This call is for PhD topics due to start in 2021, and concerns only the PhD projects fully financed by the Institute.

Proposal Form

PhD's title:	Fluid netting interaction: comparison between numerical models of fluid action only, potential flow and real fluid model, and flume tank trials
PhD supervisor *(accredited to supervise research)*: Ifremer Dpt./Unit/Lab:	Daniel PRIOUR REM/RDT/LCSM
PhD co-supervisor: Organisation, laboratory (Ifremer Dpt./Unit/Lab):	Karsten Breddermann University Rostock, ocean engineering, Germany Daniel Stepputtis Thünen Institute of Baltic Sea Fisheries, Germany
Laboratory/host structure, location:	LCSM/RDT/Plouzane and University of Rostock
Doctoral School:	EDSML
Two suggested referees' names and contact details for the international evaluation of this proposed PhD project:	- Barry O'Neill, DTU AQUA National Institute of Aquatic Resources, barone@aqua.dtu.dk - Jean-Yves BILLARD, Irenav, jean-yves.billard@ecole-navale.fr - Yves-Marie SCOLAN, Ensta Bretagne, yves-marie.scolan@ensta-bretagne.fr

Résumé en Français – *1200 caractères*

Mots-clés :

Profil de candidature souhaité – *400 caractères*

English summary – *1200 characters*

The objective is to assess the quality of numerical models in the representation of the interaction of fluid with nettings. 3 types of numerical models will be involved, which are from the least to the most complete: a) fluid action only in which the forces of fluid on netting are assessed by Morison formulations and in which there is no action of the netting on the fluid, b) potential flow model in which viscous aspects which is not part of the model and which could be assessed by Morison formulations, c) real fluid model in which viscous aspects are taken into account. Generally speaking the more complete is the model the slower it is to execute. The structure numerical model to be investigated is the model of Ifremer and is the base of the fluid action only model. This structure model will be used by the 2 other fluid models in development by university of Rostock. The main objective of the work will be the assessment of the quality of the models relatively to the netting use: fish farming in which the current and waves are moderated, fishing gear for which the water speed could be large, beaches protection where the waves are pretty large. Flume tank tests carried out by Ifremer in previous projects (Premecs, hydropeche) and new tests in the flume tank (in Tsunami project and SimuNet project (University of Rostock) as well as wind tunnel experiments at the university of Rostock could be used in order to assess the accuracy of the numerical models.

Key-words:

Netting; fluid models; fluid structure interaction; flume tank tests

Preferred profile of the PhD student– *400 characters*

Engineering School, specialty in hydrodynamics or fluid mechanics
Master in Hydrodynamics or fluid mechanics

Detailled Research Project *(3 pages)*

1- Background and scientific/ technological context

Main literature references, potential collaborative projects …

- Netting structure model: Priour 's work (a: Priour D., 2013, A Finite Element Method for Netting, Application to fish cages and fishing gear, 107 pages*, Springer ;* b: B.Morvan, D.Priour, Z.Guede, G.Bles ; 2016 ; Finite element model for the assessment of the mesh resistance to opening of fishing nets ; Ocean Engineering ; Volume 123, 1 September 2016, Pages 303-313).
- Potential flow interaction with netting: a) O'Neill FG and O'Donogue T, 1997 The fluid dynamic loading on catch and the ge-ometry of trawl cod-ends, Proc. R. Soc. Lond. A, 453, p. 1631-1648.
- Real fluid model: a) Breddermann, K., Stone, M., Yochum, N., Flow analysis of a funnel-style salmon excluder, Contributions on the Theory of Fishing Gears and Related Systems, 11 (Proceedings of the DEMaT 2019), 2019, ISBN: 978-3-8440-6995-2, 29-42 b) Breddermann, K.
  Filtration Performance of Plankton Nets used to catch Micro- and Mesozooplankton
  PhD thesis, Rostocker Meerestechnische Reihe (Hrsg. M. Paschen), 2017, ISBN 978-3-8440-5405-7
- Flume tank tests: a) Anon, 2000. PREMECS: Development of predictive model of cod-end selectivity, Final report of EC contract n°. FAIR CT96 1555, IFREMER, France ; b) On the experimental study of the flow around a fishing net ; G Pichot, G Germain, D Priour - European Journal of Mechanics-B/Fluids, 2009 – Elsevier ; c) POD investigation of the unsteady turbulent boundary layer developing over porous moving flexible fishing net structure, P Druault, E Bouhoubeiny, G Germain - Experiments in fluids, 2012 – Springer. d) Elkhadim Bouhoubeiny: Caractérisation de l'écoulement autour de structures souples et poreuses. Applications aux engins de pêche. The flume tank of Boulogne/mer is part of the LCSM laboratory LCSM and has few data bases on the flow measurement around netting panels (from especially Premecs and Hydropêche projects). These data bases could be used and completed by new flume tank tests and wind tunnel tests at University of Rostock.
- Few previous and on-going projects at Ifremer could be used: hydropêche is a previous project about behaviour of fishing gear, in which few flume tank tests have been done and recorded in the data base of the laboratory; Tsunami is an ongoing project about fish farming in which numerical model and flume tank tests will be carried out soon; previous numerical models on beach protections have been also done at Ifremer.

2- Strategic positioning within the Department/Institute

This proposal will contribute to the objectives of Ifremer: increase the number of publications and increase the number of PhD students.

This work contributes to the objective 5 of the institute's COP: A visible and recognized institute at European and international level and more precisely the pursuit of close partnerships with Germany. It contributes also to the objective 3: An innovative organization driving the development of the maritime economy.

3- Scientific objectives

The objective is to quantify the contribution of three numerical models of the fluid/structure interaction in the particular case of nettings. Attention will be paid to the quality of the representation of the interaction but also to the speed of execution of these numerical models.

4- Methodology

The work will be based on previous works on mechanics models of D.Priour, and fluid/structure interaction models of K.Breddermann. The numerical model of potential flow is based on the openFoam libaries.

In a first step a flume tank test on netting will be used. It could be extracted from the PhD of Elkhadim Bouhoubeiny or from the data base of Boulogne/mer flume tank. In this test the netting shape, the flow and tension in ropes have been recorded. The way to do is to consider this shape as rigid and to model this shape with the 3 numerical models. Once done, a vector is extracted from each model and the test. The components of the vector could be the flow in specific points. Comparing models and test would be a comparison between these vectors. The comparison would be the norm of the difference relatively to the norm of the vectors. A comparison could be carried out also on the tension in some points of the netting as it has been recorded during the flume tank test.

In a second step, the netting will be not considered as rigid. In this step the comparison would be on the shape of the netting got from the numerical models with the flume tank test.

In a third step, 3 typical uses of netting will be defined in case of a) fish farming, b) fisheries and c) beach protection. a) In the case of fish farming, Tsunami project results will be used such as the numerical model and flume tank tests. b) In the case of fisheries, hydropêche project or SimuNet results on the flow around trawl could be used. c) In case of beaches protection, previous numerical models results could be used. From these 3 cases, 3 designs will be defined and will be used by the 3 numerical models. A comparison between them and flume tank tests, if any, will be carried out.

In a fourth step, an analysis of the comparisons will be carried out, and advantages and drawbacks will be assessed relatively to the use of the netting (fish farming, fisheries, beaches protection).

5- Resources at disposal for the PhD student for the duration of the research project (human, technological…)

- Mechanics model of Ifremer and Flow model of university of Rostock, with the help of people using currently these models.
- Flume tank tests data base with the help of the researchers of Boulogne/mer and wind tunnel test data base with the help of the researchers of University of Rostock, ocean engineering department
- Results of few Ifremer projects: Hydropêche, Tsunami and University of Rostock project: SimuNet.
- The funding is expected from a) Ifremer for the PhD salary, 3K€ a year from RDT unit for travel, and opportunities of Ifremer such as mission abroad for PhD students b) from University of Rostock for flume tank tests for a computer (2K€). No funding will be required for test models: we will use test models we already have.
- Each week there will be a meeting between the student and the supervisors. This meeting will be by videoconference since the supervisors are not in the same city.

6- Expected results and valorization (publications and public dissemination)

- The development of expertise on the interaction fluid structure in case of netting and relatively to the use of the netting (fish farming; fisheries, beaches protection). That means an ability for University of Rostock and Ifremer to have a better answer on netting structures in interaction with flow.
- Numerical tools well adapted for the assessments of netting structures in waters.
- The publication of scientific papers and in international conferences.

7- Originality and innovation

The mechanical models of netting are quite common, but the fluid/structure interaction models in case of netting are almost in-existent. This work will be a opportunity to progress in the understanding of the fluid/structure interaction in case of nettings.

8- Does the project come under the ABS Nagoya Protocol and/or does it involve the use of genetic resources?

No

9- Potential partnerships

- University of Rostock for the flow modelling and wind tunnel experiments, if any
- Ifremer REM/RDT/LCSM/Brest for the mechanical modelling
- Ifremer REM/RDT/LCSM/Boulogne/mer for the flume tank tests
- Benoit VINCENT (STH unit) and Jean-Claude FALGUIERE (BIODIVENV init) agreed to contribute to the CSI (Comité de Suivi Individuel). Benoit VINCENT has a large experience in numerical modelling of netting for fishing gear when Jean-Claude FALGUIERE has a large experience in the development of fish farming.

10- Provisional schedule

10-12/2021	01-03/2022	04-06/2022	07-09/2022	10/12/2022	01-03/2023	04-06/2023	07-09/2023	10/12/2023	01-03/2024	04-06/2024	07-09/2024
Bibliography											
	First step: fix shape	First step: fix shape	First step: fix shape	First step: fix shape							
			Second step: mobile shape	Second step: mobile shape	Second step: mobile shape	Second step: mobile shape					
						Third step: 3 typical uses	Third step: 3 typical uses	Third step: 3 typical uses	Third step: 3 typical uses		
									Fourth step: Analysis		
									Redaction	Redaction	Redaction