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Correcting Working Postures in Water Pump Assembly Tasks using the OVAKO Work Analysis System (OWAS)

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Abstract

Ovako Working Postures Analyzing System (OWAS) is a widely used method for studying awkward working postures in workplaces. This study with OWAS, analyzed working postures for manual material handling of laminations at stacking workstation for water pump assembly line in Electrical Industrial Company (EICO) / Baghdad. A computer program, WinOWAS, was used for the study. In real life workstation was found that more than 26% of the working postures observed were classified as either AC2 (slightly harmful), AC3 (distinctly harmful). Postures that needed to be corrected soon (AC3) and corresponding tasks, were identified. The most stressful tasks observed were grasping, handling, and positioning of the laminations from workers. The construction of real life workstation is modified simultaneously by redesign suggestions in the values of location (positioning) factors for stacking workstation. The simulation workstation executed by mean of parametric CAD software. That modifications lead to improvement in the percentage of harmful postures. It was therefore recommended the use of supplementary methods is required to identify ergonomic risk factors for handling work or other hand-intensive activities on industry sites.

Keywords: OWAS, working posture analysis, stacking workstation.

1. Introduction

Work-related musculoskeletal disorders (WMSDs) have been recognized as a serious social problem because of the rising costs associated with wage compensation, medical expenses, reduced productivity, and lower quality of life [1,2,3]. This is a serious problem in many countries; these injuries now comprise 52% of all work-related injuries in the United States, disable 5 million workers each year, and cost about $100 billion annually [4]. in the Netherlands alone, some 250.000 persons each year are declared incapable to work due to physical complaints The percentages of the WMSDs of all work-related or occupational injuries increased from 10% in 1998 to 23% in 2000, while the percentages of the occupational injuries of all work-related or occupational injuries and illnesses decreased from 57% in 1998 to 29% in 2000 [5]. These ailments can often be attributed to work-related physical load [6]. It is possible to get reliable information about risk factors of WMSDs by using the observational methods such as OvakoWorking posture Analysis System.

2. Posture Assessment

Postural Analysis provides an analysis of the operator's posture while working. The emphasis in this section is on minimizing unnecessary operator actions and on reducing the amount of lifting done by operators during work. The psychophysical approach estimates worker capacity to perform a given task based on perception of the difficulty of a task [7].

Extreme postures will adversely impact energy expenditure and the strength we can bring to bear to accomplish a task awkward or extreme postures are less efficient than postures that keep joints near the center of their range of-motion [8].

2.1 Ovako Working Posture Analyzing System: OWAS

The physical workload was assessed using the Ovako Working-posture Analysis System (OWAS). This is a multimode observation method that was originally designed in Finland for the steel industry. In the OWAS observer makes an instantaneous analysis of posture and defines it with a three digit code. The first digit describes the position of the back (four choices), second digit describes the arms (three choices), and the third digit describes the legs (seven choices) [9]. An example of the classification chart is given in figure (1). It is based upon expert judgments of the harmfulness of particular postures. A time-based sampling approach can be used with it so that the categorization can take account of the length of time spent in any can take account of the length of time spent in any particular posture [10]. OWAS does not have any kind of underlying mathematical model. Instead it relies on a lookup table that converts three digit posture codes into Action Categories (AC). Table (1) converts the action category into action requirement. OWAS action categories were derived based upon work postures and loads managed for each job-task. Action Categories (AC) classify the relative risk and urgency for intervention to prevent musculoskeletal disorders due to exposure, especially to Low Back Pain (LBP) [11]. The workers' postures were analyzed according to different work phases (corresponded with the task analysis) calculated in percentages and assigned an action category code [10].

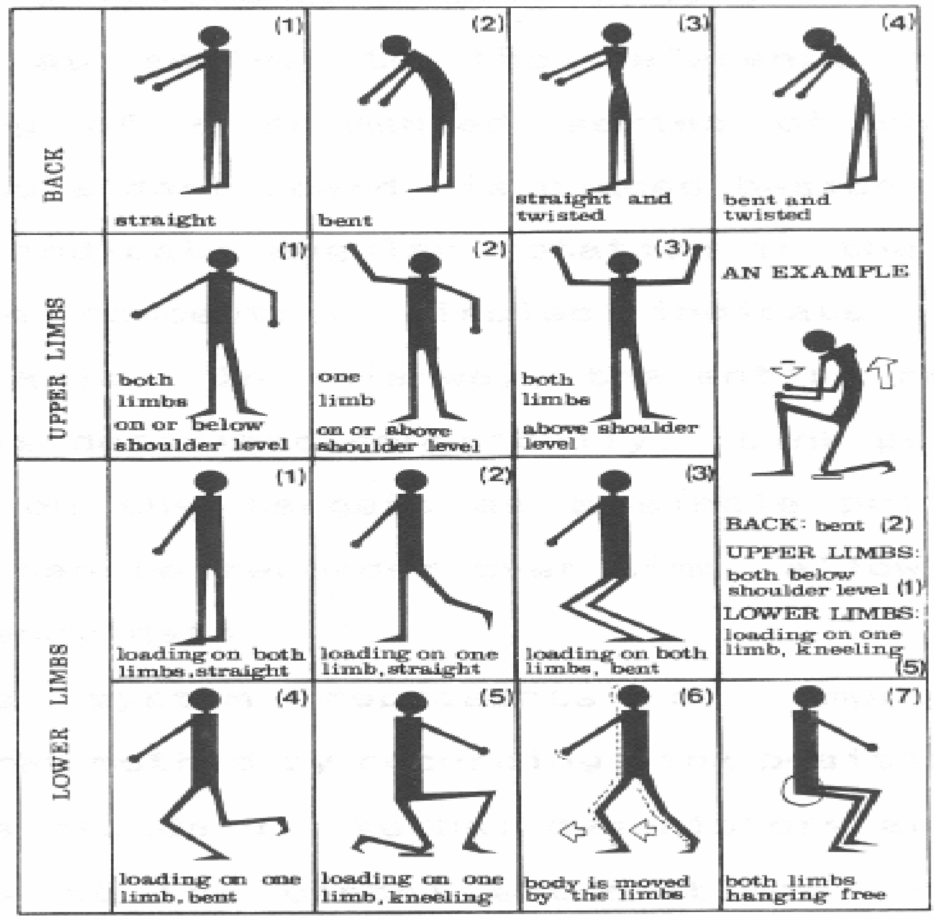

Fig.1. Example OWAS Classification Chart [9].

Table 1
The OWAS Action Code [10].

Action Category	Action Required
AC1	No action required
AC2	Action required in the near future
AC3	Action required as soon as possible
AC4	Action required immediately

2.2 WinOWAS: Software for OWAS Analysis

The posture evaluation method developed in this study was implemented as a computer software program has a timer, called WinOWAS [12] (Figure 2) which can be used to measure the observation phasing. The system was designed to automate all the procedures for the analysis of the postures, except for observing the postures and recording them according to the postural classification. The user observes and records the working postures using automatically paused motion pictures. The motion pictures can be recorded by digital camcorder directly at the working site or transformed from the video in the analog form using a MPEG computer system. When starting the observation, the user enters the location of the movie files along with some information about the work. The observer can also record postures in other ways: by direct observation at the working site, by indirect observation through a video on another monitor, and from pictures or image files. This system enables the user to observe working postures continuously or intermittently. For intermittent observation, the player pauses the movie file automatically for the user to observe the working postures regularly. The user can set the sampling interval. In the continuous observation, the user can record working postures by the event-driven way, controlling the play of the movie file manually. After the postures are recorded, the system analyzes the recorded postures. The frequencies, temporal changes, and durations of postures at each joint are documented, and the predicted workload level of each recorded posture is calculated. A very useful characteristic of the system is that the user can retrieve and view the image of the corresponding posture as a result of the analysis. For example, the image of the posture found to have the highest workload level can be shown by clicking the bar representing the posture on the graph of workload level. The user can easily understand the results of the analysis simply by viewing the postures together. This system may enhance the applicability of working posture analysis by the safety managers in the field.

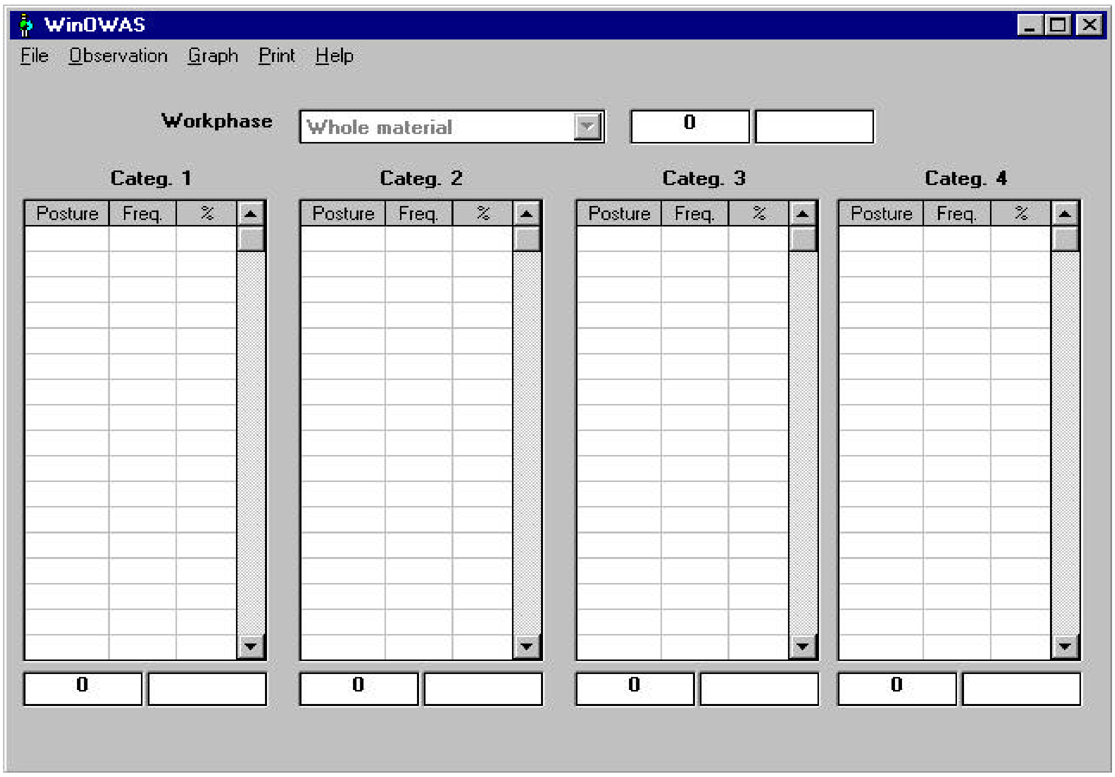

Fig. 2. Shows the Main Interface of the WinOWAS.

3. Poor Working Postures in Iraq

There are cross-cultural variations in postural habits; Iraqis frequently use postures that are unfamiliar to western people, such as deep squatting, kneeling, cross-legged sitting, and so on. The squatting posture was found to require more than 5 times the workload compared to sitting on a chair, based on subjective discomfort. This implies that the squatting posture is not proper for prolonged work, though it is a common posture for many Iraqis workers. Iraqis workers typically perform their jobs in prolonged squatting postures in shipbuilding shops, automobile assembly lines, farms, and machine repair shops. Back injuries in manufacturing and transportation industries were mainly due to overexertion, while they were ascribed to incidental injuries in construction industries. Overexertion injuries are related to the repeated exertions and poor working postures during manual materials handling (MMM). Non-neutral trunk postures as well as manual lifting of moderate-to-heavy loads have been referred as major risk factors for LBP [5]. Figure (3) illustrates the examples of poor working postures, such as prolonged squatting, simultaneous trunk flexion and lateral bending, at workplaces including shipbuilding shops, automobile assembly lines, and farms in Iraq. Especially in the automobile assembly lines, there exist many jobs that require improper working postures. Often, assembly line workers need to raise their arms and bend their trunk, and they have to assume these kinds of postures, say, 500 times a day.

Fig.3-A. Sampling Picture of Grinding Worker's Posture.

Fig. 3-B. Welding Task of a Mechanics Worker.

4. Method

4.1 Process Description

In State Company for Electrical Industries, the winding & insulating department is the one from the departments of the water pump assembly line. The department consists of five workstations included stacking, brazing, insulating, winding and testing. One operator for each workstation performed a job specified to them except the first one (stacking) illustrated in figure (4) where the manual material handling tasks for the laminations stator in that station achievable by two operators working in alternative period due to highly physical stress demand required for that job. According to the requirements of balancing on line, the capacity planning limited to 1000 stator for 8 hours shift work separated by 60 minute standard break period, laminations cylinder are continuous unloaded at the rate of 2.38 lifts per minute (i.e. 2.38 lifts / min. per tier are loaded). The time study for the processes in winding & insulating department confirmed that the long cycle time for first process (stacking) had significant effect in specified the capacity planning and total balancing for the line. This is the bottleneck station in the line. In order to increase the throughout of the line, redesign suggestions for station responsible about maximized cycle time should be execute. The basic configuration for this workstation comprised attention to facilities and tooling systems, material-handling systems, and ergonomic workplace. A checklists survey among 8 workers working at this station in different times, showed that among those who worked in an existing stacking workstation design leads to long cycle time, uncomfortable work posture, bending, squatting, and forceful exertions when unloading stator laminations.

Depending upon the checklists indications, the existing workstation for stacking process presented in figure (4) needs changes in some components design and reconfiguration for layout of workplace.

Fig. 4. Real Life Workstation.

4.2 Simulation Model

The main task is the manual handling of the laminations at the stacking workstation in Argon welding machine; we focus on ergonomics improvement and minimize the cycle time related to this task.

The construction of real life workstation is modified by redesign suggestions in some factors. All the factors are location (positioning) factors of stacking workstation. In particular these factors are (A), (B), and (C) as illustrated in figure (5) show the redesign suggestions of workstation by mean of parametric CAD software. The body position category is affected by configuration changes.

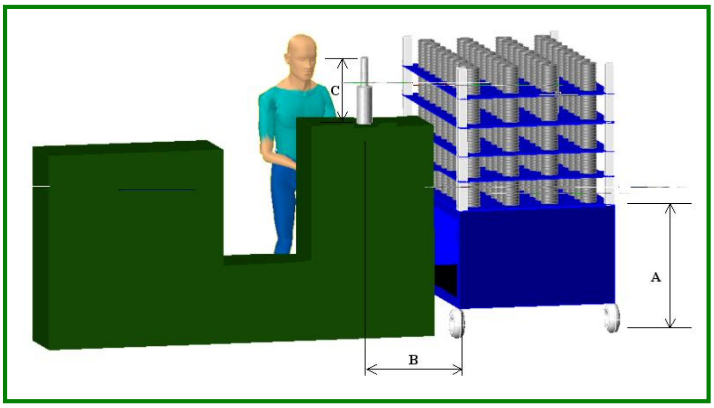

Fig. 5. The Redesign Suggestions of Workstation.

4.3 Research Aims

The aims of this study were to:

1. Analyze working postures for manual material handling of cupper laminations at stacking workstation for water pump assembly line.
2. Develop recommendations for work improvement for the handling job observed.
3. Identify the relationship between working postures and strenuous tasks observed such as bending, twisting, and kneeling/squatting.

5. Results

5.1 Postural Analysis Existing Stacking Workstation Design

Data were collected and analyzed using the WinOWAS [12]. The cycle time for completing the task (one lifting) as longer period for the last tier in the pallet. At this tier when the worker grasp the stator laminations is lateral bending with picking up objects below knuckle height, twisting the back without moving the feet. The worker works with bent back, low arms and a standing posture.

According to the OWAS's classification, worker's working postures needed more attention with more than 13% having harmful postures and 13 % needing correction recently. Figure (6) summarizes the action categories for the postural observations recorded for the material-handling tasks. The construction ratios of standard working postures were listed in table (2). The worker works with straight back, low arms and a standing posture, but 13% bent and twisted their back and 12% walking.

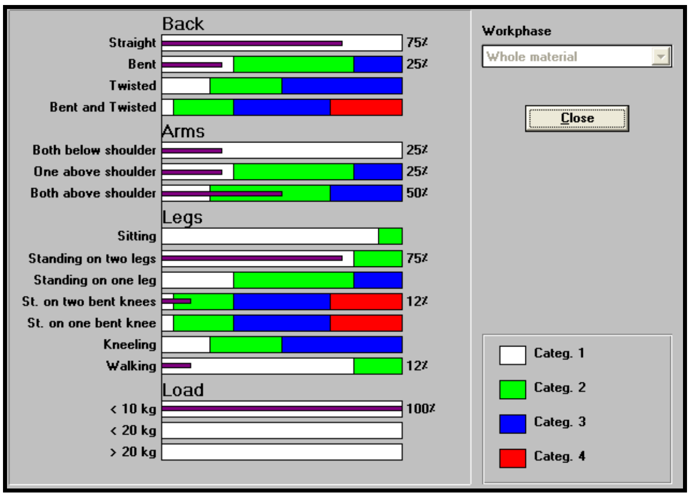

Fig. 6. Construction of Working Postures in Real Life Workstation.

Table 2
OWAS Action Category Frequencies and Percentages in Real Life Workstation.

AC1 (%)			AC2 (%)			AC3 (%)			AC4 (%)		
Posture	Frequency	%	Posture	Frequency	%	Posture	Frequency	%	Posture	Frequency	%
1321	3	37	2121	1	13	2141	1	13	----	----	--
1221	2	24	----	----	---				----	----	--
1371	1	13	----	----	---				----	----	--
Total	**6**	**74**	Total	**1**	**13**	Total	**1**	**13**	Total	**----**	**--**

5.2 Posture Evaluation in Reviewing Workstation Design

The simulation results of posture evaluation in suggestion workstation are listed in table (3).

Due to the redesign suggestions for workstation, the percentages of observed postures showed that the harmful categories for the handling laminations job caused by AC3 was eliminated and the majority of harmful postures for job was classified as AC2 level increased to 20% rather than real life workstation which may harm the worker in the long run. The range of movement or working posture where risk factors causing load on the structures of the body segment are minimal for comparison with the real life workstation as shown in figure (7). The interobserver reliability was 60% for straight back postures, 60% for arms above shoulder postures, 100% for leg postures, and 100% for weight handled, respectively.

Table 3
OWAS Code for the Postures and Percentages in Suggestion Workstation.

AC1 (%)			AC2 (%)			AC3 (%)			AC4 (%)		
Posture	Frequency	%	Posture	Frequency	%	Posture	Frequency	%	Posture	Frequency	%
1321	2	40	2121	1	20	---	---	--	----	----	--
1121	1	20	----	----	---	---	---	--	----	----	--
3321	1	20	----	----	---	---	---	--	----	----	--
Total	**4**	**80**	Total	**1**	**20**	Total	**0**	**0**	Total	**0**	**0**

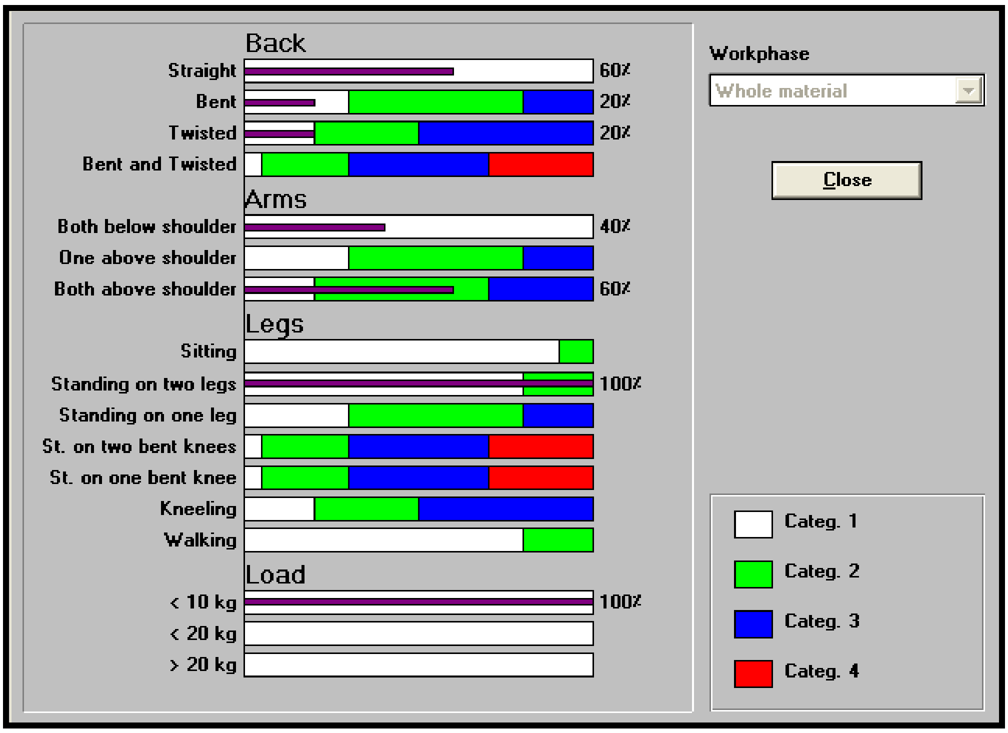

Fig. 7. Construction of Working Postures in Suggestion Workstation.

6. Discussion

For real life workstation the observed posture combinations classified according to the harmfulness of the postures, into two action categories AC2, AC3 that will require remedial action in the near future, and as soon as possible, respectively. The most common harmful postures for the job were identified by OAWS code 2121 and 2141. The ergonomic risk caused by 2121 was the bending of the back. The risk of 2141 was caused by the bending of the back and kneeling on both knees simultaneously. The 2121 posture was observed when the worker was bending, grasping, and positioning. The 2141 posture was recorded when a worker was positioning the laminations for an argon welding machine. These postures were recorded when the workers were grasping, manual handling, and positioning. The bending and kneeling/squatting of the workers always occurred when they worked near floor level. A change of posture is not easy if working height cannot be brought to a level near the waist or the elbow These postures can be reduced just to 2121 in AC2 code when these strenuous postures considerable in the modification suggestions of workstation. This can be improved by choosing the values 80 cm, 35cm, and 40 cm for factors (A), (B), and (C) respectively according to considerations for a well designed workstation. Even with these modifications in workstation the worker's working postures with 20 % needed correction recently but our suggestions can be improved the most strenuous awkward working postures such as body twisting, bending, kneeling/squatting, and walking of the worker.

7. Conclusion

This study employed the OWAS method to study the working postures for four jobs at two construction sites. The aim was to identify the tasks by ergonomic risk factors and develop recommendations for work improvement.

The AC2 postures, from the output of WinOWAS, were listed. The most problematic working postures found for the job were bending of the back and squatting/kneeling on both legs. Frequent handling of laminations in stressful postures was found for worker. The AC3 postures were identified and work improvements were discussed.

The OWAS method suitable and reliable for analyzing the tasks at assembly workstations. It is a proper method for studying working postures involving the movement of whole body. With the help of videotape and computer technology, OWAS can be used efficiently in identifying awkward working postures for the shoulders, back and legs.

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تصحيح أوضاع العمل في مهام تجميع مضخة ألماء بإستخدام نظام تحليل العمل ((OWAS))

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الخلاصة

يُستخدم نظام تحليل ألعمل ((OWAS)) بكثرة كطريقة لدراسة أوضاع العاملين في أمكنة العمل. وفي هذه الدراسة، تم إستخدام هذا النظام لتحليل هذه الأوضاع أثناء المناقلة اليدوية للصفائح في محطة اللصق العائدة لخط تجميع مضخة الماء في الشركة العامة للصناعات الكهربائية/ بغداد. وبأستخدام برنامج حاسوبي يدعى ((WinOWAS)) تم إعداده لهذه الغاية، وُجد أنهُ في محطة العمل الحقيقية هناك 26 % من هذه الأوضاع التي تمت ملاحظتها يُصنف بكونه أما يقع في الصنف الثاني من الأوضاع ((AC2))- قليل الضرر- أو من الصنف الثالث ((AC3))– يؤثر بشكل سلبي على ألمدى البعيد-حيث يحتاج هذا الصنف من الأوضاع إلى تدخل قريب لتصحيحه خصوصا وقد أمكن ألتعرف على ألمهام المسببة لنشوءه. إن أغلب المهام الشاقة التي تمت ُملاحظتها كانت تكُمن أثناء مسك ألصفائح، مُناقلتها ووضعها من قبل العاملين.

وباستخدام المُحاكاة من خلال برنامج الرسم الآلي ((CAD)) تم تطوير هيكليّة تلك المحطة الموجودة فعلا من خلال إقتراحات بإعادة التصميم لها بتغيير قيّم (أبعاد) عدد من العوامل الداخلة في تركيب هذه المحطة بحيث يمكن صياغتها بشكل آخر ومن ثم دراسة أوضاع العمل فيها إفتراضا. وقد أثمرت تلك التحويرات في هيكليتها عن تحسُن في نسبة أوضاع العمل بتقليل السلبي منها. ومما تمت ملاحظته أيضا، أن إستعمال الطُرق الإجرائية من شأنه أن يُسهم في توضيح العوامل المُسببة للأخطار البشريّة في أعمال المُناقلة أو تلك التي يتم فيها عمل يدوي في ألمواقع الصناعيّة.