus, we were able to prove the success of the optimization proposal before realization and to calculate the return on the investment. Thanks to the modification of workstation layout and the reallocation of tasks we reduced the workload, increased the speed of the conveyor belt by 15%. We also reduced the number of employees at the cable box assembly station and reduced the space requirement of the pre-assembly line to 58%.**

STEP 1: SCREENING, I.E. ERGONOMIC IMPACT ASSESMENT

Commissioned by Secret Hungary Ltd., the ergonomics and engineering experts of ViveLab Ergo Ltd. carried out a production line screening and production process optimization in the client's company. During the process, that we call screening, the workstations on the production line are going to be categorized according to the intensity of workloads along with the seriousness of health effects and involved risks.

This first phase is important in order to be able to assess the overall state of the production area as quickly as possible and to see where the problem is most acute, where corrective measures are needed immediately.

The following methods were used during the test:

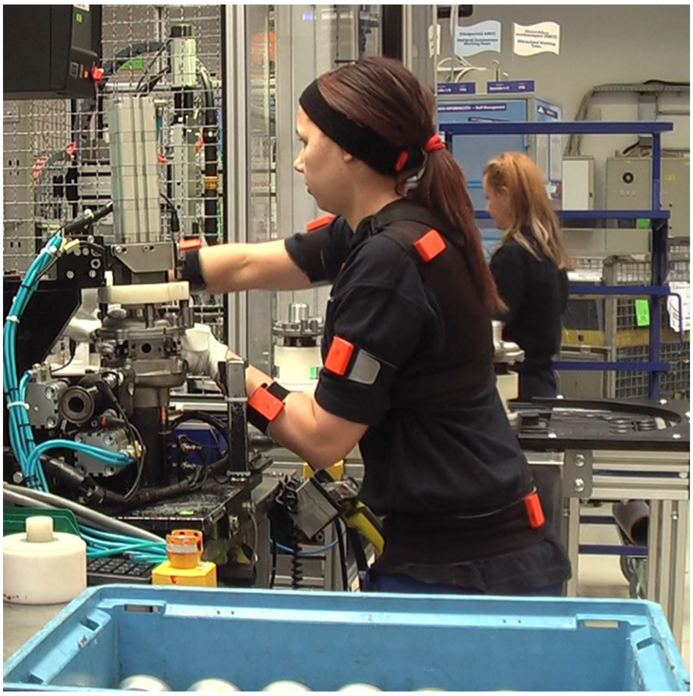
- Inspection of the production area: we walked through the production area and recorded our observations taking into account 89 ergonomic aspects. We observed the tools being used, the working conditions and the workflow.
- Interview with employees: the employees were asked about their experience and about any pain they might feel or any inconvenience they might suffer during work.
- Interview with the production superintendent: the production superintendent was asked about the intensity and possible cause of fluctuation as well as about other problems that may have arisen in the production unit.
- Interview with the occupational health physician: the occupational health physician was asked about eventual accidents and about health-related complaints of the employees.

The workstations got a score and were ranked according to the evaluation results of the incoming data that had been gathered during the observations and interviews. The result was an easy-to-read table that is called deficit map, which clearly showed at which workstations and what kinds of problems should the company address. The screening revealed shortcomings in several areas. The deficit map was interpreted together with the management and we selected those workplaces where the recording of movements with sensory motion capture equipment followed by analysis using the ViveLab software was required.

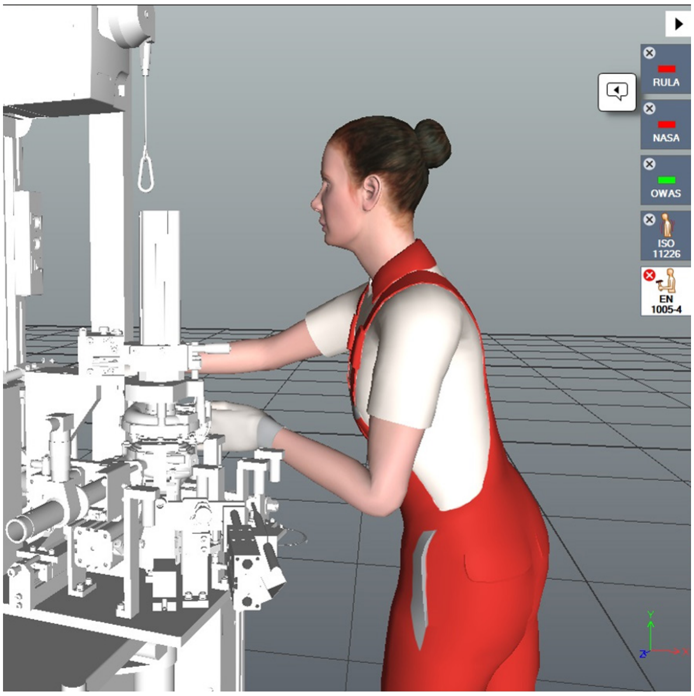
Due to the complexity of the issues identified in this case study we would like to highlight only one of the problem areas. We are going to describe below the optimization of a pre-assembly line that represented a bottleneck in the production line. It took the longest time to complete that component part of the end product which was manufactured here. It had an adverse effect on the whole production process because it was not possible to increase the speed of the conveyor belt on the main production line. In order to be able to increase the speed of the conveyor to the extent as the customer requested, the pre-assembly line should have released a new product every 44 seconds instead of the original 51 seconds.

STEP 2: MOTION CAPTURE WITH SENSORY EQUIPMENT

In order to be able to locate accurately the problem in the pre-assembly unit and to determine how to fix it, we needed objectively measured data. Therefore, the movements of the workers on the pre-assembly line were captured with 17 wireless inertial sensors fixed on their bodies. These sensors can be calibrated quickly and easily without hindering the production. They do not impede or influence the movements of the body, so employees can move naturally and do their job as usual. Unlike optical sensors, there is no need for a camera system. Thanks to the Xsens Motion Capture technology, electromagnetic waves do not distort data.



factory worker in Xsens sensor suit



factory worker in ViveLab Ergo software

In the course of this process we recorded the 5 different workflows in about two hours. With this step our task in the production area was completed. Data analysis is always carried out outside the production area at the office of our experts.

The motion capture equipment registers every detail of the movement in a realistic, fast and objective way but does not answer the questions, whether the frequently repeated body positions are comfortable or at least acceptable, whether the loads on the different parts of the body are within the acceptable limits or whether the health of the employee is endangered in the long run. To answer these questions various ergonomic analysis methods are used in the virtual space. These methods evaluate the body postures and check whether the loads on different body parts exceed the acceptable limits. The tools of the ergonomic analysis are the seven internationally known and recognized analysis methods that have been implemented in the ViveLab Ergo software.

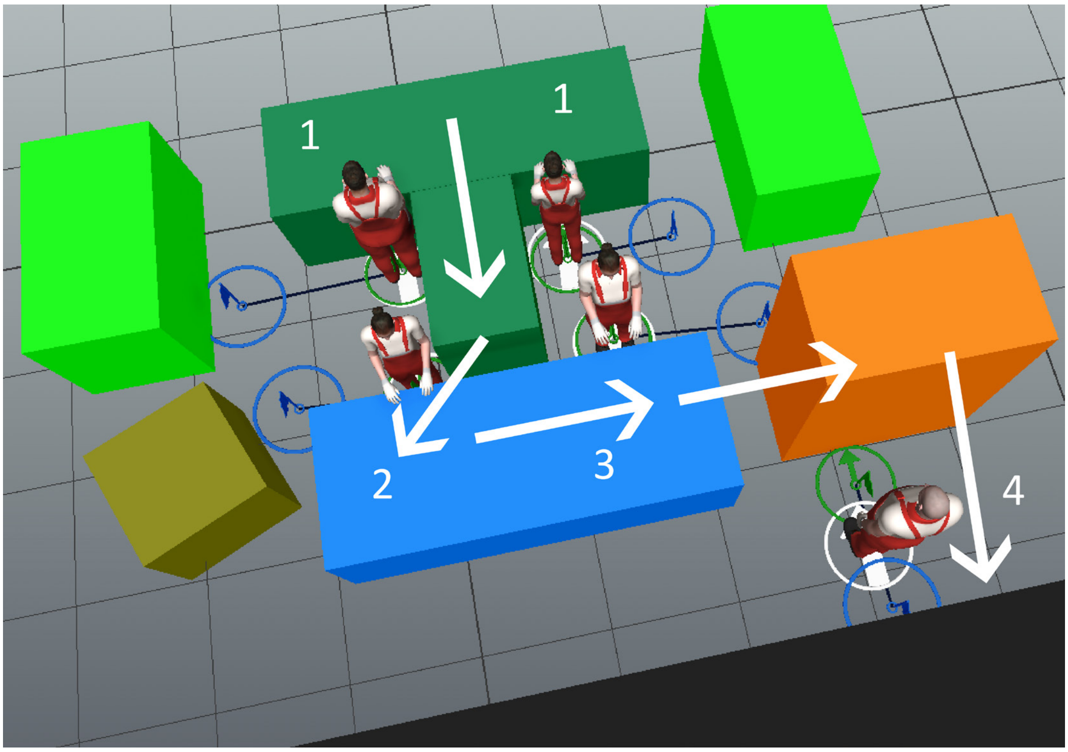
STEP 3: VIVELAB ERGO SIMULATION AND ANALYSIS

STEP 3.1: VIVELAB ERGO SIMULATION

CAD files of a manufacturing unit with dimensions up to 50mx50m can be imported into the ViveLab Ergo software, or built from available geometric primitives. Larger production areas should be divided into smaller parts and the simulation and analysis should be carried out for each part separately.

Secret Hungary Ltd. could not provide the CAD model of the workstations. Based on the floor plans, we had to build up the pre-assembly line from geometric primitives. The simple model of the work environment we got this way was in this case sufficient to subject the working process at different workstations and their interfaces to diverse ergonomic analysis methods.

We generally need an accurate CAD environment model if we want to carry out a thorough ergonomic examination and efficiency analysis of the workplace with the tools and machines available and of the work process. In those cases, when the client cannot provide the CAD model of the production area, we can make a 3D scan of the area or build the CAD model ourselves.



Schematic view of the workstation (because of lacking CAD files)

In the picture, the flags in the green and blue circles and the lines between them represent the path of the workers' movements. Thick white arrows indicate the path of the product on the pre-assembly line. White numbers indicate the workstations.

After we had constructed the environment, we created virtual human characters and assigned to each character the relevant motion files that had previously been captured by the sensors. As a result, we had finally a digitized model of the pre-assembly line and of the work activity there.

Description of the original workflow:

In the surveyed pre-production area the cable organizer boxes of the final product get pre-assembled. The employees thread and wind the cables into a plastic case where they step by step place other fittings and components as well. The cable container box gets then mounted on a steel plate which is part of the final product and the result is put in a temporary storage. Another employee takes it from this in-between storage and assembles it with the final product on the main production line. The space required for the pre-assembly line is 42 square meters. The storage containers shown in the picture are filled by other workers who are responsible for supplying the entire production line. Their job was not part of our investigation.

1. Cable box assembly: The two workers take the necessary cables and the plastic cable container box from the containers next to them that are indicated with light green color in the picture and put them on their table. These are then assembled and fixed on the table. The cables get thread and wound into the box and fixed. At the end of this step, the wired cable container box is placed on the protruding middle part of the table. The employees have enough space to put the necessary parts for 4 or 5 wired cable boxes on their desk, but they must take them from the container themselves.

2. Pre-assembly Step 1: The employee removes the wired cable organiser box from the protruding middle part of the above-mentioned table of the previous worker and takes a larger piece from the container which is on his right side. He fixes the piece onto the cable container box with a screw. He then puts it in the middle of the table so the next worker can take it. Every time he is making a new item, the employee must walk to the container that is standing on his right side.

3. Pre-assembly Step 2: The worker takes the item that was put on the table by the previous employee and fixes an additional cap with a screw on it. Afterwards, he seals the product. When his task is done, he places the item in the orange container shown in the picture.

4. Final product assembly: The worker takes the item from the orange container and assembles it with the item that arrives on the final assembly production line that is indicated with black color in the picture.

STEP 3.2: VIRTUAL ERGONOMIC ANALYSIS IN VIVELAB ERGO

After building the virtual environment and importing the motion files, we carried out the ergonomic analyses. The software evaluates the postures of the employees according to seven built-in ergonomic analyses tools: RULA, OWAS, NASA-OBI methods, ISO 11226, EN 1005-4 standards, Spaghetti Diagram and Reachability Test. The software checks whether the load on each body part exceeds the acceptable limit. Thanks to the accurate capturing of motion, the built-in analyses methods also detect those critical movements and postures that might not have been noticed without the sensors or that might have remained hidden because of potential screening effects.

As the animation is being carried out in the 3D environment, the right panel in the software window displays in real-time the evaluation results of the analyses. We can see the scores of the body parts at any moment. For the purpose of a detailed investigation, we have exported the analysis reports that highlight with relevant angles and with accuracy of hundredths of a second those positions that need to be adjusted to reduce the workload of employees.

STEP 3.3: EVALUATION OF THE ANALYSIS REPORT

RULA analysis in the old days and now

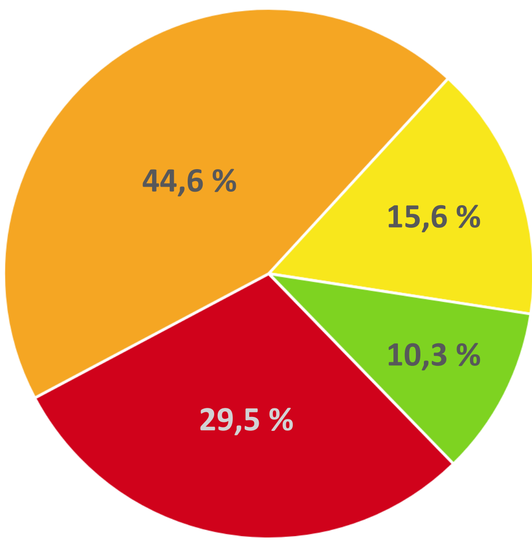
The RULA analysis method was originally a manual ergonomic evaluation method. When using the outdated manual method, the ergonomics experts gave a score to each examined body part based on visual observation during a particular workflow. They estimated the position of the examined body parts with the naked eye and compared it with angular ranges that corresponded to comfortable, uncomfortable, or for longer or shorter period unbearable postures. The final evaluation of the workflow was based on the most health-harming body position of the worker. In the course of the manual analysis, the duration and start time of the critical movement could only be estimated, so it was impossible to perform precise engineering work during the optimization.

In contrast to the manual RULA evaluation, the ViveLab Ergo software evaluates the position of the body parts sixty times every second in absolute objectivity, thanks to the accurate recording of the movements with sensory motion capture equipment.

The RULA method gives scores on a seven-point scale. The points are classified into four categories according to the urgency of the corrective measures. The ViveLab Ergo software evaluates the workflow on a statistical basis, resulting in a pie chart. This indicates the percentage of time the score was in line with each grade on the seven-point scale and the percentage of time when the movement fell into each category regarding the urgency of corrective measures.

RULA analysis results based on the ViveLab Ergo report

During the project, the RULA pie chart was created one by one for each of the five workers. Subsequently, the values of the pie charts were averaged in order to obtain a comprehensive picture regarding the workloads during the whole process. This summary is shown in the pie chart below.



RULA pie chart showing the average values regarding the five workstations

The RULA pie chart showing the average values regarding the five workstations indicates that in only 10.3% of the time were the movements of the workers correct from ergonomic point of view. In 15.6% of the time further attention was needed. In 44.6% of the time further investigation and corrective measures were needed and in 29.5% of the time corrective measures should have been taken immediately.

More project related analysis methods

The workflows were further analyzed according to the NASA ergonomic analysis method and tested according to the ISO 11226 and EN 1005-4 standards. Finally a detailed RULA analysis documentation was prepared as well. We examined what kind of health-harming postures occur often and which movements slow down the work process significantly. While examining the motions, we identified those movements that were not utterly necessary for the successful completion of the task and looked for ways to avoid them. As a result, we were able to reduce the cycle time and it was possible to speed up the conveyor belt.

Not acceptable

	Critical Postures	Average Angle	Starting Time	Holding Time
1	Right knee flexion is >0° while standing (bottom is not rested) for more than 4s	19°	0s 800ms	21s
2	Left knee flexion is >0° while standing (bottom is not rested) for more than 4s	20°	1s 300ms	29s 700ms
3	Right knee flexion is >0° while standing (bottom is not rested) for more than 4s	19°	22s 100ms	5s

Extract from ViveLab Report – ISO11226 evaluation results

Results of cycle times measurements

The table shows the cycle time for each task performed at the different workstations. Cycle time means the time span an employee needs to complete his/her task. As one can see in the table, it takes almost twice as much time to complete the wiring of the cable container boxes as to complete the other tasks. This is the reason why two employees are needed at the cable assembly workstation in order to properly supply the following steps of the workflow with material.

At regular intervals the workers have to take the components to be assembled from the container. Therefore, when we calculated the cycle times we included the time needed to fetch the necessary items from the container. We have taken into account that it was not always necessary to go for a new supply. In those cases when the employee used to fetch the component parts for four new items at the same time, a quarter of the time needed to walk to the container and back was taken into account when we calculated the cycle time of the task.

Name of the workstation	Cycle time [s]
Cable box assembly – 2 workplaces	78/2=39
Pre-assembly step1	47
Pre-assembly step2	51
Final assembly	45

The table shows that originally the pre-assembly line was able to produce a new item for the final product assembly line every 51 seconds. This time span had to be reduced to 44 seconds or less in order to be able to accelerate the speed of the conveyor of the final product assembly line as it was desired by the customer. To succeed in this endeavour, the cycle time of almost every task on the pre-assembly line had to be reduced.

Description of the identified problems in general:

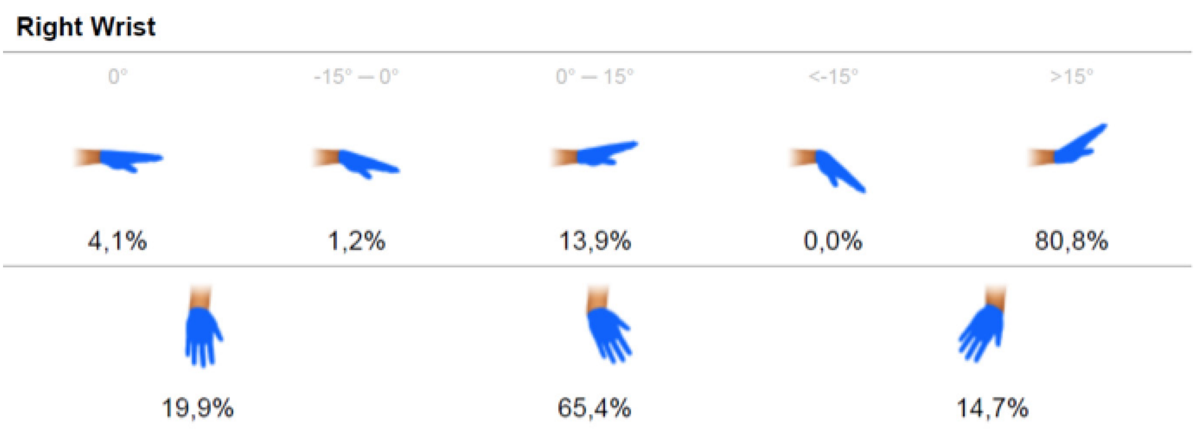
One of the biggest problems we have discovered was the scarcity of space. As a result, it was difficult to access the different parts of the workstations, it was impossible to find a suitable place for the supply containers, the employees often hampered each other's movements, the tools and fittings were rather encumbrance than help.

Although the employees had to move lightweight workpieces, this had to be done at a high frequency, which is nonetheless harmful for the musculoskeletal system. There was a mess on the tables because of the badly organized material handling and employees obstructed each other's way.

It has been found to be a serious problem that working in a standing position can cause muscle pain and fatigue and can lead to musculoskeletal disorders on the long term. Due to the poor design of the working environment, objects were difficult to grasp and move, which was causing joint pains in the hands. Uncomfortable and strained postures, such as bending forward to take the necessary items from the container or leaning over the table during installation, were common. In addition, the hands were regularly raised even above the shoulder.

We found basic size and dimension fitting problems regarding the design of the workstations. Working heights were not appropriate. The height of the supply containers did not meet the requirements either. Therefore, it was very difficult for the employees to complete their task and they had to take on postures that were harmful to their health in the long run. Reachability problems were common. The workers had to stretch far and wide for certain tools and parts. We found that the placement of tools and parts was irrational. These were difficult to access and were located at a distance from the employee. Employees wasted precious seconds walking and reaching for different parts and tools. Unnecessary movements made the workers tired and in many cases they had to take inconvenient postures.

High frequency movements and sustained uncomfortable static postures occurred in many cases. As shown in the figure below, the wrist joint was heavily stressed because the hand was raised or tilted sideways during a high percentage of the cycle time.



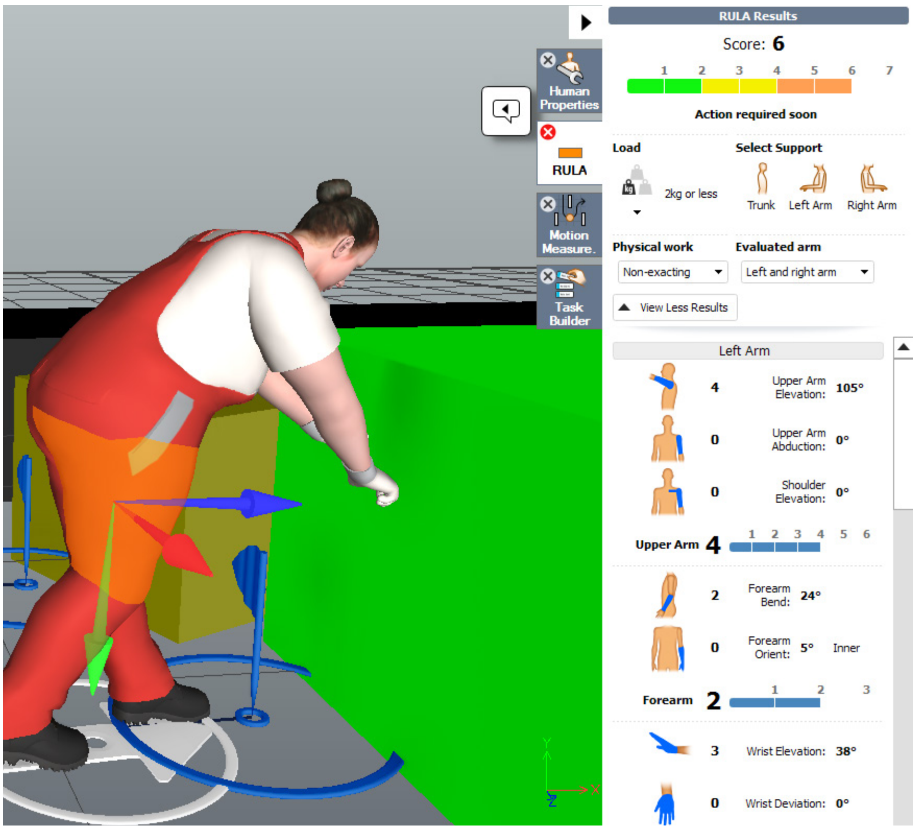
Extract from ViveLab Report - RULA Detailed Statistics

Noise levels were too high at all workstations, mainly due to machines on the company's other production lines.

Problems one by one for each workplaces

1. Cable box assembly:

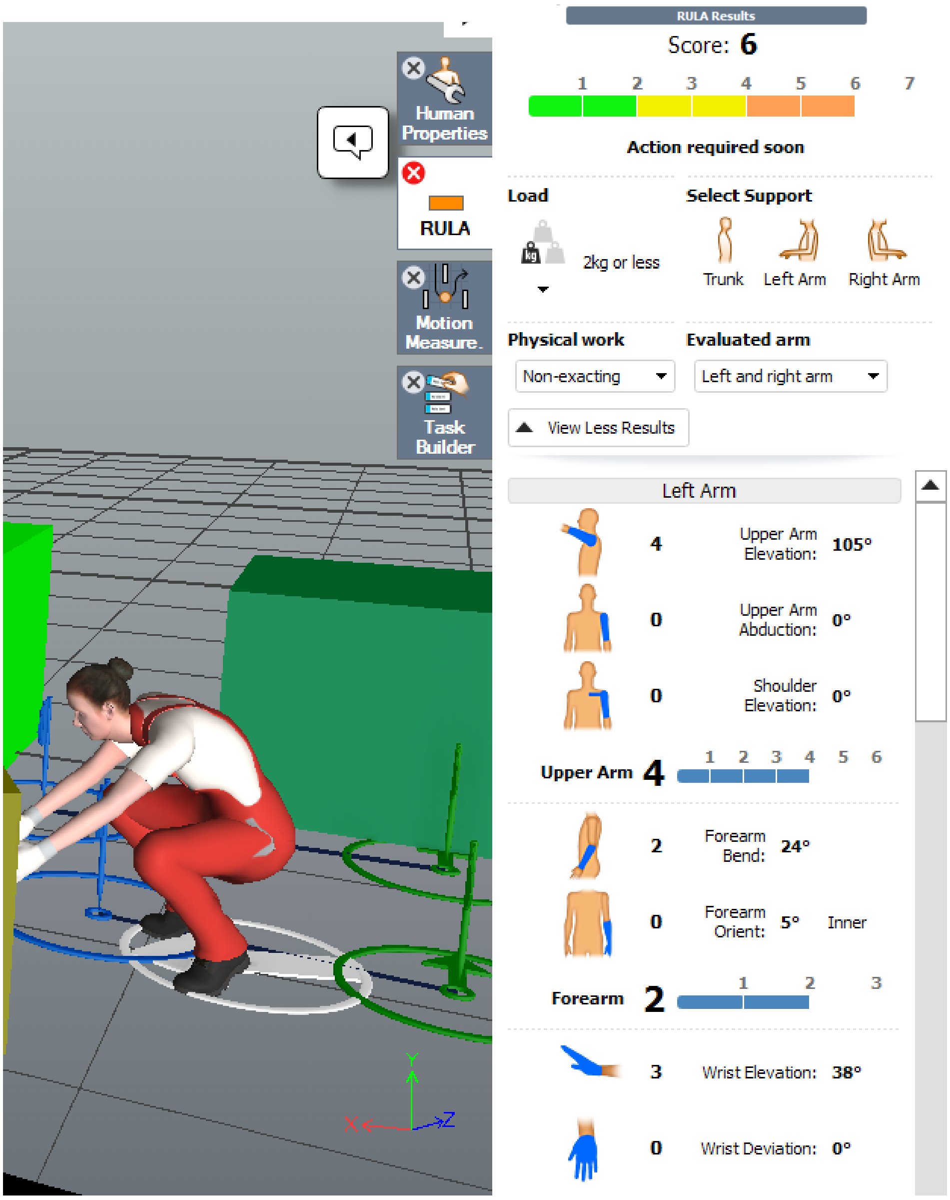
- Due to the distant location of the supply containers, large quantities of component parts were placed on the table at the same time creating a mess on the table.
- Working in a standing position all day long is enormously stressful for the musculoskeletal system of the employees. Still the strain of the body was not alleviated by any support, by chairs or by carpet that would facilitate standing.
- Workers were wasting much time walking unnecessarily between the supply container and the desk.
- The tools provided to the workers did not help the completion of the task properly either. For example, the method of storing the insulating tape that was used to bond the cables made it difficult to use it.
- As shown in the picture above, the height of the table shared by the two employees did not make their work comfortable. There are two employees of different heights working at the table. The height of the table was only for the taller worker approximately suitable.
- The height of the supply containers was not adequate. Each time the employees had to lean deeply forward into the container to fetch the necessary parts, as shown in the picture below.
- The wrist joints of the employees were heavily strained during installation and wiring operations.



The posture of the worker when taking the required item from the supply container

2. Pre-assembly step1:

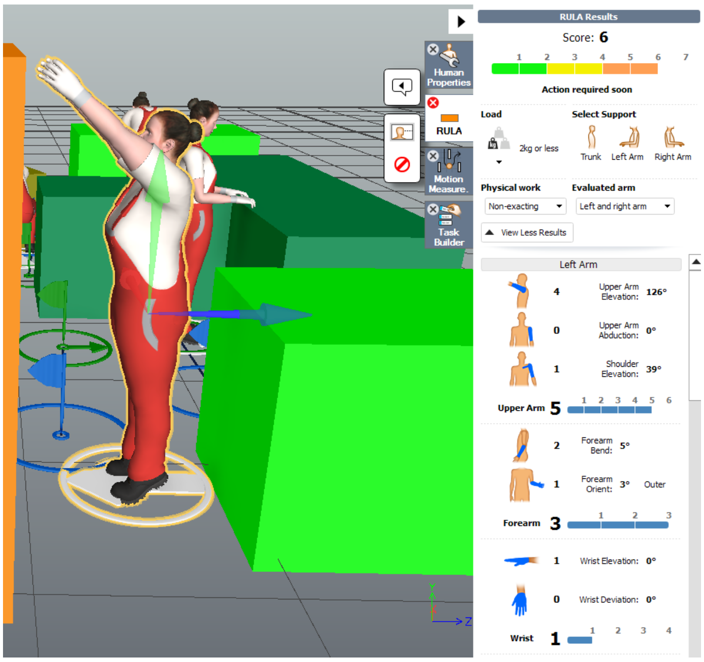
- Similarly to the previous case, the worker had to walk a lot to the supply container and back to fetch the items he needed.
- The employee had to fetch a rather large item from the supply container and more than one piece would not fit on his table. It slowed down the working process that he had to walk to the supply container each time when he began to work on a new piece.
- Working in a standing position all day long is enormously stressful for the musculoskeletal system. Still the strain of the body was neither in this case alleviated by any support, by chair or by a carpet to facilitate standing.
- Since the employee had to take an item from the table of the previous worker that was placed perpendicular to his desk slightly behind him, the trunk of the employee was oft in a twisted position.
- The wrist joints of the employee were highly stressed during the completion of the task.



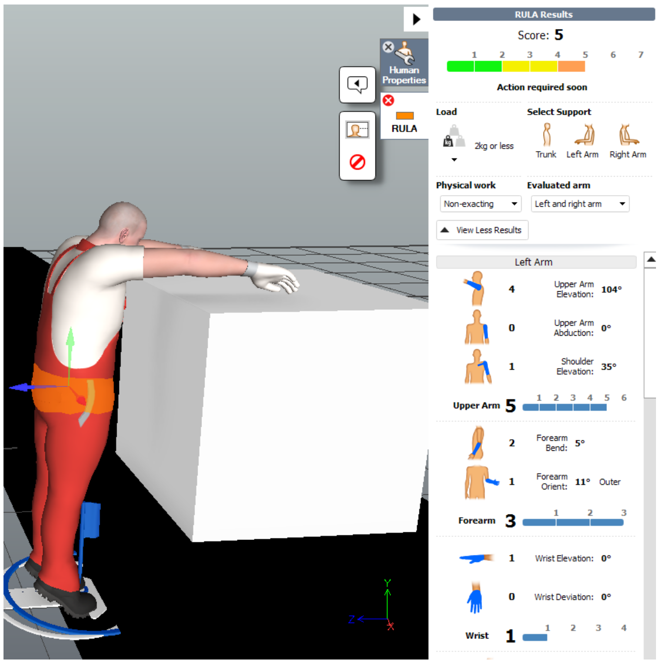
The posture of the worker when taking the required item from storage

3. Pre-assembly step2:

- At this workplace the employee also had to walk a long way to place the workpiece on the orange container.
- The employee had both to work above shoulder and to stoop down when placing the workpiece in the storage.
- The worker had to lean sideways and stretch his muscles firmly in order to take the item that he needed to complete his task from the supply container.
- The wrists joints of the employee were heavily stressed during the workflow.
- Similarly to the previous workstation, it was here too extremely demanding for the worker to work in a standing position all day. Again, the company did not provide any solution to alleviate the fatigue.



The worker places the finished item on the top shelf of the storage



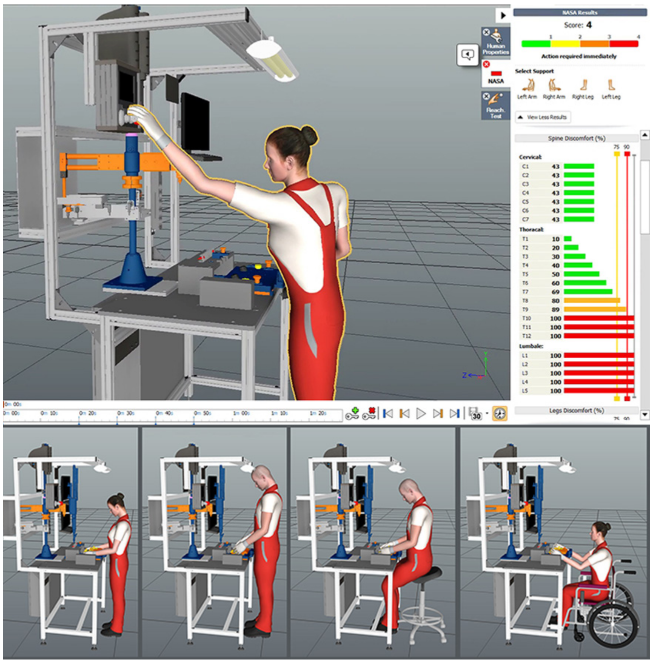
The worker assembles the item removed from the shelf with the piece arriving on the main production line

4. Final product assembly:

- The employee had to work in a very limited space.
- The employee's hands were often raised above shoulder when he was taking the necessary part from the supply storage and assembling the product.
- The worker had to stoop down frequently in order to take items from the bottom shelf of the storage.
- The previously already mentioned problem of standing all day was encountered here as well. Neither here was any carpet or support provided for the worker to alleviate the fatigue.

STEP 4: TECHNICAL DESIGN, VIRTUAL VALIDATION

The report, that was exported form the software, clearly shows those movements that are physically demanding or avoidable. This report, which is based on accurate and objective measurements, provides essential data for the design team of engineers and ergonomics experts. On this basis, our specialists develop an action plan that includes several possible individual, organizational and technical proposals. We recorded the appropriate motion files for the selected new layout and simulated the new workflows. After analysing the results, we were convinced that the cycle time would indeed be shorter and that the workload would be reduced.



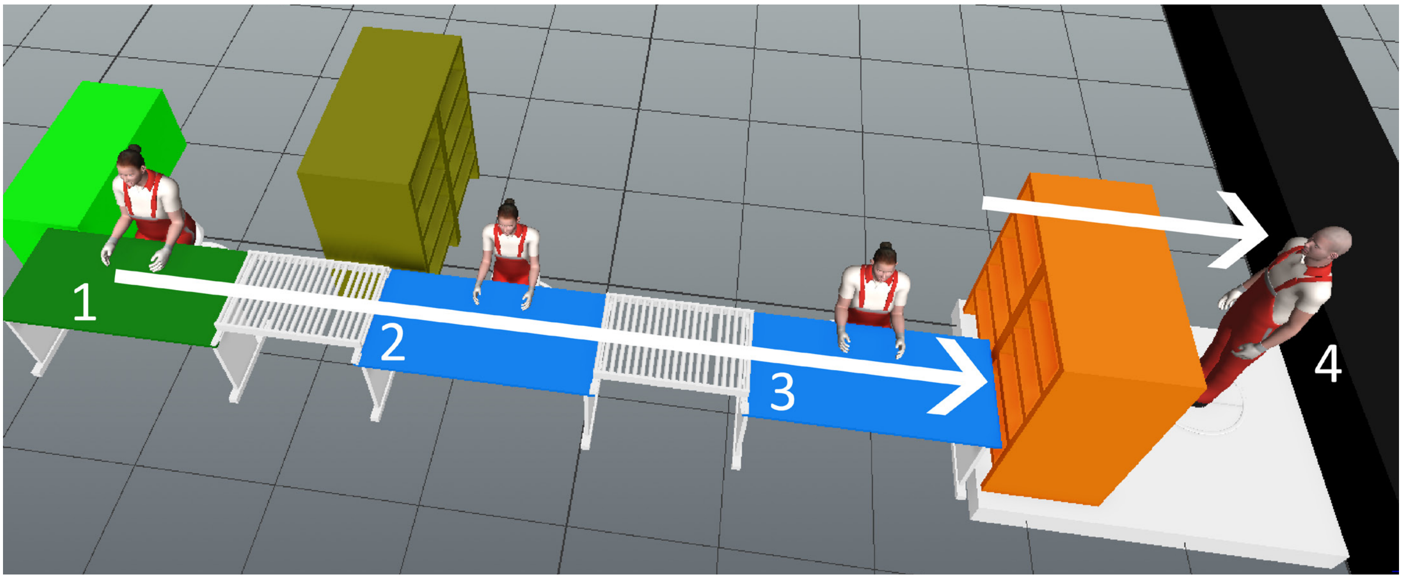
Ergonomic design with the help of the anthropometric database

Virtual validation without a prototype before the implementation

DESCRIPTION OF THE REDESIGNED PRE-ASSEMBLY LINE

The colors used in the original model were retained. In the two models objects with the same function are marked with the same color. The pre-assembly line has been aligned in a row to make the material flow linear, faster and simpler.

Instead of working on two larger workbenches as previously, each employee works at his own height-adjustable desk on the new pre-assembly line. This allows them to work at a table suitable to their own height. The advantage of this solution is that they are all able to carry out their tasks in the most comfortable manner and they get less tired during work. **As a result, the muscles of the neck, shoulders and spine of the worker are less strained. He is going to feel fatigue later and he can maintain high productivity. We can expect that in the second half of the shift his performance will not slow down and he is going to make fewer mistakes.**



Schematic illustration of a redesigned pre-assembly line

We recommended that the employees should be given a chair so that they could alternate between working in a standing or sitting position, which is also supported by the height-adjustable desk. The chair they use should also have wheels so that they can easily roll closer to the container or to the conveyor belt.

We have proposed the installation of roller bar conveyors between the different workplaces for the transfer of items to be assembled. In this way the employees have to raise less weight and they can simply push the workpiece to the next table. Another benefit of the new arrangement is the elimination of clutter on the desktop that was previously caused by the accumulation of component parts for several new items on the table.

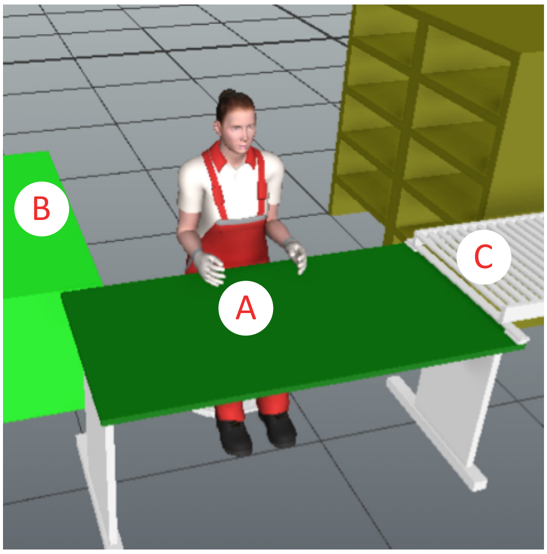
We have also rationalized the method how tools and parts are stored. It can be seen in the picture that the supply containers are placed closer to the workers and consequently, they can reach more easily the necessary parts. According to the new work organization, the light green supply container and some smaller storages on the desktop (that are not visible for confidentiality reasons) are going to be filled by the pre-production line supplier instead of the person working at the workstation. The orange container gets filled by employee No. 3. This is where the pieces completed on the pre-assembly line are stored. Normally only one or two shelves of the orange container are going to be filled because the worker No.4 continually takes the pieces and assembles them with the pieces arriving on the conveyor of the main production line. The other shelves remain in most cases empty. However, if for some unforeseeable reason the conveyor belt of the main production line stops, the orange container, that is substantially larger than necessary, makes it possible to store more pieces. Consequently, the pre-assembly unit does not have to stop.

It is not shown in the schematic diagram above, but the tools in use have been replaced with ergonomically more suitable ones, and they have been placed better. (Due to the confidentiality agreement with the customer we cannot show these corrective measures in detail.)

CORRECTIVE MEASURES ONE BY ONE FOR EACH WORKPLACE

1. Cable box assembly station

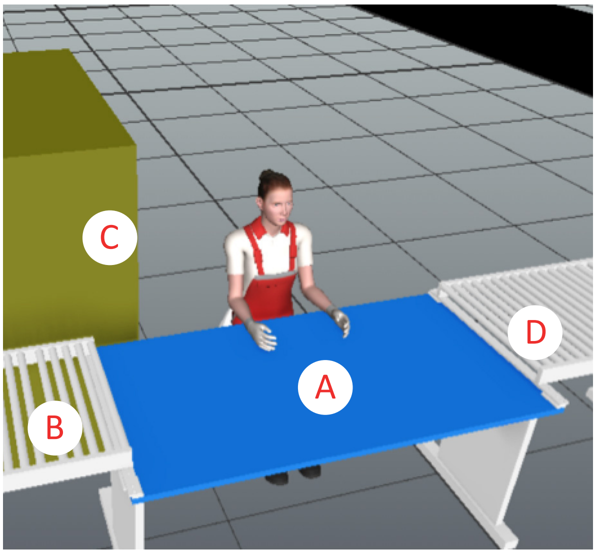
At this workstation we recommended the use of the aforementioned height-adjustable table (A) and ergonomic chair. In this way we have achieved that the worker does not have to work in the same body position all day. The storage of the parts to be assembled (B) was placed near the workplace, saving the fatigue of walking to the supply container and back. We also split the workflow and passed the second phase to the next employee. At this workstation only the assembly of the cable box is carried out, and the next worker has to fix the cables with an insulating tape. The workpieces are passed to the next employee on the roller bar conveyor (C) that is placed between the tables. In this way the workpiece can be transferred to the next workstation much faster and without superfluous movements.



Cable box assembly station

2. Pre-assembly station 1

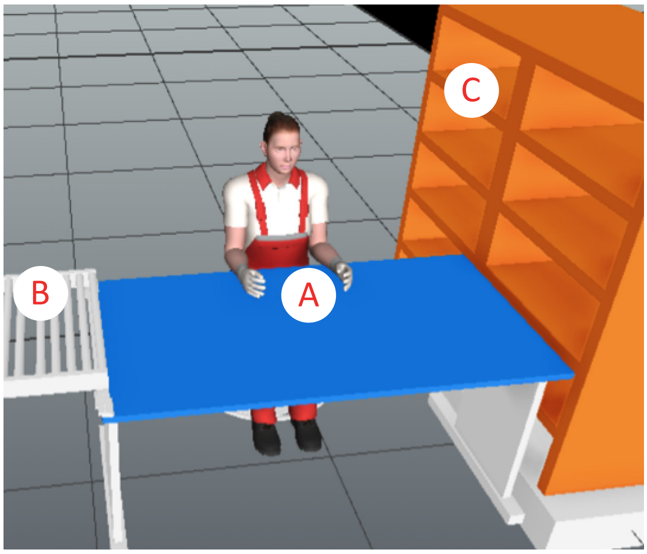
In this case too, the station was transformed into a sitting-standing workplace with a height-adjustable table (A). This was the best way to relieve the worker. During the workflow, the worker reaches sideways for the workpiece that arrives on the roller bar conveyor B and then glues the workpiece. This step was originally done by the previous worker. Similarly to the previous workplace, we planned to place the storage containing the rather large parts next to the workstation. The container is indicated by the letter C in the figure. We have saved the fatigue of walking to fetch the parts to be assembled. As a consequence, we could accelerate this workflow as well. During the final step, the worker screws the pieces together and then pushes them onto the roller bar conveyor D.



Pre-assembly station 1

3. Pre-assembly station 2

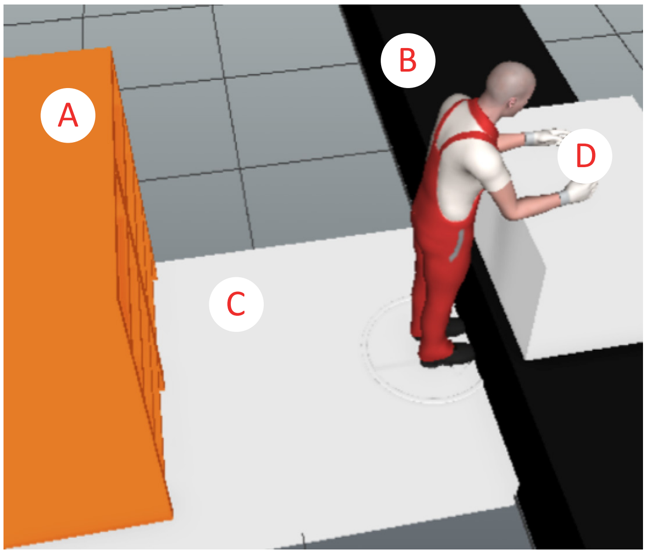
This workstation has been transformed into a sitting-standing workplace with a height-adjustable (A) desk as well because, similarly to the previous cases, working in a standing position all day long had the most serious health effects for the worker. Here, the workflow has been optimized as follows: the employee removes the workpiece from the roller bar conveyor B and performs his previous task. He also completes some of the screwing originally done by the previous employee. He then places the finished workpiece on the orange container C on his side.



Pre-assembly station 2

4. Final product assembly station

As during the original workflow, the employee takes a piece from the orange container (A) and assembles it onto the workpiece that arrives on the main production line which is indicated with black color and the letter B in the picture. At this workstation we recommended the use of a platform in order to raise the worker (C), which makes it easier for him to carry out his task at the height of the conveyor belt (D). In addition, the position of the tools he uses has been rationalized. Their position has been chosen in a way that they are as close as possible to the place where they are used and come in handy to the worker. This saves valuable seconds when taking and using the tools.



Final product assembly station

PROJECT RESULTS

The entire project from the on-site screening until the technical design and virtual validation took approximately 12 working days. The most important result of the corrective measures was that it reduced the cycle time in the pre-assembly unit. In this way we could achieve the goal that had been set by the customer. It became possible to speed up the conveyor belt as it was requested. The time required to produce the final product has been reduced as well. The speed of the conveyor belt has been increased by 15% compared to the original speed. This faster production process increases the annual revenues of the company approximately by 250 000 Euro. In addition, it is a big success that at the cable box assembly workplace one employee can fulfil the task instead of two, yet the production is faster. This is going to save approximately 15 000 Euro annual wage costs for the company. In addition, supplying the line with raw materials has become much smoother. Space requirements for the new pre-assembly line are 24 square meters. The financial gain achieved by protecting the health of workers is harder to quantify. Preventing musculoskeletal disorders also means financial savings, as the cost of sick leave days is significantly reduced.

Evaluation of cycle times

The following table summarizes the cycle times for the original and modified workflows

Name of the workstation	Cycle time [s]	
	Original workflow	Modified workflow
Cable box assembly station	78/2=39	43 (one worker)
Pre-assembly station 1	47	40
Pre-assembly station 2	51	42
Final product assembly	45	39

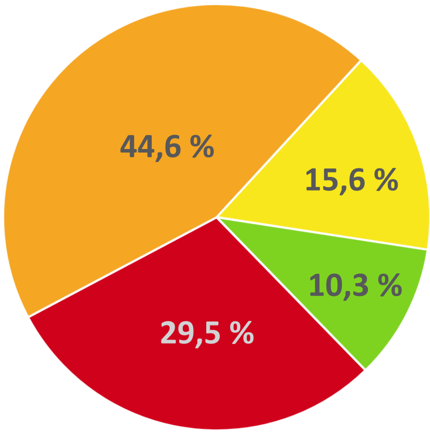
Originally, a workpiece was completed every 51 seconds on the pre-assembly line. However, there was a step of the task that took 78 seconds. Therefore, the company was forced to employ two workers to complete this task. This allowed passing a new workpiece approximately every 39 seconds from this station to the next one. **It can be understood from the table that we succeeded in reducing the time it takes to complete the task to less than the desired 44 seconds at each workstation. This is largely due to the reasonable placement of the parts to be assembled and to the reallocation of some work steps to other workers.** Thanks to the reorganisation, one employee instead of two can fulfil the task at the cable box assembly workstation and yet the production is faster. As a consequence, the worker can be moved to another area where there is a shortage of workforce. In addition, it has played a major role that the employees were provided with the right tools and that we succeeded in improving the comfort level of the employees.

Analysis of the original and redesigned workflows

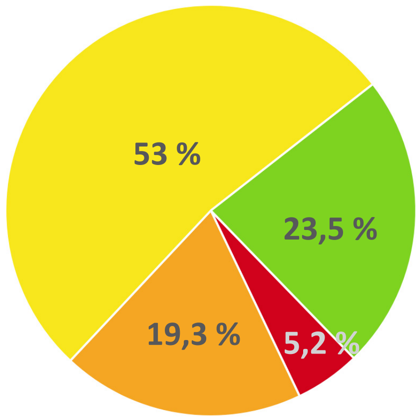
We tested with the ViveLab Ergo software the redesigned workstations according to the same ergonomic analysis methods as we had done in the case of the original workplaces. The report exported from the software details the analysis results for each workstation. From this document the RULA analysis results are compared below.

Avaraged pie chart of workflows on the pre-production line

Original pre-production line



Modified pre-production line



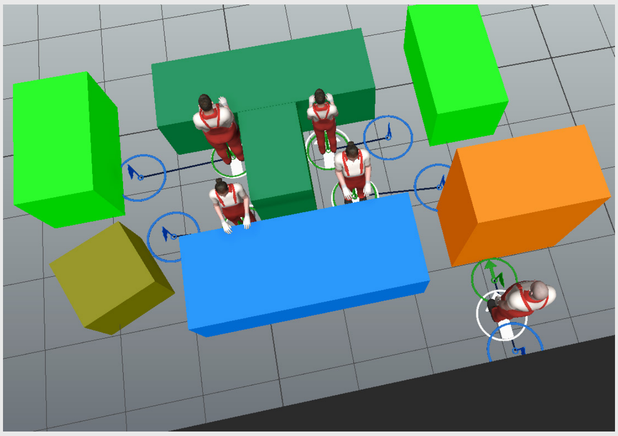
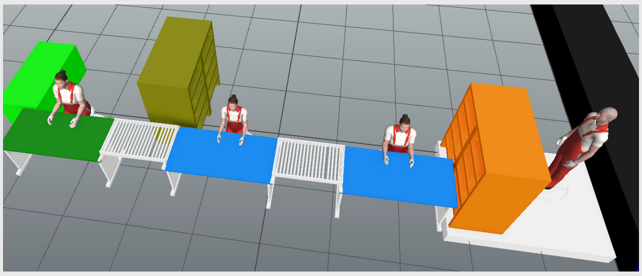
At the redesigned workstation, according to the above pie chart, in 23.5% of the cycle time the body position of the worker was ergonomically completely correct. Moreover, in 53% of the cycle time the movement requires later further attention. In 19.3% of the time the movement requires examination and corrective measures on the long run and only in 5.2% of the time are immediate corrective measures needed. **As one can see from the charts, the proportion of postures that pose long-term health risks has been significantly reduced. In parallel, the proportion of healthy postures has increased. This example illustrates that significant results can be achieved with a few simple modifications when we want to reduce the workload for the employees.**

Like the original workstations, the redesigned ones were examined according to the NASA method, and tested according to the ISO 11226 and EN 1005-4 standards. Every analysis method proves that the redesigned workflow is much less burdensome for employees.

We consider it to be an outstanding achievement that we were able to secure the compliance with the strict requirements of the EN 1005-4 Work Safety Standard, which examines the posture and movement of workers in relation to the machine during work.

As a result of the changes we have brought about, workers will be less exhausted by the end of the shift. Musculoskeletal disorders are going to be less common. In addition, ergonomically designed workplaces help the company to keep the workforce, as everyone likes to work in a workplace where the tasks can be carried out comfortably.

Production area

Original pre-assembly line	Modified pre-assembly line
	
41 m2	24 m2

As can be seen in the table above, the space requirements of the workstations have been reduced from 41 m2 to 24 m2, which means that the space requirement has been reduced to 58%.

Number of employees

Original pre-assembly line	Modified pre-assembly line
5 employees	4 employees

Thanks to the optimization, one cable assembly workstation is enough instead of two, because one employee can complete the task on as many workpieces as is needed in order to supply the next workstations on the pre-assembly line.

CONCLUSION

The example presented here demonstrates how can, based on the results of a detailed ergonomic study, a successful redesign of a workstation or of a complete manufacturing unit reorganise the workflow and improve the efficiency of an entire factory. It is a huge achievement in itself that with fewer workers production is yet faster and production space is reduced, but it is invaluable that the employer has done everything he can to prevent musculoskeletal disorders. This will make the company more attractive than its competitors.

ViveLab Ergo is a cloud-based ergonomic lab for modeling objects, machines and human beings moving together in a virtual 3D space. Thanks to its massive anthropometric database and 7 built-in ergonomic analyses it precisely simulates, analyzes and validates human interactions with industrial and other environments. With the help of the ViveLab Ergo the ergonomic analysis of constructions is possible in the planning phase without prototype production by simulation in the virtual space.

Our mission is to provide fast and accurate three-dimensional virtual ergonomic tests, analysis and planning for wide range of companies to create optimal working environments and workflows for health, efficiency and competitiveness.

If you would like to learn more about ViveLab Ergo software and our ergonomic service, please contact us.

VIVELAB ERGO LTD. VIVELAB.CLOUD INFO@VIVELABERGO.COM