Journal of Industrial Information Integration 000 (2017) 1–16

Contents lists available at ScienceDirect

Journal of Industrial Information Integration

journal homepage: www.elsevier.com/locate/jii

Improving the creation and management of collaborative networks within the European maritime sector

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ARTICLE INFO

Article history:
Received 21 September 2016
Revised 29 May 2017
Accepted 30 May 2017
Available online xxx

Keywords:
Operational Collaboration Model
Engineering design
Maritime sector
Collaborative networks
Case study
Knowledge management

ABSTRACT

The first ever model of operational collaboration for the European maritime industry is presented, built upon the established current state-of-the art in engineering collaboration modelling and addressing key industry requirements. The requirements for operational collaboration practices in the European maritime industry were identified using three approaches: an industrial survey of 69 associations, companies and institutions in the maritime sector; an analysis of prototype collaboration tools; and through an analysis of literature. These requirements were thematically grouped and consolidated where they overlapped, and then translated into model elements and interactions between them. A model that accurately abstracts service and technology collaboration provision between companies in a variety of collaboration modes was built, and validated against a series of steps that an organisation would need to undertake, to develop a particular mode of collaboration to supports their needs. It was tested in three industrial case studies, providing encouraging feedback demonstrating successful implementation. It provides the opportunity for reassessment of the employed processes and activities, and provides a structure for improving collaborative engineering design. Whilst the research was based in the European maritime industry, the model has wider applicability within the collaborative design of complicated engineering artefacts such as automotive or aerospace.

1. Introduction

Collaborative engineering involves a diverse range of themes relating to human factors, technology, organisational characteristics, and trust and intellectual property, which have been investigated individually in numerous industrial and academic contexts. The attempts made to elicit and understand the needs of different collaborative engineering industries, are highly domain specific, limited by the size or type of the group investigated, and tend to focus on a subset of collaborative engineering themes. Typically the focus of past research is either: technical support for collaborative engineering design; system engineering based modelling of a specific design/management process; exploring processes within an organisation; or a relatively closed collaborative operation, aimed at improving collaborative efficiency.

Existing models tend to focus on a specific stage, aspect or type of collaboration.

The supply chain stage has been modelled frequently, and various models exist that explore different aspects of collaboration in the field of supply chain and logistics, e.g. models aiming to assess operational effectiveness of different collaboration tools [1], decisions [2], hierarchies [3], and models aiming to improve information management development [4]. Others focus on a specific aspect of collaboration such as cybersecurity or implementation of specific tools. Bijon et al. [5] investigated intellectual property issues when groups which are a part of a multilevel system collaborate with outsider consultants on specific projects. Takahashi et al. [6] developed a cybersecurity operation activity model, and

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http://dx.doi.org/10.1016/j.jii.2017.05.002
2452-414X/

Andert and Morgan [7] explored the implementation of specific tools aimed at collaborative virtual prototyping. Bencic et al. [8] explored collaboration tools for ship design and production. Zhang and Luttervelt modelled design process information [9].

Models for specific types of collaboration are present as well. Zhang et al. [10] developed a model of collaboration for e-business. Jiang et al. [11] developed a context-aware model focusing on international trade. Oppenheim et al. [12] investigated cross enterprise collaboration within a distributed organisation, Limonad et al. [13] cross enterprise collaboration for particularly service based organisations, and Hutchins et al. [14] and Hutchins and Kendall [15] explored team collaboration within an enterprise aimed at problem solving.

Models which focus on inter-organisational collaboration usually have a very specific topic. Chi and Holsapple [16] delivered a model of computer mediate inter-organisational collaboration. Philbin [17] created a process model for university-industry research collaboration. Hocevar et al. [18] developed a model to enable diagnosis of current collaborative capabilities and guidance in terms of changes required to improve them, and does not focus on technical systems. Xu et al. [19] developed a model to organise the semantic web services and improve their integration. Anderl et al. [20] described a model of global product development projects which takes into account the changes in organisational structures and operational processes, and puts them in context of the developed products.

Only one model addresses similar issues as the focus of this research. Lau et al. [21] developed a model and a framework of collaborative development and production, which further develops operational aspects of cross-sectorial inter-organisational collaborative work. However the focus of their model is knowledge-intensive product development, is high level and does not consider specific tools/technologies. While we agree on the necessity of implementation in industrial practice of strategic considerations into operational realm, we approach it in the context of the maritime sector which focuses not only on products, and particularly not only innovative products, but also services, supply chains, simulation and analysis, along with any other activity present in a ship lifecycle. The model presented considers all technical and management activities present in maritime collaborations, inter or cross-organisational, which may include engineering tools and CAD tools, have a range or collaboration types from fully service based to fully technology based, virtual or co-located, and considering a wide range of IP requirements. We explore cross-enterprise cross-disciplinary collaborations, which can take different forms and range from trade to collaborative design and manufacture. They may include CAD/CAM tools, but this is not the only focus. The model provides the flexibility to combine and consider legacy systems and practice as well as supporting innovation in all aspects of the collaboration.

From a systems engineering perspective, it is necessary to understand and model the interactions between the elements associated with these research themes, in order to reliably improve collaborative efficiency. It is important to understand how collaborative engineering could be modelled and supported from a wider industrial perspective. In creating a collaborative engineering model which spans an industry it is also important to acknowledge that the model should be capable of supporting multiple modes of operational collaboration: different stages of the collaboration process (creating and/or supporting the collaborative network); and different intra/inter organisational boundaries for collaboration.

Creating an Operational Collaboration Model that is accepted by industry, should be the first step towards the development of appropriate collaborative support solutions through the implementation of the model. In constructing a model that is accepted by industry, it is necessary to investigate and capture current industry practice: what industry aims to achieve through collaboration, and what are the stages and the pace at which industry is able to undertake them in order to achieve the aim.

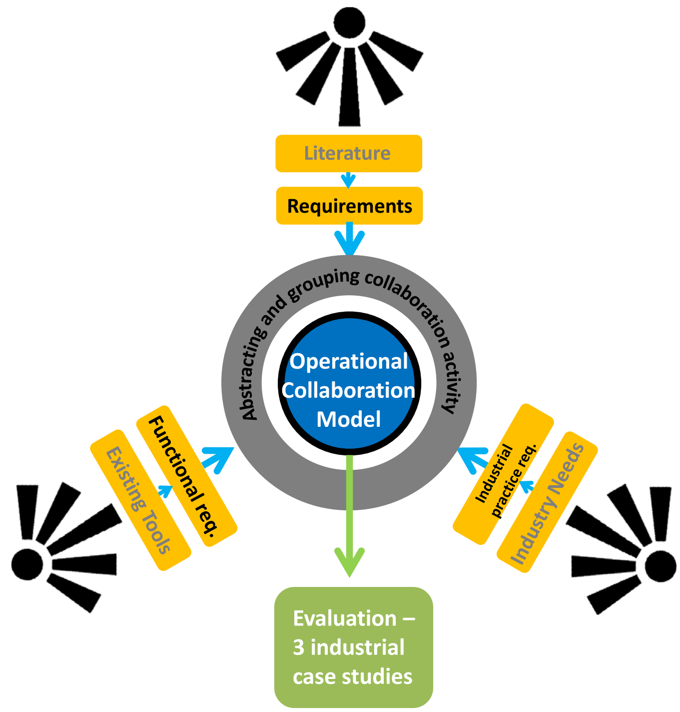

Fig. 1. Model building methodology.

Fig. 1 illustrates the requirement elicitation sources, and steps taken towards the Operational Collaboration Model building and evaluation. More detail on requirements elicitation is provided in Section 2, the model in Section 3, and its evaluation in Section 4.

In this paper we present the first ever operational collaborative engineering model, informed through sector-wide industrial engagement to elicit model requirements, developed by abstracting and grouping collaboration activity, and implemented within two integrated collaborative support systems. The model encapsulates a range of industrial collaboration modes, which were implemented within the maritime industry with the support from collaborative engineering tools, demonstrating its potential to transform current practice. Whilst other models exist within a collaborative engineering context, they are all solution dependent rather than problem dependent. The abstract form of the model allows it to be implemented using alternative collaborative engineering tools, supporting its transferral and application to different industrial sectors. The model was developed within the EuroVIP project, which focused on supporting collaboration between European maritime enterprises. The EuroVIP project consisted of European maritime SMEs, large enterprises, associations and universities who had a common focus of improving collaboration practices through better technology transfer, knowledge exchange, and service provision.

The literature review, presented within Section 2 was undertaken in order to support the initial model development, and then expanded to consider recent developments in the area. The results from the industrial survey and the prototype tools are discussed in the form of requirements for the creation of the Operational Collaboration Model within Section 2. Section 3 describes the model. Case studies demonstrating the model application are described in Section 4 and finally the Discussion and Conclusion are given in Sections 5 and 6.