# Netting equilibrium shape calculation using optimization methods

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## ABSTRACT

Computer simulation is becoming an essential tool for the design and optimization of fishing nets since it provides a fast and low-cost method to evaluate new strategies to improve their performance. In this context, robustness and computational performance of the computer simulation methods are a key factor for designers, especially when they are intended to be used for design optimization.

This work compares two families of simulation methods to calculate the equilibrium shape of underwater netting: Newton-Raphson (NR) iteration and Optimization methods. While NR has been commonly applied to trawls, there are not many studies that use optimization methods. In both cases, the structural behaviour of the net is modelled using the triangular finite element proposed by Priour [1].

In the Newton-Raphson method, the non-linear system of equations $\mathbf{F}(\mathbf{q}) = 0$ is solved, where $\mathbf{F}$ is the nodal force vector and $\mathbf{q}$ is the nodal coordinate vector in equilibrium. The method is implemented using a direct sparse linear equation solver and a global convergence algorithm with a two-point parabolic model [2].

Optimization methods minimize the total mechanical energy of the system, which is evaluated from the shape of the net. Several gradient-based optimization methods have been tested [3], and it has been found that the LBFGS method (limited memory Broyden-Fletcher-Goldfarb and Shanno) is the most efficient in terms of function evaluation for underwater netting simulation.

Finally, the NR method and the LBFGS method have been compared using a set of tests involving netting panels with different boundary conditions in a uniform water flow. In addition, dynamic simulation has been used to find reference solutions for all tests, in order to validate the solutions found by NR and LBFGS. Result show that LBFGS has several advantages over NR: it is more robust in most cases, twice as faster and easier to implement.

## REFERENCES

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