Proceedings of the 2021 Winter Simulation Conference
S. Kim, B. Feng, K. Smith, S. Masoud, Z. Zheng, C. Szabo and M. Loper, eds.

DES FOR THE EFFICIENT DESIGN OF A JACKET NODES WORKSHOP USING DISRUPTIVE TECHNOLOGIES

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ABSTRACT

In this study, Discrete Event Simulation (DES) has been used for the development of a jackets nodes workshop, located at the NAVANTIA - Fene shipyard facilities. Specifically, three plant layouts were analyzed, in which different equipment's technology improvements were used (from the least innovative and disruptive to the most). In this way, we were able to obtain the most favorable workshop design while minimizing the technological investment needed to meet the pre-set project takt-time. With this methodology, the company can verify that the project investment is profitable and minimizes the probability of missing due dates in jacket projects.

1 INTRODUCTION

Offshore wind energy is established nowadays as one of the renewable energies with the greatest projection in the medium and long term. For this reason, the international Spanish shipbuilder NAVANTIA is betting on the development of an innovative workshop for robotized node welding for jackets (offshore steel structures). Therefore, we have performed an analysis of three different case studies to find the design that best suits the requirements. Thus, the economic investment is based on the implementation of disruptive technologies only in the workshop stages that require it to meet the project's production objectives.

2 CASE DESCRIPTION

This work shows the design of a robotized nodes workshop to fulfil the specifications of two jackets projects, form by 62 and 35 units respectively. Each offshore structure has a total of 9 X nodes. In addition, the workshop layout must be able to achieve the target takt-time set by the company, that is 9 X nodes per week (7 days).

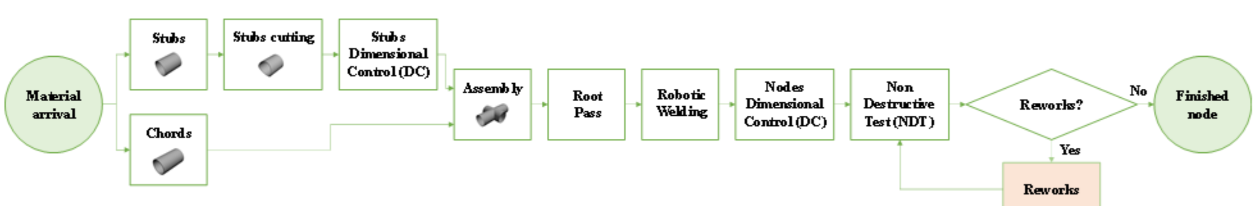

Figure 1. Manufacturing process flow.

Nodes are steel tubular joints made up by a pair of stubs that are welded to a central chord. This welding process is critical, as it determines the takt-time in jackets projects. In this way, to ensure that the welding has been carried out correctly, providing the necessary structural efficiency, the welded nodes must pass several technical inspections as shown in Figure 2. If the nodes do not pass the inspections (DC or NDT) they will have to go through the rework stage.

For the design of the three cases, a detailed technological study has been carried out for the needs of each stage. Only those stations whose technologies have been replaced with a disruptive one are shown in Table 1. In this line, along with the technological implementation, some of the stages have also been robotized. The remaining stations use the same type of technology in the new designs as in the base case: assembly is always performed manually, the root pass uses semi-automatic FCAW technology and, finally, the robotic welding uses a pulsed-arc MCAW technology. With these improvements the defectology of the weld bead is reduced. Therefore, the node's manufacturing time is minimized.

Table 1. Technologies of each stage.

Case	***Stubs Cutting***	***Stubs DC***	***Nodes DC***	***NDT***
Base	-	-	Laser triangulation	US Pulse-Eco
1	Robotized Plasma cutting	-	Laser triangulation	US Pulse-Eco
2	Robotized Plasma cutting	Robotized stereovision	Laser triangulation	US Phased-Array
3	Robotized Plasma cutting	Robotized stereovision	Laser tracker	US Phased-Array

3 RESULTS

Once all the possible layouts of the plant have been developed, the results shown in Table 2 have been obtained. As can be seen, as the robotization of the workshop increases, rework is reduced. So, in the second and third case, the required takt-time specifications are met.

Table 3. DES Results.

Case	***Defectology***	***Mean Cycle Time Jacket***	***Improvement*** (*)
Base Case	5%	10 days	-
Case 1	1%	9 days	10%
Case 2	0.1%	6 days	40%
Case 3	0.1%	4 days	60%

(*) *The percentage improvement of cases 1, 2 and 3 has been calculated with reference to the base case.*

Based on the results shown above, it is necessary to carry out an investment analysis to determine which case is more profitable for the company. Then, the main difference between case 2 and case 3 is that in the second case no technological investment is made for the DC Nodes stage, so the initial investment is lower.

Table 4. Investment Analysis Results.

Case	***Net Present Value (NPV)***	***Internal Rate of Return (IRR)***
2	0.84 M €	54.52%
3	0.72 M €	41.33%

As can be seen in Table 4, both cases have an IRR greater than 30% and are consequently profitable. Case 3 minimizes the takt-time, but it has a higher technological investment. However, case 2 is more economically profitable (lower initial investment, higher NPV and IRR) and it is more in line with the required project takt-time.

4 CONCLUSION

In this work, the optimization of the robotized node workshop layout has been developed through DES. In this way, we have been able to know in which stations it is profitable to make a technological investment to ensure that the manufacturing line achieves the production and economic targets.