# Ergonomics Application to Work Design on Seafood Processing Line

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**Abstract.** Nowadays the seafood processing industries have been developing rapidly in Vietnam. Modern equipment and state-of-the-art technologies are used for processing seafood. However, there are workstations in the manufacturing process where manual manipulation is indispensable. Field surveys conducted at seafood processing companies show the improper manipulation of workers, equipment and tools which are not ergonomically designed – not working well with human factors, leading to occupational diseases. This article focuses on research into the manipulation, posture and motion of workers on the production line based on human factors, ergonomics, and motions. Postural analysis tools using RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment) method were applied for assessment. From the results of the above analysis, this study will redesign the work motion, work posture of workers and the equipment, which is aimed at minimizing the risk of workers suffering from occupational diseases and working more safely.

**Keywords:** Ergonomics, Work design, Motion, Posture, Workstation

## 1. INTRODUCTION

Ergonomics focus today is designing jobs that meet the capabilities of the worker. It's the science of fitting the job to the worker, is used to design environments, procedures, and tools that improve efficiency, alleviate physical and psychological stress, and reduce the potential for injury.

### 1.1 Problem Statement

The food-processing industry is facing many challenges to compete in today's global market. The seafood processing industry is the largest export industry in VN. Thus, the industry plays a very important role in the cultural and economic life of Viet Nam. Currently, there are over 1,300 seafood processing facilities, of which about 627 seafood processing establishment industrial scale. The total capacity is of about 2.8 million tons / year.

Fish processing can be subdivided into the preliminary processing of raw fish, and the manufacture of fish products. Another subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces chilled, frozen and canned products.

Food-processing workers may fatigue and discomfort when performing highly repetitive tasks, and awkward postures. Working under these conditions may result in chronic injuries to muscles, tendons, ligaments, and nerves. Injuries of this type are known as work-related musculoskeletal disorders. Fish processing workers may face a lot of work related health hazards due to various reasons, which the majorities were females.

In this study, I concentrated on one particular group to allow detailed investigation of how workers interact with each element of the task (Filleting and Trimming fish). The overall aim was to use a combination of methods the Rapid Upper Limb Assessment and Rapid Entire Body Assessment.

### 1.2 Methodology

Firstly, to observe directly the postures and the motions of workers in the seafood processing line, the ergonomics problems are considered at the workstations those have wrong postures and motions. Secondly, Digital camera is used to record video of worker's motions. Video filming is a valuable method of evaluating movements, especially where work is repetitive and performed at a brisk pace. Thirdly, Applying RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment) method to evaluate the postures and motions for improve

them. RULA is a specific task analysis method muscle use, force applied and posture are assessed according to a standard method to give a number score for the task.

Workers often experience muscle discomfort, aches and pains because of the hand and arm movements they make. These undesirable movements may be forced upon them by the design of their workplace and hand tools. The workstations must be redesign to 'fit' the worker, using the correct 'shape' and 'size'.

## 2. LITERATURE REVIEW

N. A. Ansari, Dr. M. J. Sheikh (2014) applied Rapid upper limb assessment (RULA) and Rapid entire body assessment (REBA) for assessment work posture of workers engaged in different activities of small scale industry.

Chang, S.W., Wang, M.J (2007) proposed a method using Digital human modeling for conducting workplace assessments in the digital environment. By integrating dynamic simulation and ergonomics evaluation, digital human modeling enables the system designer to visualize and improve workplace design in the digital space.

Nadia Rego Monteil et al (2013) presented a fish processing facilities simulation analysis of a factory ship based on a real case. The objective of the study was to detect opportunities for improvement, and proposed a Discrete Event Simulation (DES) and a Digital Human Model (DHM) to go from generals to specifics.

Prakash C. Dhara et al (2016) The sitting stool was suggested to design according to the body dimensions of the fish processing worker, those may be helpful for reducing the occupational hazards, physiological cost and at the same time the productivity may be enhanced. It was effective to reduce the musculoskeletal disorders of the fish processing workers and the work posture was improved.

## 3. MOTION ANALYSIS

This descriptive study was carried out in a food processing factory in Tien Giang Province, Viet Nam, which produces canned tuna.

By postures and motions analysis of fish processing workers, there are not the difficult postures and work tasks, the posture sustained for the longest period of time or the highest force loads. So we use Rapid Upper Limb Assessment method only.

### 3.1 Filleting

Using a filleting knife, and cutting behind the head. This cut does not cut the head off the fish. Without removing the knife, turn it so that the cutting edge is pointing toward the tail of the fish. Run the blade down the length of the fish against the backbone. By cutting evenly and smoothly, you will split the tail. This job includes the motions:

Motion 1: Grasp a fish from a basket then put on the cutting board.

Motion 2: Use a filleting knife to stab the fish and move the knife along the entire length of the body. This motion is performed twice, stab in the back of the fish then into the spine.

Motion 3: Use the filleting knife to cut out the fish fillet.

Motion 4: Flip the fish

Motion 5: Use the filleting knife to stab the fish and move the knife along the entire length of the body. This motion is performed twice, stab in the back of the fish then into the spine (Similar motion 2).

Motion 6: Use the filleting knife to cut out the fish fillet. The same with motion 3

Motion 7: Soak the fillet in water to wash, then put it in a basket. Meanwhile, use right hand to push the leftover of the fish to the waste basket next to the table.

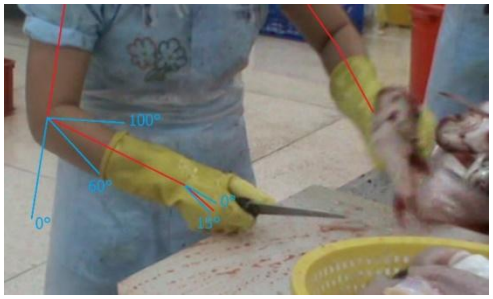


Figure 1: Motion 1, Grasp a fish from basket then put on the cutting board

Figure 2: Motion 2 (similar motion 5), Stab the fish and move the knife along the entire length of the bod

Figure 3: Motion 4, Flip the fish

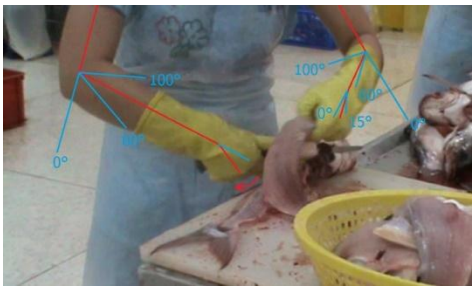

Figure 4: Motion 6, Cut out the fish filet

### 3.2 Trimming fish

Motion 1**:** Grasp a fish fillet from a basket then put on the cutting board

Motion 2: Using a knife to remove one edge of the fish fillet (raw cut), then quickly rotate it 180°.

Motion 3: Using a knife to remove the other edge of the fish fillet (raw cut), the same with motion 2.

Motion 4: Keep working on the same side of the fish fillet, use the knife to remove that edge of the fish fillet (precision cut)

Motion 5: Use the knife to remove excess parts near the top of the fish fillet, then quickly rotate it 180°.

Motion 6: Use the knife to remove the previous edge of the fish fillet (precision cut), the same with motion 4.

Motion 7: Put the finished fillet in a basket.

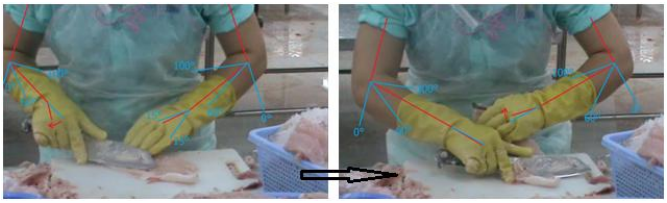
Figure 5: Motion 2, Remove one edge of the fish fillet

Figure 6: Motion 5, Remove excess parts near the top of the fish fillet


Figure 7: Neck and trunk of worker

Table 1: RULA Scoring for Filleting

| FILLETING | RULA Scoring | | | | | | |
|---|---|---|---|---|---|---|---|
| | Motion 1 | Motion 2 | Motion 3 | Motion 4 | Motion 5 | Motion 6 | Motion 7 |
| **A. Arm and Wrist Analysis** | | | | | | | |
| Locate Upper arm position | 2 | 3 | 2 | 3 | 2 | 3 | 2 |
| Locate Lower arm position | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| Locate Wrist position | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| Wrist twist | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| Posture score in Table A | 3 | 4 | 4 | 4 | 3 | 4 | 4 |
| Muscle use score | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Force/Load score | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Final Arm and Wrist Score*** | **4** | **5** | **5** | **5** | **4** | **5** | **5** |
| **B. Neck, Trunk and leg Analysis** | | | | | | | |
| Locate Neck Position | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Locate Trunk Position | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Legs | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Posture score in Table B | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Muscle use score | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Force/Load score | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Final Neck, Trunk and legs Score** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| **FINAL SCORE** | **5** | **6** | **6** | **6** | **5** | **6** | **6** |

RULA Score: 5 (Further investigation, change soon)
RULA Score: 6 (Further investigation, change soon)

Table 2: RULA Scoring for trimming fish

| TRIMMING FISH | RULA Scoring | | | | | | |
|---|---|---|---|---|---|---|---|
| | Motion 1 | Motion 2 | Motion 3 | Motion 4 | Motion 5 | Motion 6 | Motion 7 |
| **A. Arm and Wrist Analysis** | | | | | | | |
| Locate Upper arm position | 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| Locate Lower arm position | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| Locate Wrist position | 2 | 3 | 3 | 3 | 3 | 3 | 2 |
| Wrist twist | 1 | 2 | 2 | 2 | 2 | 2 | 1 |
| Posture score in Table A | 4 | 3 | 3 | 3 | 3 | 3 | 2 |
| Muscle use score | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Force/Load score | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Final Arm and Wrist Score*** | **5** | **4** | **4** | **4** | **4** | **4** | **3** |
| **B. Neck, Trunk and leg Analysis** | | | | | | | |
| Locate Neck Position | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Locate Trunk Position | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Legs | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Posture score in Table B | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Muscle use score | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Force/Load score | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Final Neck, Trunk and legs Score** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| **FINAL SCORE** | **6** | **5** | **5** | **5** | **5** | **5** | **4** |

RULA Score: 4 (Further investigation, change may be needed)
RULA Score: 5 (Further investigation, change soon)
RULA Score: 6 (Further investigation, change soon)

## 4. MOTION IMPROVEMENTS

**Holding knife**

The first issue need to be noticed is how workers hold knives. Through pictures used for analyzing motions, the current way workers hold knives is wrong. It makes controlling knife is not completely convenience and lead to accident at work. As can be seen, thumbs and forefingers rest on the blade. The thumb will get hurt because worker uses thumb to push more force on the blade.

Improvement: the handle grip is figure as below. With the handle grip, the hand is completely behind the on the handle itself. It should be used by beginners or people who have small hands. Workers in filleting stations should apply this.

Figure 8: Holding knife is wrong

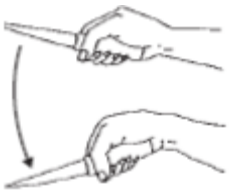

Figure 9: Holding knife is correct

**Locating the items on work table**

Through pictures used for analyzing motions, locating the items is not entirely logical. This will slow down the operation and cause them pain later. As the baskets are placed too far to reach, workers have to lean forward, and arms have to work across midline or out to side of body.

Improvement: This should be the position of baskets, raw fishes which helps lower arm can reach easily, and also according to the order of steps to increase operation speed and improve performance.

**Group B: Neck, Trunk and leg Analysis**

It can be noticed that group B scores are the same for all motions. The workers have to work in the same condition, the height of work tables are the same but not suitable for all workers. The table is 85 cm high, resulting in them having to bend down too much and poor postures. These make workers have to bend their necks and trunks, their legs have to bear the weight of the whole body.

Improvement: Data collected from working workers.The height of workers is varied. There are 3 body sizes: small, medium, and height, the table height are 90cm, 95 cm, and 100cm respectively. B score reduces from 5 to 3.

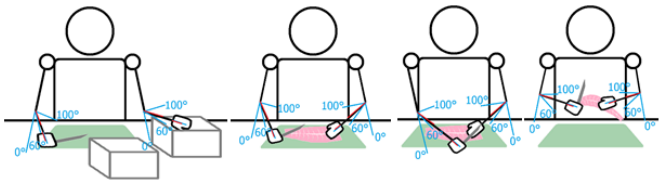

Figure 10: Filleting improvement

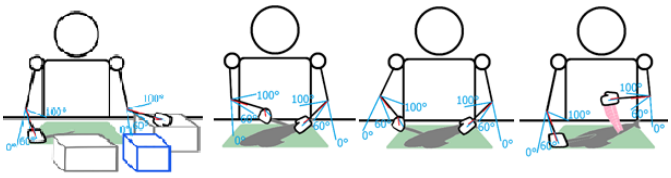

Figure 11: Trimming fish improvement

**Group A: Arm and Wrist Analysis**

When the work table height is respectively the worker size, changing the way of holding knife, and redesign the position of items on the work table, then the factors are changed as:

Table 3: Final Scores got before and after improvement

| FILLETING | RULA Scoring | | | | | | |
|---|---|---|---|---|---|---|---|
| | Motion 1 | Motion 2 | Motion 3 | Motion 4 | Motion 5 | Motion 6 | Motion 7 |
| **FINAL SCORE (Before)** | **5** | **6** | **6** | **6** | **5** | **6** | **6** |
| **FINAL SCORE (After)** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| TRIMMING FISH | RULA Scoring | | | | | | |
| | Motion 1 | Motion 2 | Motion 3 | Motion 4 | Motion 5 | Motion 6 | Motion 7 |
| **FINAL SCORE (Before)** | **6** | **5** | **5** | **5** | **5** | **5** | **4** |
| **FINAL SCORE (After)** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

RULA Score: 3 (Low risk, change may be needed)

## 5. CONCLUSION

After changing the way to hold knife and locating the items on the working table: Workers can avoid injury more effectively, controlling the knife gets easier, working efficiency is increased, fish fillets can be in good shape and high quality, and performance of workers is improved. From the results of the above analysis we know that, redesigning the workplace, and the way of holding tool are important. These results help workers perform their task easily, reduce stress and pain. This is aimed at minimizing the risk of workers suffering from occupational diseases and working more safely.

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## Appendix A. Assessment of some filleting motions

| Filleting | Motion 1 | | Motion 2 | | Motion 4 | | Motion 6 | |
|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After |
| **Upper arm position** | From -20° to 20°, abducted (1+1=2) | From -20° to 20° (1) | From -20° to 20°, abducted, shoulder is raised (1+1+1=3) | From -20° to 20° (1) | From -20° to 20°, abducted (1+1=2) | From -20° to 20° (1) | From -20° to 20°, abducted (1+1=2) | From -20° to 20° (1) |
| **Lower arm position** | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) |
| **Wrist position** | From -15° to 15° (2) | Straight at 0° (1) | From -15° to 15°, bend from midline (2+1=3) | Straight at 0°, bend from midline (1+1=2) | From -15° to 15° (2) | Straight at 0° (1) | From -15° to 15°, bend from midline (2+1=3) | Straight at 0° (1) |
| **Wrist twist** | Twisted in mid-range (1) | Twisted in mid-range (1) | Twisted near end of range (2) | Twisted in mid-range (1) | Twisted in mid-range (1) | Twisted in mid-range (1) | Twisted near end of range (2) | Twisted in mid-range (1) |
| **Muscle use score** | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) |
| **Force/Load score** | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) |
| **RULA Score** | 5 | 3 | 6 | 3 | 6 | 3 | 6 | 3 |

## Appendix B. Assessment of some trimming motions

| Trimming | Motion 2 | | Motion 5 | |
|---|---|---|---|---|
| | Before | After | Before | After |
| **Upper arm position** | From -20° to 20° (1) | From -20° to 20° (1) | From -20° to 20° (1) | From -20° to 20° (1) |
| **Lower arm position** | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) | From 60° to 100°, across midline (1+1=2) |
| **Wrist position** | From -15° to 15°, bend from midline (2+1=3) | Straight at 0° (1) | From -15° to 15°, bend from midline (2+1=3) | Straight at 0°, °, bend from midline (1+1=2) |
| **Wrist twist** | Twisted near end of range (2) | Twisted in mid-range (1) | Twisted near end of range (2) | Twisted in mid-range (1) |
| **Muscle use score** | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) | Action repeated occurs 4x per minute (+1) |
| **Force/Load score** | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) | Load is less than 4.4 lbs (+0) |
| **RULA Score** | 5 | 3 | 5 | 3 |