Journal for Re Attach Therapy and Developmental Diversities
eISSN: 2589-7799
2023 August; 6 (7s): 1396-1401

Ergonomic Analysis Of Virtual Assembly of Exercise Cycle Using CATIA

Dr.RajKumar.E[1*], Dr.Bindu.S.S[2], Sreeraj.M.P[3], Joe Jeba Rajan.K[4], Manoj.A[5], Ullas S[6], Krishnakumar. K[7], Mohan.R[8]

[1*]Professor, School of Mechanical Engineering, VIT,
[2]Associate Professor, Department of Mechanical Engineering, , Rajadhani Institute of Engineering and Technology,
[3,4,5,6,7]Assistant Professor, Department of Mechanical Engineering, , Rajadhani Institute of Engineering and Technology,
[8]PG Student, School of Mechanical Engineering, VIT,
rajkumarpillai2020@gmail.com

Abstract:

Ergonomics is a multidisciplinary field of Medicine, Engineering and Environment. It plays a significant role in the Product Design and development cycle. Ergonomics explains the relationship between the Human, Machinery and environment. The aim of the paper is to discuss the Design, Virtual assembly, Impact of Ergonomics in product design and development cycle within the virtual environment. With the aid of virtual assembly by computer simulation, the product designers do design verification and nullify design effects and ergonomic errors in the design. In this paper we analyzed the product after virtual assembly and human posture analysis and their observations are carried out by CATIA V5 R16. Its great advantages are to improve quality of the product, shortening the product development cycles, reducing the Ergonomic risks while stages in designing the product and simultaneously reducing the product cost etc.

Keywords: Product Development Cycle, Virtual Assembly, Ergonomics, CATIA V5R16.

Introduction:

The assembly plays a significant role in manufacturing a product apart from that by using virtual assembly technology we can do design considerations like Geometric Dimensions, Tolerances limits and fits and the problems which may arise during real time assembly so that we can suppress the specified problems during the design stage itself and also used to evaluate the ergonomic effect at the Virtual Environment itself. In virtual reality we can carry out the sequences required at the time of complex assembly without any trial. CATIA is one of the most widely used software which can provide a human simulation based on anthropometric data. By using CATIA, virtual mannequins in their standard positions can be put in pre-designed workstations and can predict the desired amount of power and strength based on body postures. In this paper we discuss human posture analysis and their observations are made by CATIAV5 R16 software, to design the components and assembly in the virtual reality. In this we are considering the factors affecting the ergonomics to improve the quality of the product such as easy handling, safety and comfort in the virtual environment.

Literature Review:

Based on ergonomic principles, the posture and movement of workers provide important information to diagnose the risk of musculoskeletal disorders in the workplace. Moreover, the workstation is one of the most important factors affecting people's posture while they are working. One of the main tasks of ergonomics specialists is to redesign the workstation. The ergonomic workstations design implies through different approaches such as 1) improving the quality of productivity, working life, and production 2) modification of working spaces to make services easier and more speed along with better-maintained operations 3) change in working methods including automation and task assignment between operator and machine 4) Controlling physical factors such as heat, cold, sound, vibration, and light. These approaches are being applied to increase efficiency, productivity, and safety. Besides, they would be beneficial to make applications easier, reduce human errors, stress and fatigue, improve workplace comfort of workers and eventually job satisfaction and acceptance. Product Development Cycle engages with a variety of cross-functional participants from engineering design, Manufacturing, Inspection, Quality control, procurement, marketing, sales, and service departments. It consists of all the processes and the documents related to the Product Development stages from the conversion of raw materials into finished products. The Product Development cycle helps to improve the features of the product ultimately reaching the needs of the customers.

Virtual Assembly:

The virtual assembly is defined as the process of matting the components of different shapes and sizes as per geometrical and modeling features of the components to make a sub-assemblies or a products in the Virtual environment that is with the help of Software like PRO E Wildfire 4.0, CATIA V5 R16 etc. It plays an important role in the product development cycle to analyze the Geometrical Dimensioning, Limits and Tolerances etc before manufacturing the product in a real time environment. It helps the designer to take decisions upon the design and modification virtually.

Ergonomics:

The term ergonomics refers to the study of human activity analysis which evaluates all elements of human performance from static posture analysis to complex activity. The aim of the ergonomics in design is to increase the human contribution to the system and the users in their regular activities. The optimum allocation of function between the user and the system. The user-system interface must be compatible with human capabilities and limitations. The main aspects of the design with ergonomics are procedure, workspace and environment. The main objective of ergonomics is most convenient to control the environmental conditions to execute human tasks without physical and psychological risks.

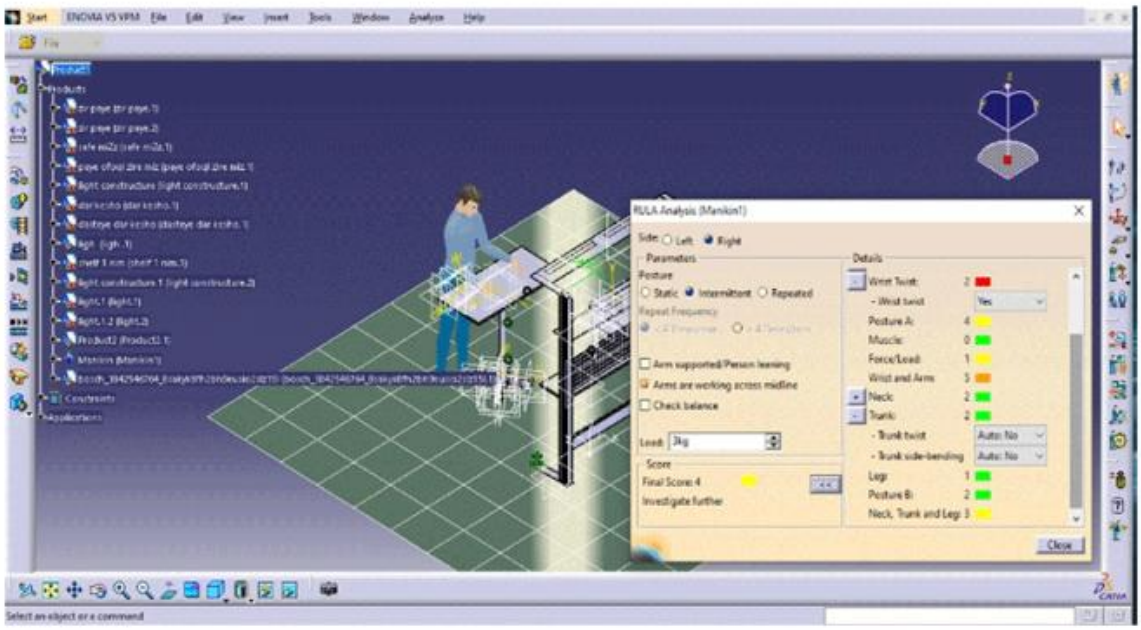

Figure 1. Ergonomic analysis using CATIA

Proposed Methodology:

In this paper we have designed an Exercise cycle using CATIA V5R16. The exercise cycle is designed and assembled in a sequence manner as per prioritizing the components to be assembled. Once the assembly is over the cycle is analyzed to meet ergonomic aspects. The analysis involves identification of handling and safety of the product which has been designed using CATIA V5R16. In this Exercise cycle we are considering the general design with the human posture analysis. Simulation software can be used to implement ergonomic needs in the design and optimization of workstations or the entire production system. Besides, there are several emerging technologies supporting human-centered simulation based on ergonomic validation in the workplace. Such tools allow us to simulate the places and tasks even before the workplace is physically present. Ergonomic principles are applied in Digital Human Models (DHM) in the early stages of design.

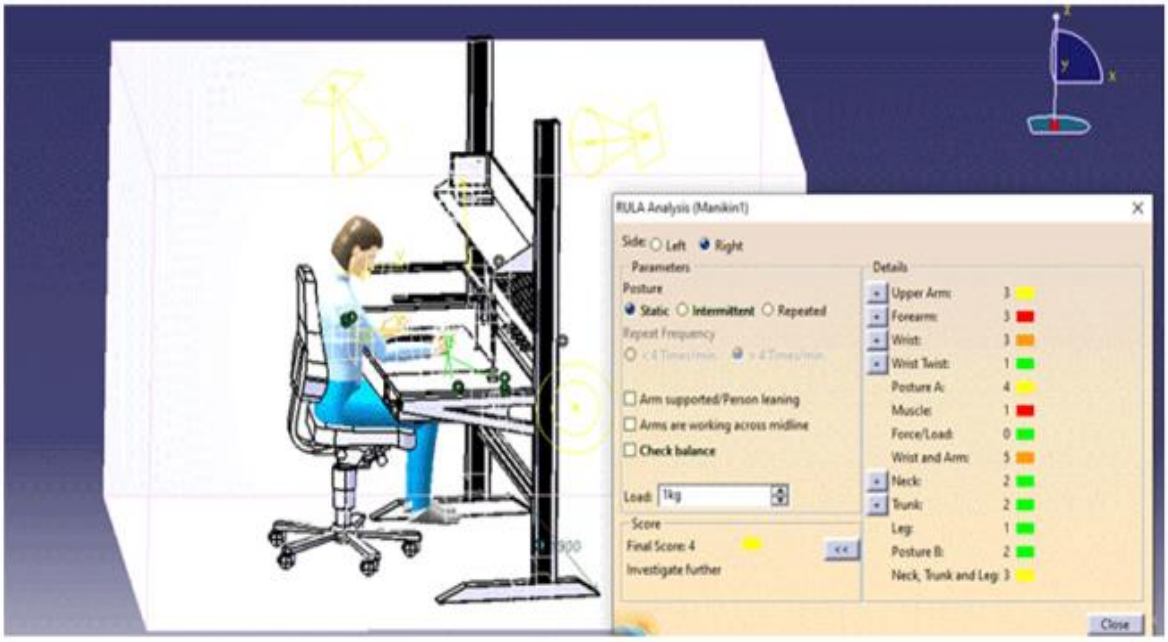

Figure 2. Human posture using CATIA

The ergonomic factors like comfort handling and safety in the product are checked while changing the assembling procedure by reducing ergonomic errors in the virtual reality. With this methodology under product development cycle we can make changes to improve the design which finally leads to fulfill the customer satisfaction.
Posture evaluation guide simulated by RULA method in CATIA software:

- 1 and 2: (green) determines that the posture is acceptable if not maintained or repeated for a long time.
- 3 and 4: (yellow) indicates that more research is needed and changes may be needed.
- 5 and 6: (orange) indicates that research and changes are needed soon.
- 7: (red color) indicates that research and changes are needed immediately.

These tools provide a fast and virtual representation of the role of the human in a simulated workplace. They can be used to identify ergonomic problems and prevent the risk of musculoskeletal disorders. If we use the desired posture, the plan can be implemented in the real environment.

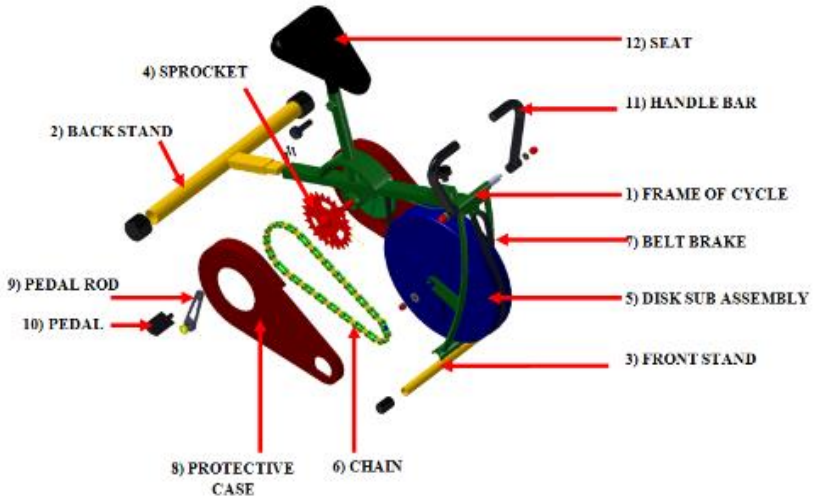

Figure 2: sequence of assembly of exercise cycle

Figure 3: assembled view of exercise cycle

Results and discussion:

Case1:

From this case 1, the picture represents the more difficulties in pedaling the cycle because of improper position of the Handle bar. Apart from that the more stresses have been identified virtually in the spinal cord of the human modal analyzed with the help of CATIA V5R16 therefore the changes are required in the product development cycle.

Figure 3: improper position of the Handle bar

Case2:

From this case2, the picture represents the still more difficulties in the spinal region due to more bending due to increase of height of seat and position of the handlebar in the Case 1 and are identified by human posture analysis using CATIA V5 R16.

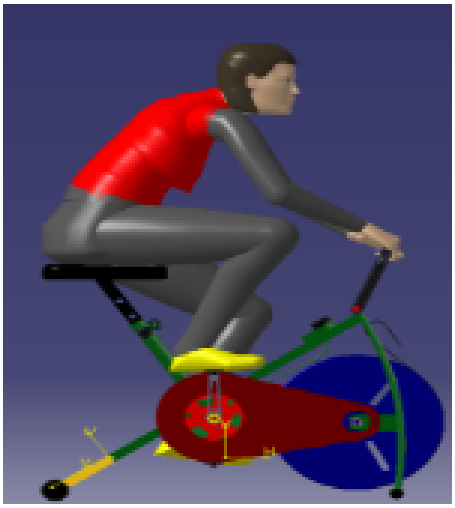

Figure 4. Bending due to increase of height of seat

Case 3:
It represents the position of the human modal more comfortably when comparing Case1 and Case 2 after rectifying the Ergonomical errors using CATIA V5 R16 in the virtual Environment.

Figure 5. Comfortable position of height of seat

Conclusion:

We have analyzed the ergonomic aspects in design and the necessary steps to be followed by designers to improve the product development cycle. Designing an ergonomic workstation for assemblers based on anthropometric data and opinions of experts and users, as well as posture evaluation using Kinect sensor, computer simulation, and opinions of assemblers. The ergonomic workstation was designed in CATIA. Also, working postures were analyzed in this software using the RULA technique.In designing a product, the product should ensure health and safety conformance standards and maximizing human comfort and safety. The method of analyzing the ergonomic factors using CATIA V5 R16 which gives the proper knowledge about modeling and ergonomic analysis of a product. This analysis will be very useful for industries, which strive for customer satisfaction. Future work is analysis of Human posture using Ansys and reactions on the Exercise cycle.

References:

1. B. Das, and A. K. Sengupta, “Industrial workstation design: A systematic ergonomics approach,” Applied Ergonomics, 1996.
2. Charles LE, Ma CC, Burchfiel CM, Dong RG. Vibration and ergonomic exposures associated with musculoskeletal disorders of the shoulder and neck. *Safety and Health at Work*. 2018; 9(2): 125–32.
3. H. Bullinger, P. Rally, and J. Schipfer, “Some aspects of ergonomics in assembly planning,” International Journal of Industrial Ergonomics, 1997, vol.11. PP.198-2010
4. Hong-Chul Lee , Jae-man Choi , Bokwon Lee , Tae-Gu Kim "Failure analysis of stress corrosion cracking in aircraft bolts", Elsevier,vol 14,No 8,2007, pp. 209-217.
5. JaapSchijve (2004), Fatigue of Structures and Materials”, Kluwer Academic Publishers.Ding Yulan. “Ergonomics”, third edition, Beijing:Beijing Polytechnic University Press,2000.
6. Mali S, Vyavahare R. An ergonomic evaluation of an industrial workstation: A review. *International Journal of Current Engineering and Tehnology*. 2015; 5(3): 1820–6.
7. R. Feyen, Y. Liu, D. Chaffin et al., “Computer-aided ergonomics: a case study of incorporating ergonomics analyses into workplace design,” Applied Ergonomics, 2000.
8. Sun Y, Nimbarte AD, Motabar H. Physical risk factors associated with the work-related neck/cervical musculoskeletal disorders: A review. *Industrial and Systems Engineering Review*. 2017; 60–44(1): 5.
9. SINGLETON, W.T.: 'Introduction to ergonomics' (World Health Organization), 1972
10. V. Jovanovic, M. Tomovic, I. Cosic et al., “Ergonomic design of manual assembly workplaces,” in Annual ASEE IL/IN sectional conference, 2007.