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OPUSS PROJECT: FIRST RESULTS AND ROADMAP OF DEVELOPMENT

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Abstract. The current state of one of the foremost demanding challenges to humanity, namely pollution of rivers and the world's oceans by plastic debris, is analysed in short. The authors' attention is focused on the solution of ocean cleaning from the point of view of ship architects, using a classical approach to the so-called external task of ship design, i.e., on the method of the corresponding fleet (ships system) design. Some results of the first work package of the OPUSS R&D Project and the draft roadmap of its development are presented.

Keywords: plastic debris, maritime logistic, circular economy.

Introduction. One of the foremost demanding challenges to humanity nowadays is long lasting and drastically progressing pollution of rivers and the world's oceans by plastic debris [1, 2]. More than five trillion plastic particles currently are floating in oceans five largest convergence zones and about 300 million tons of plastic is produced yearly, resulting in accelerating oceans' pollution [3, 4] (Fig. 1). On the other hand, many companies started making products from recycled materials to bring their environmentally friendly practices to the forefront [5, 6].

The European scientific community has long led the world in research such areas as cleaning rivers and oceans from plastic debris [7]. The Ocean Cleanup is testing a method to passively collect this floating plastic debris, transport, recycle, process, and sell it [7, 8]. The Dutch innovators have already started landmark experiments on practical ocean cleanup, preventing plastic inflow to seas and oceans, and building more or less sustainable reinvestment in these processes [9].

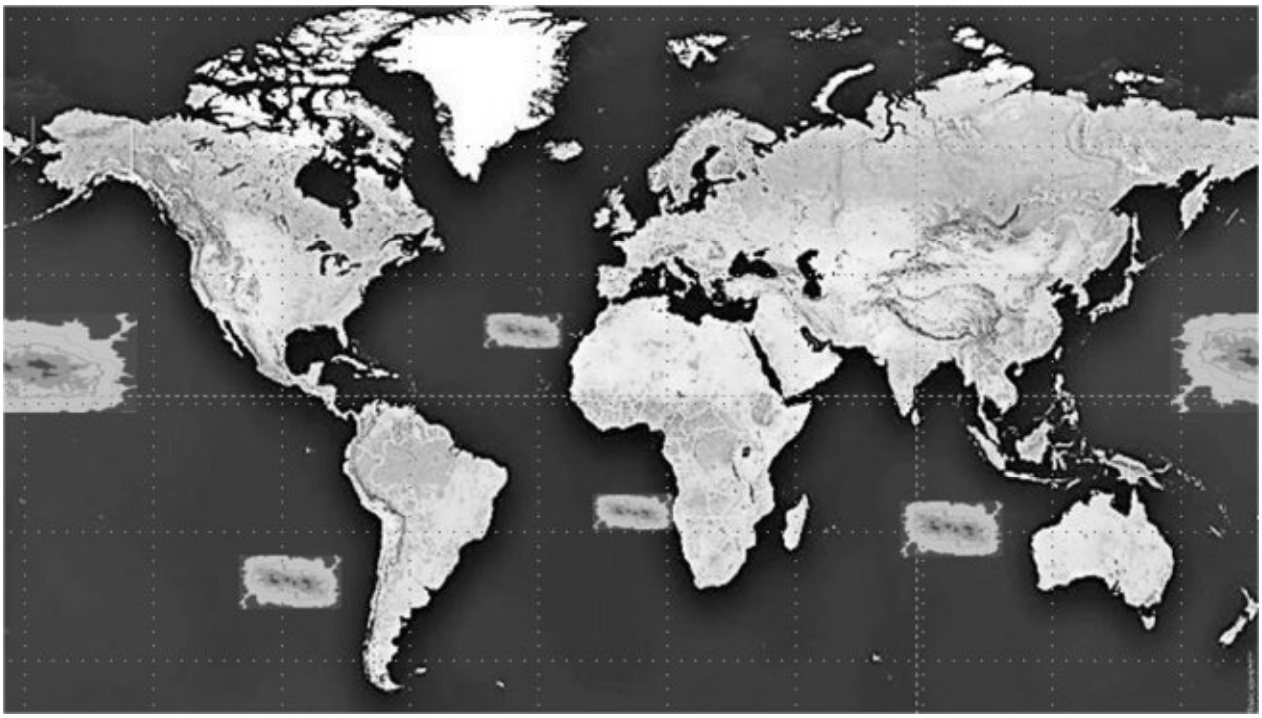


Fig. 1. More than five trillion plastic particles currently floating in oceans five largest convergence zones

But at the same time, a part of the research community insists on rather a gloomy commercial and time prospects of the Ocean CleenUp project in its current state, from a logistical, economic, and environmental point of view [8, 10, 11]. This means that the involvement of charity to finance the R&D and transport costs will remain needed as long there is not a profitable business model … based upon revenues from the collected and processed waste [8, page 11].

The initiative group of Ukrainian inventors from "C-Job Nikolayev" LLC and the Admiral Makarov National University of Shipbuilding (NUS) proposed to combat ocean plastic debris via technical decisions from the point of view of professional shipbuilders, economists, and ecologists. Such vision and approach formed the basis for mutually beneficial interdisciplinary, international cooperation in frames of "Ocean Plastic Utilisation Ships System R&D project (OPUSS). The main objective of this project is to make the ocean cleaning from plastic debris process commercially realistic in time, environmentally efficient and viable in general. The central idea of the OPUSS project lies in developing new circular logistic scheme of the ocean cleanup, as existing reverse logistics supply chains are not able to capture the specifics of the plastic waste collection out on the ocean [8]. The proposed project consists of several Work

Packages, of which the first one was successfully finalised in June 2021, resulting in several patent applications [12, 13] and a roadmap of their further development and industrialisation.

The share of transport cost in total cost of plastic garbage recycling process presented in Table 1 are derived based on data of three reverse logistic structure scenarios analyses [8, p. 11]. It seems evident that such essential share is not acceptable from commercial, ecology and return of investment point of view.

Table 1

Share of transport cost in total cost of plastic garbage recycling

From Great Pacific Path	SF (USA)	ES (Denmark)	TP (Indonesia)
Transport cost (sea plus hinterland transport), $:	448520	1353338	1081893
Total cost (transport cost plus port handling, storage, and manual sorting cost), $	542023	1451418,417	1244997
Share of transport cost in total cost, %	82,75%	93,24%	86,90%

The article considers the reverse logistic structure, tested in 2020, with the illustrative diagram in Fig. 2, where NL denotes The Netherlands, GPGP – Great Pacific Garbage Patch, PD – Plastic Debris, VPPP – New Product Production Plant.

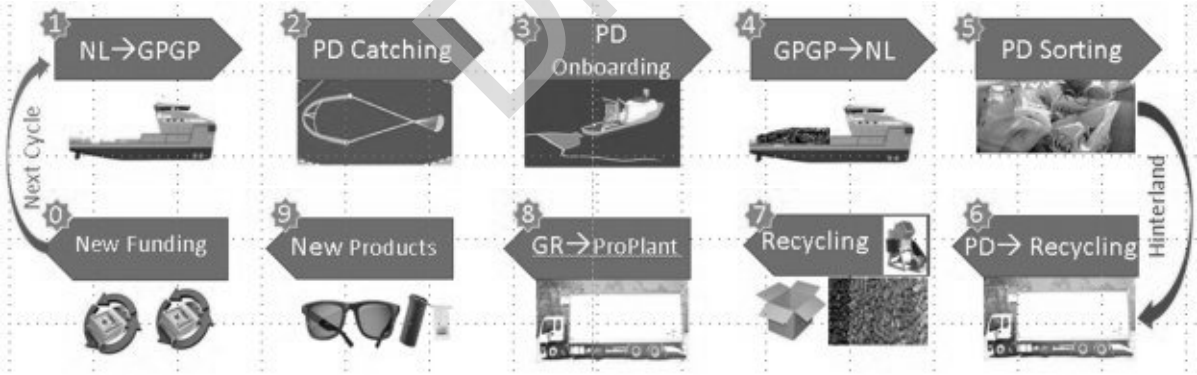


Fig. 2. General scheme of the reverse logistic structure

Unfortunately, the optimistic prediction [7, page 795] seems unjustified (see Fig. 3), since even the total performance of plastic harvesting systems in the ocean (like Systems 002 "Janny") and the estuaries of rivers (like "Interceptor-N") more than 50 Mt in 2023 and 57 Mt in 2025 is not achievable.

The actual performance of System 002 is about 1.5 metric tons per day [8]. According to [14], the GPGP contains about 100 million kilos of plastic, and the other four plastic debris sets jointly hold roughly 75 million kilos of plastic. These figures

mean that it will take more than 40 years to clean up only so-called legacy plastic garbage provided the 25 System 002 will successfully and non-stop catch debris at least 100 days per year. The annual cost of such a process would be around $200 million, with an uncertain source of funding and refinancing over 40 years.

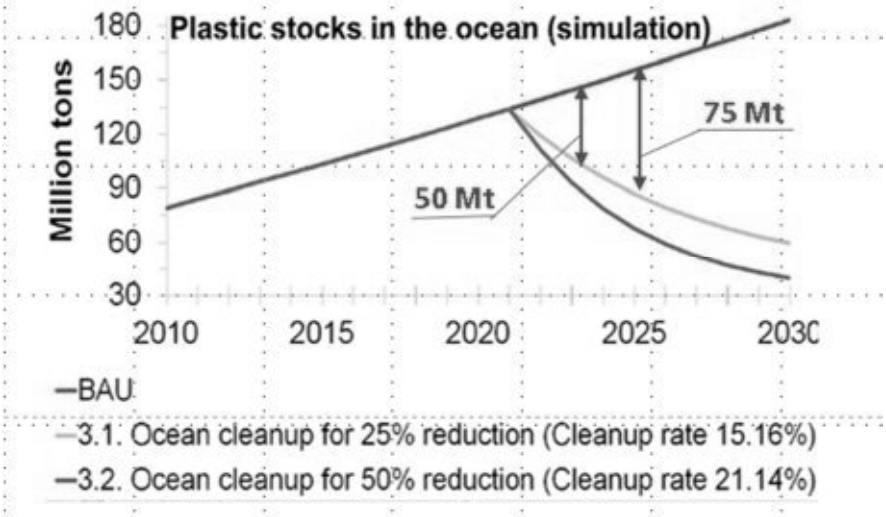


Fig. 3 – Forecast of ocean cleanup scenario designed to reduce the amount of ocean plastic debris below 2010 level [7, Fig. 5]

The main ideas and tasks of the developed «road map» for further development of the OPUSS project are:

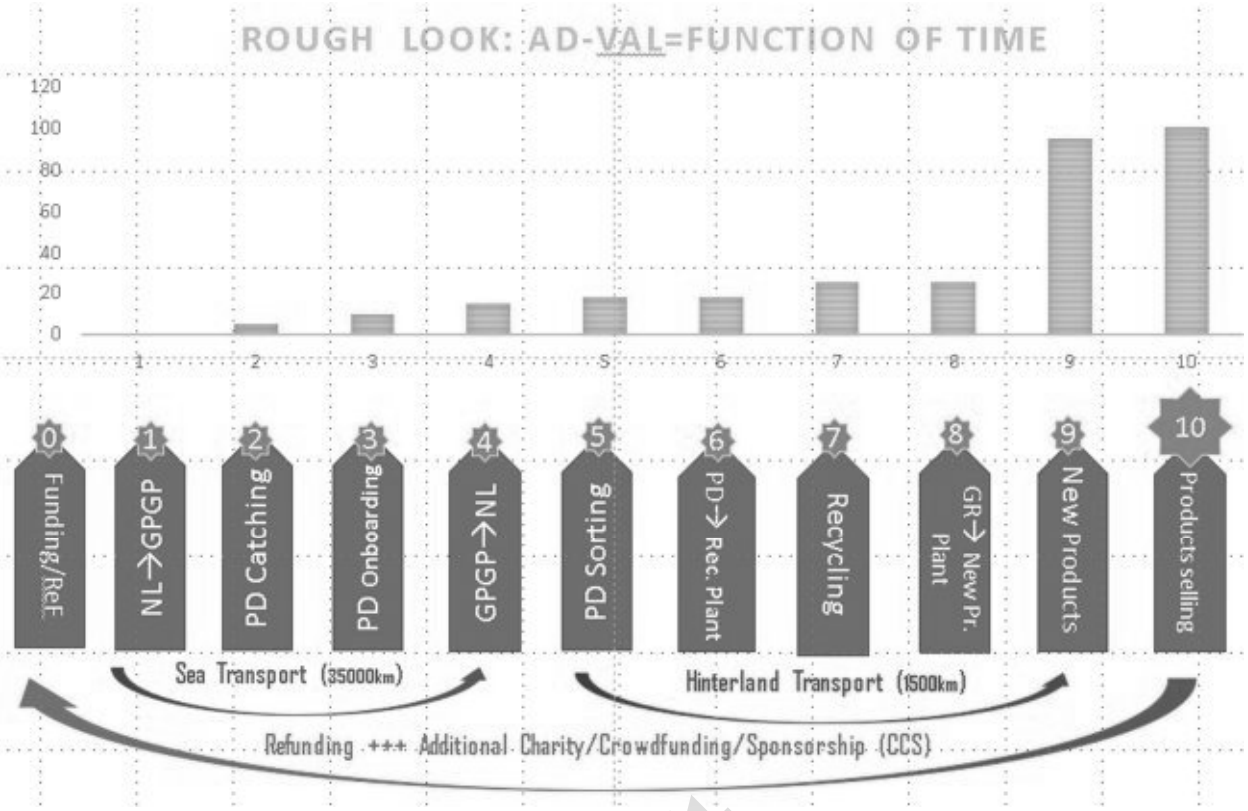
1. Localisation of OPUSS in space and time for commercially and ecologically optimal sea logistics and accelerated formation of added value AV.

2. Design of Ocean Plastic Utilization Ships System (OPUSS) with Ocean Plastic Utilization Ship (OPUS) as a basic unit.

3. Development of a digital model of accelerated formation of added value to optimise OPUSS structure and to achieve time-cost-ecology feasibility of Ocean Cleanup project.

The main advantage of the proposed logistic scheme is clearly illustrated by comparing the timeline for the growth of the added value of this scheme and the similar timeline of the reverse logistics scenario [8] (Fig. 4).

This approach will permeate the entire cycle from inception, execution, monitoring and further development of the OPUSS fleet [12, 13].



a)

b)

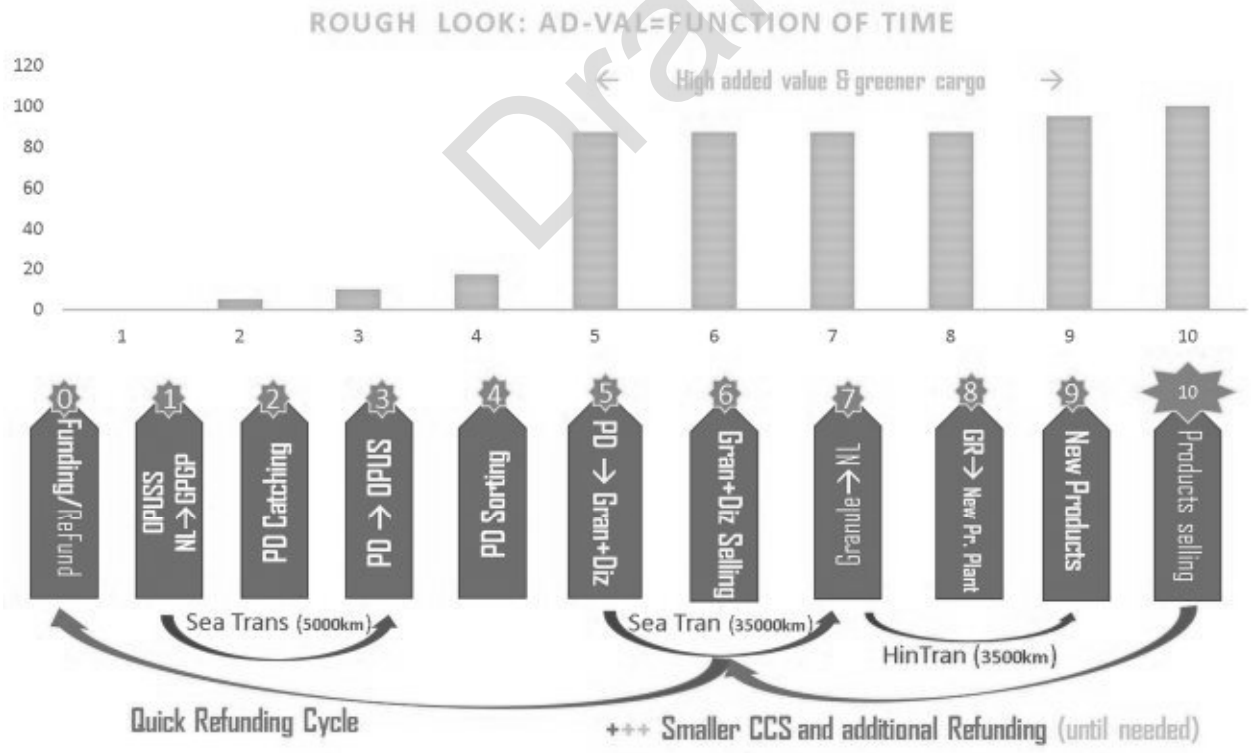


Fig. 4 – Comparison of two logistics scenarios: a) the reverse logistics scenario; b) the localised circular scenario

An important localised circular logistic structure scenario refinancing drivers except shipping distances are the total time of plastic recycling and new products sale,

and added value of the products shipped during different stages of the ocean cleanup process. Naval Architect's vision of Ocean CleenUp development includes the following:

1. The urgency is to radically change the reverse logistic model to the localised circular scenario to assure the reduced time of ocean cleanup refinancing and optimised operational cost.

2. The model should be based on the shipbuilders' experience and the latest achievements in shipbuilding, using new innovative types of ships and floating structures and their combinations in the fleet growth process.

3. The latest green innovations such as autonomous shipping and green power supply (ammonia, hydrogen) and accelerated digital transformation with Big Data analytics should also be utilised.

The OPUSS Project planned result forecast is presented in Fig. 5.

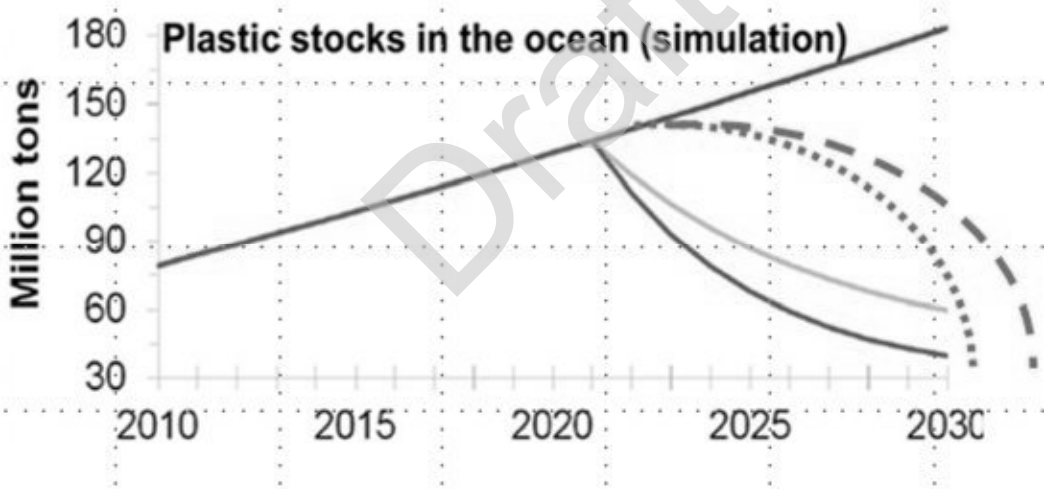


Fig. 5 – Realistic Ocean cleanup scenario

Conclusions. The developed concept for ocean plastic recycling offshore system (Ocean Plastic Utilization Ships System - OPUSS) will provide the process of cleaning the ocean of plastic with optimal results in terms of logistics and construction costs, as well as with minimal operating costs.

OPUSS system meets the requirements for minimum atmospheric emissions, with maximum use of autonomous electric vehicles (solar panels, wind support or hydrogen batteries), as well as ammonia, LNG, or hybrid propulsion systems.

OPUSS Project general and/or its concomitant results may be interesting to ecology and green associations, EU programmes and grants, or at least public opinion and interest in general supported by non-stop crowdfunding.

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ПРОЕКТ OPUSS: ПЕРШІ РЕЗУЛЬТАТИ І ДОРОЖНЯ КАРТА РОЗВИТКУ

Жуков Ю.Д. [1], Зівенко О.В.[2]
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Анотація. Коротко аналізується нинішній стан однієї з найбільш складних проблем людства, а саме забруднення річок і Світового океану пластиковим сміттям. Увага авторів зосереджена на вирішенні проблеми очищення океану з точки зору корабельних архітекторів з використанням класичного підходу до так званого зовнішнього завдання проектування судна, тобто на методі проектування відповідного флоту (суднової системи). Представлені деякі результати першого робочого пакету проекту OPUSS і проект дорожньої карти його подальшого розвитку.

Ключові слова: пластикове сміття, морська логістика, циркулярна економіка.