# Contribution to the minimization of vibration of rotating machines

For Graduation to Magister
Specialty: Mechanical Engineering in Sidi Bel Abbes
Option: The Vibration Machines
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***Abstract***

***Rotating machines are used in areas as diverse as transport (trains motorized vehicles, etc.) Production industry, or appliances. The vibrations from them may êtregênantes; they are the source of some noise radiated by this machine and are therefore undesirable for users, they can be transmitted to neighboring structures and accelerate deterioration or aging, can also damage the rotating machines-they mêmes.il is therefore of interest to develop methods to reduce the vibration level of the machines, as well as that of their environment direct.Ces optimization methods (minimization) can minimize the natural vibrations using against vibration generated by actuators requiring external power. The objective of this work is to develop a method of minimizing vibrations of a rotating machine, which aims to reduce the vibrational level of an area of its outer casing. This field can then be used for attachment of this machine and so help to minimize the amount of vibration it transmits to its direct environment. A new method also converge to the global optimum (minimum vibration value), and take into account possible variations of vibrational disturbances to eliminate. It allows a significant reduction of vibrations, without changing the characteristics of the system.***

***Keywords: rotating machines, vibration sensors, optimization.***

## I. INTRODUCTION

The vibrations of optimization problems have several challenges related to user needs (looking for a comprehensive solution, reliability and accuracy of the solution, diversity of the problems, calculations of available time ...), the characteristics of the problem optimization (nonlinearity derived inaccessible ...) and the time of important calculations. The optimization methods are classified according to the optimum search mode, in to two groups: one starting first by deterministic methods have been studied in the machinery they design and optimization team are based on the calculation that can be done in a research direction, usually related to the derivative of some results against device design parameters. They are really usable in the restricted or if the desired solution is deemed close to a known solution. These deterministic methods can be divided into several classes, heuristics, statistical methods, methods Branch & Bound, mathematical methods, and machine learning methods starting point of this research. This is to remove this difficulty, we have chosen to take an interest in development and we go talk second optimization methods is stochastic methods used to locate the optimum of a function in the parameter space without using derivatives of the function with respect to these parameters. Moreover, they do not get trapped in a local optimum and succeed more often to determine the optimum global the reporting function. Their principle is to work with a set of solutions, and to make them evolve through heuristic and probabilistic rules. We especially selected for our study genetic algorithms, simulated annealing, and tabu search methods, the algorithm will be considered part of the class of evolutionary algorithms that makes the selection steps, reproduction (or crossover) mutation and finally replacing each step using more or less operators specific. Notre study is to minimize vibration of rotating machines and we chose to minimize vibration of a crane. [1]

## II. DESCRIPTION MACHINERY CRANE

The crane ensures loading ensures loading and unloading trucks the crane is of type double girder box (power: 330 KN, carried 40 M, general characteristics). [2]

- Movement crane

The crane makes three different movements [3]:
-Movement lifting: with a speed of 0 à 8 m / min through a three-phase asynchronous cage motor with four poles, with power of 55 kw Alsthom type.
- Movement direction: moves with a speed from 0 to 30 m / min, with two three-phase cage motors with four pole and a power of 1.1 kw Alsthom type.
- Translation movement: the movement speed can go until 60 m / min, this movement is provided by two asynchronous motors with cage four pole and a power of 4 kw Alsthom type.

- Electrical equipment

Power supply: 3 x 400 V - 50 Hz
Control voltage: 48 V - 50 Hz

## III. Application Results

We made a study of two phases [4]:
With: speed of rotation of the motors

$$n = 60 F / P \qquad (1)$$

## A. *Déplacement à vide*

| Hoist motor speed (tr/min) | steering motor speed (tr/min) | translation engine speed (tr/min) | overall speed (tr/min) |
|---|---|---|---|
| 389 | 650 | 505 | 2699 |
| | 650 | 505 | |

Table 1. The overall speed of the crane and the speed of each motor in the case empty and without optimization.

| Hoist motor speed (tr/min) | steering motor speed (tr/min) | translation engine speed (tr/min) | overall speed (tr/min) | calculation time (s) |
|---|---|---|---|---|
| 650 | 369 | 349 | 2086 | 0.07813 |
| | 369 | 349 | | |

Table 2. The overall speed of the crane and the speed of each motor in the case in vacuum and deterministic optimization.

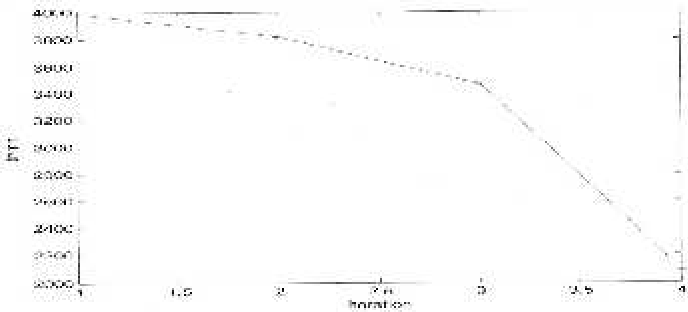

Fig 1. The optimization of the overall speed of the crane with a deterministic method in the vacuum case

The curve shows that against the rapidly converges to the deterministic method with a local optimum [5].

| Hoist motor speed (tr/min) | steering motor speed (tr/min) | translation engine speed (tr/min) | overall speed (tr/min) |
|---|---|---|---|
| 170 | 190 | 109 | 0.26563 |
| | 190 | 109 | |

Table 3. The motor speeds with optimization (evolutionary method), vacuum case.

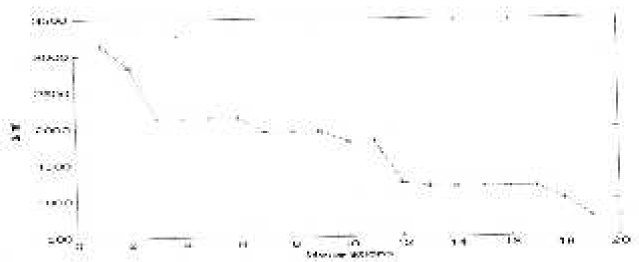

Fig 2. Optimization of the overall speed of the crane according to the number of generations (evolutionary method) in the vacuum case.

This figure shows the optimization of the overall speed of the crane according to the number of generation in the vacuum case. From the curve we can see that improving the speed increases with the number of generation, with 20th generation of the optimization method (evolutionary method) [6].

## A. *Déplacement en charge*

| Hoist motor speed (tr/min) | steering motor speed (tr/min) | translation engine speed (tr/min) | overall speed (tr/min) |
|---|---|---|---|
| 359 | 550 | 521 | 2501 |
| | 550 | 521 | |

Table 4. speeds without optimization engines

| Vitesse du moteur de levage (tr/min) | Vitesse du moteur de direction (tr/min) | Vitesse du moteur de translation (tr/min) | Vitesse globale (tr/min) | Temps de calculs (s) |
|---|---|---|---|---|
| 590 | 359 | 330 | 1968 | 0.07813 |
| | 359 | 330 | | |

Table 5. The motor speeds with deterministic optimization.

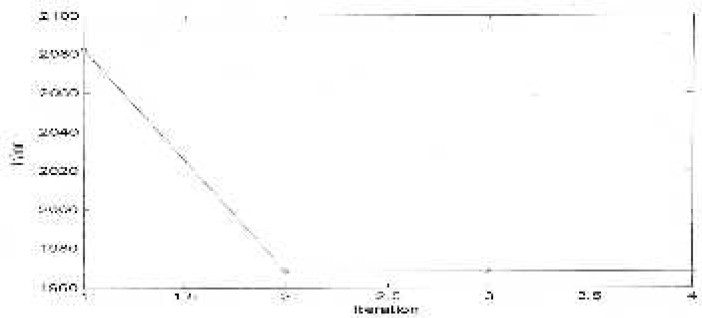

Fig 3. La overall speed crane with a deterministic method in the case supported.

The curve in Figure 2 shows the rapidly converges to the deterministic method but the result is less accurate [7].

| Hoist motor speed (tr/min) | steering motor speed (tr/min) | translation engine speed (tr/min) | overall speed (tr/min) | calculation time (s) |
|---|---|---|---|---|
| 130 | 160 | 124 | 698 | 0.26563 |
| | 160 | 124 | | |

Table 6. The Motor speeds with optimization (evolutionary method)

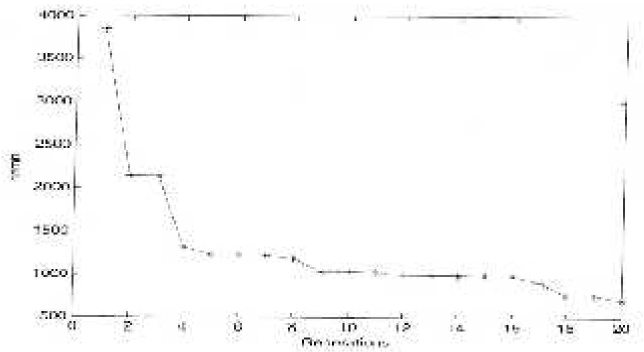

Fig 4. The overall speed of the crane according to the number of generations (evolutionary method) in the case supported with optimization.

This figure shows the optimization of the overall speed of the crane according to the number of generation in the case supported. From the figure more than the number of generation increases more than improving the overall system speed increases to 20th generation and a time of 0.26563 s calculations we obtained a speed of 698 turn / min with less vibration.

B. *Minimizing vibrations of the cab*

The study was conducted in a business that includes a crane with cab driver. A second study was to select the position of the driver's cab to undergo less vibration. The measurement was made using a triaxial accelerometer.

The overall acceleration on the seat is given by the following expression:

$$A_{gw} = \sqrt{2a^2_{xw}+2a^2_{yw}+2a^2_{yw}} \qquad (2)$$

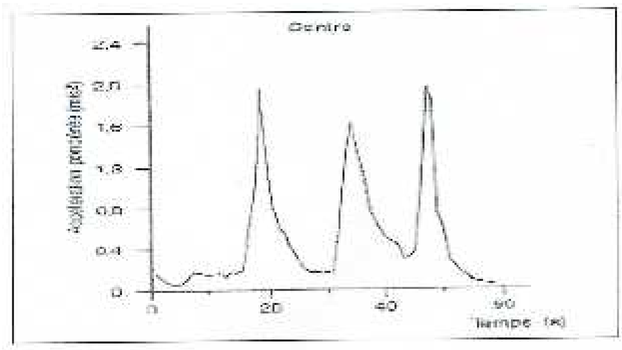


Fig 5. Practice location of the driver at the center of the box.

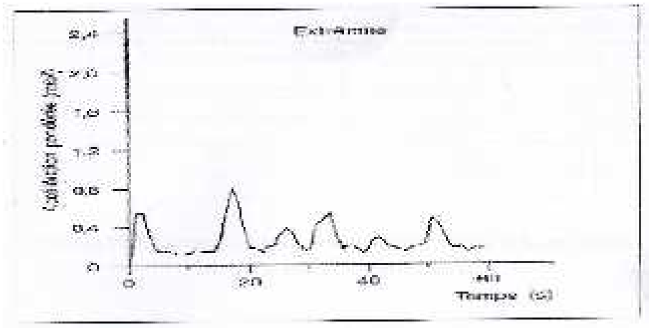

Fig 6. Location of the driver's cabinet at the end of the box.

This figure shows changes over time of the weighted acceleration measured with the cab placed in the center or the end of the box.

The weighted acceleration increases by 40% when the cab is attached to the center rather than the end. The figure shows the increase in vibration when lifting loads or removals of the cabin is at the center or at the end of the box, the amplitude and duration of the shock are greatly increased when the car is placed in the center.

C. *Minimizing vibrations at the reach of the crane*

A third study was focused on the relationship between the range of the crane and the overall weighted acceleration. We made several attempts to see the relationship between the scope of the crane and the overall weighted acceleration [8].

| Crane span (m) | Weighted acceleration (m/s$^2$) |
|---|---|
| 0.2 | 20 |
| 0.3 | 21 |
| 0.4 | 22 |
| 0.5 | 23 |
| 0.6 | 24 |
| 0.7 | 25 |

Table 7. The results of the relation ship between the scope of testing of the crane and the weighted acceleration.

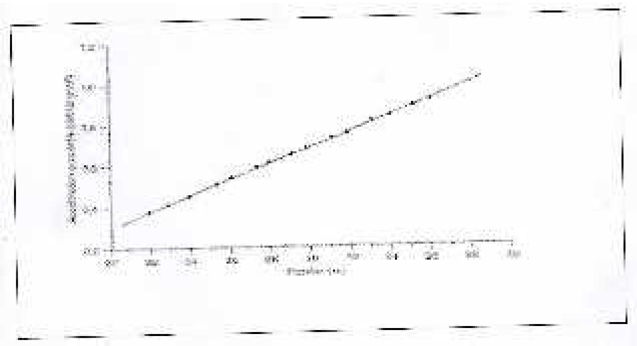

Fig 6. Overall weighted acceleration based on the range of the crane.

The figure above shows us clearly the direct proportionality between the range of the crane and the overall weighted acceleration, thus to reduce the weighted acceleration in our interest to work with a smaller scope.

## IV. CONCLUSION

Through the study we tried to present a method to minimize vibration and we chose to do an overhead crane.

-The first study of the crane to empty and the latter supported. The application of evolutionary approach has allowed us to determine the overall speed with which the system has less vibration.

-The second study we focused we are searching for the best location of the driver firm to suffer less vibration and found that the ends have the best location to the center.

-Third study was to find the relationship between the scope of the crane and the overall weighted acceleration we can notice that more scope is increasing the overall acceleration increases so we can say that there is a direct proportionality between them.

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