

Developing a methodology for Co-creation in aviation industry using extended reality technologies

Sandhya Santhosh^{1,a*}, Francesca De Crescenzo¹

¹University of Bologna, Italy

^asandhya.santhosh2@unibo.it

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Abstract: In the recent times the concept of Co-creation, involving stakeholders, customers, and partners in the design, development, and delivery of products and services, has gained importance in various industries, including aviation. This PhD research paper presents the concept of co-creation in the aviation sector, focusing on its key elements and the potential of extended reality (XR) technologies as enablers. The paper highlights collaboration, interaction, and user experience as the essential elements of co-creation and discusses existing co-creation platforms and tools. Traditional co-creation platforms have limitations, prompting the proposal to leverage XR technologies such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) as future co-creative platforms. These immersive technologies offer the potential to enhance collaboration, visualization, and engagement in a virtual environment. The study explores how XR tools can aid digital co-creation methods and whether XR systems can induce effective co-creation sessions. In this context, the research develops a multi-user real-time XR environment that fosters collaborative and interactive co-creation aiming to enhance engagement, communication, and idea generation. This paper includes use-case scenarios for adapting such environments in view of investigating the potential of XR tools to improve the quality and novelty of ideas, reduce communication challenges, and decrease time and costs in the aviation industry's co-creation process.

Introduction

The aviation sector is a highly competitive and rapidly evolving environment thus facing various challenges ranging from long life cycles, high service quality, needs to customer value. To be competitive in this sector, manufacturers need to continuously accommodate new strategies to ensure the final products meet the needs of the customers and users [1]. As technology has emerged at an expeditious pace, many airlines have issues to think outside the box in order to develop innovative ideas for new products and services. By engaging with customers and other stakeholders, aviation companies can gain a deeper understanding of their needs and preferences, identify opportunities for improvement, and create more effective solutions. The concept of involving stakeholders, customers and partners in the design, development, and delivery of the products and services is called “Co-creation”. This collaborative approach seeks to create better products that meet their expectations and requirements. Developing a customer-centric culture is essential for any organization that wants to improve its service quality. This involves creating a culture where the needs and expectations of customers are always taken into consideration [2]. This research commenced towards studying insights to emerging design practices with co-creation in view of delivering innovation to aviation industry and improving the process by adapting cutting edge technologies in building co-creation environments/platforms.

Co-Creation at a glance

Co-creation has been a business topic till today, but, however, is emerging to numerous domains including the aviation industry. It can be defined as *collaborative development of new value*, the



value being products, solutions, risks and services. The key elements of co-creation include Collaboration, Interaction and User experience. How and Where to collaborate, How to interact and What will be the experience are the three main research questions this PhD research is oriented. Studies have anticipated the development of tools and methods that would extend the definition of co-creation to various domains [3]. Co-creation has become an important aspect of product design in other industries such as automotive, fashion, technology and aviation. For example, companies such as BMW and Audi used this concept to involve customers in the design process of their cars in order to collect feedback on various aspects of design. LEGO adapted to customer co-creation allowing customers to contribute ideas for a rocket model through an online platform [4][5].

Co-creation is foreseen to involve diverse participants ranging from researchers, engineers, designers, non-designers to end users. During this PhD research, it has been established that due to the diversified notion of user participation during a product development process, the platform where they co-create and the tools used play an important role in facilitating active and creative participation of the users.

The power of co-creation lies in how well the users are collaborating and interacting in the environment/ platform. Development of such co-creative platform or environment which is capable of accomplishing the three key elements of co-creation has been unprecedented and has not been given much of importance. In this context, it becomes essential to identify the technological tools that allow non-designers to go beyond the validation of already designed products and to play an active role in generating ideas and directly building solutions [6]. Through the survey of the literature, it has been observed that visual representations of the product during its development helps to foresee any issues and contributes to leading edge solutions and the aspect of simultaneous work and real-time sharing induces co-creation by reducing time and costs. Bringing both these aspects to a platform could overall improve co-creation [7].

Co-Creation Platforms

There are various co-creation platforms and tools available today to enable business and individuals to collaborate in creating, developing and testing the products and services. Some of the existing popular co-creation platforms are Idea Scale (an idea management platform that helps business to collect and evaluate ideas from employees, customers and partners), InnoCentive (a crowdsourcing platforms to solve complex problems), Canva (a design collaboration platform enabling teams to create and edit designs collaboratively) etc. All these platforms or tools are based on the concepts of Netnography & Crowdsourcing [8]. It can also be observed that these are also web and network based and limits user experience towards the aspect of co-creation .

Alongside of advanced science and technology, digital or virtual worlds for co-creation has gained momentum in offering a wide range of co-creation aspects by enhancing collaboration and improving engagement between the participants [9]. Digital co-creation platforms are web-based tools and software solutions that enable the collaborative creation and developments of products and services online. These platforms facilitate the exchange of ideas, data and feedback between different stakeholders allowing them to work together in real-time regardless of their location. Virtual worlds for co-creation systems have been studied in the past and featured the importance of user experience in these environments which induce quality of interactions thus positive relationships between companies and customers [10].

With immense growth in technology, digital technologies have emerged to immersive technologies such as Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). Immersive technologies create and extend reality by immersing a user in a completely digital environment (VR), or adds and augments users surrounding by adding digital elements (AR) or both (MR). Extended Reality (XR) serves as an umbrella term for all the existing and upcoming reality-virtuality technologies[11]. These technologies offer high potential to virtually collaborate, visualize and co-create in an imaginary unknown world. Through this PhD, I propose XR

technologies as potential co-creation enabler [7]. The research leverages as a collaborative and visual approach to service and product design creating many synergies as ideas, insights, expertise and vision. The research explores the below points:

- a. How XR tools can aid digital co-creation methods?
- b. Can XR system induce co-creation session?

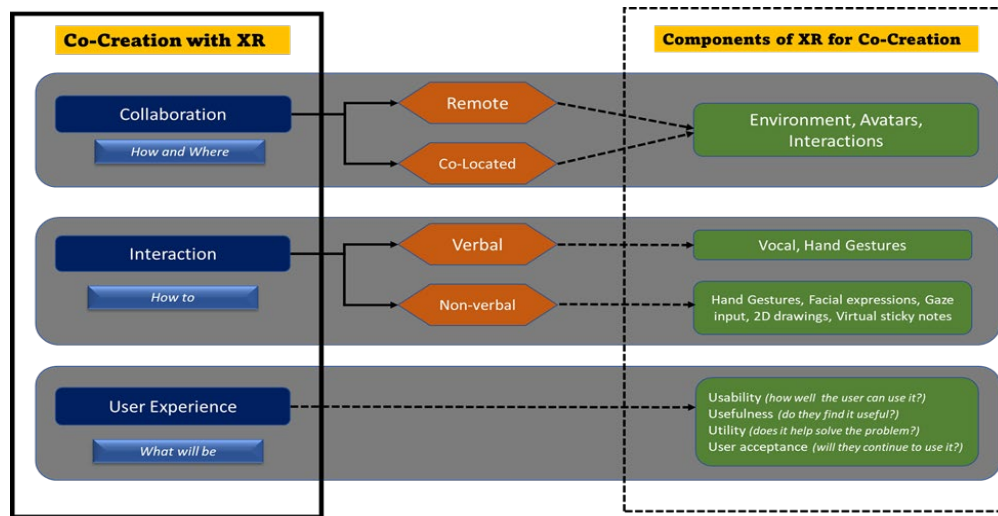


Fig. 1 Outline of components of Co-creation mapped to XR components

There are multiple reasons for enabling XR system as co-creation platform such as real-time sharing, product involvement, reduced communication challenges, media rich information, reduced time and costs etc. However, there are more pressing investigation to be performed in understanding if XR enabled co-creation session:

- Improve quality of ideas?
- Improve novelty of ideas?
- Reduce communication challenges?
- Provide better understanding of design?
- Reduce time and costs?

To back up the above questions, this PhD study has outset the number of aspects XR tools can offer and map them towards the key elements of co-creation as in Fig. 1. Taking this in to account, I have developed a multi-user real-time extended reality environment for collaborative and interactive co-creation platform. This platform is expected to serve as an effective and efficient solution for co-creation sessions when compared to conventional co-creation sessions by inducing co-creation in several ways such as providing immersive environments allowing participants to experience a shared virtual space fostering collaboration, enhancing communication by providing shared visual language and tools for collaboration, increasing engagement and motivation by providing visually rich and interactive environment, increasing accessibility by allowing remote participants to join and participate in real-time and real-time feedback allowing participants to quickly see the results and adjust their ideas accordingly.

This tool can be used in different types of activities in an innovation project. It's potential and role will also vary according to the various stages of the product development process and the roles of stakeholders during the process.

XR-Co-creation Platform Development and Use Cases

The XR process is an ideation model to design thinking and, following this process a system and workflow has been developed for multi-user Mixed Reality device, Microsoft HoloLens2. The application developed can be expanded to remote collaboration and necessary components of interaction to build a successful co-creation platform. The system is developed on UNITY software and is built within the framework of a networking and anchor solution for local position of virtual content and absolute position of user respectively in the 3D shared space. It ideally consists of a table which is common for every HoloLens2 and any content placed on this table is shared between all users. Multiple users can share this unique system and the scene can be customized for any use case of a co-creation sessions. In this regard, some examples of the scenes where this XR co-creation platform can be implemented in order to improve user creativity are as below.

Use case Scenario1:

The first application is in the aviation domain and regards the validation of the design of a cabin interior environment. It is built upon a scenario of design review and task analysis setting and is drawn between two potential users, a flight attendant and a human factors expert. The scene is designed to happen in front of a full scale immersive and interactive Galley of a Regional Aircraft. The task of flight attendant picking up a water jar and placing it on the platform of the galley while a second user acting the role of human factor expert human factors is observing over the shoulder and collecting feedback in real-time is organized. Till now, human factors experts are known to be present outside the loop while any task is on-going unless the physical prototype of the product is available. Through this mixed reality space, both users can simultaneously visualize, collaborate and interact with the full-scale product which is in design phase. Due to the nature of the scene, a co-located version of the platform has been considered. Both users can anticipate any issues related to task, design, reachability, comfort, wellbeing etc. Overall, this scene is to be evaluated for created value and if the highlighted co-creation elements are satisfactory[12].

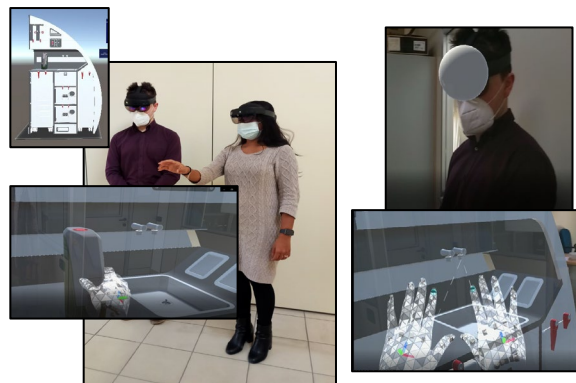


Fig. 2 Multi user co-located collaborative and interactive platform for Aircraft Galley use case

Use- Case Scenario2:

The Multi-user XR environment developed was applied to a use-case in aviation domain in regard to the validation of the design of a aircraft cabin interior. It is built up for the scene of a product tester role of the user [13] in order to test the compliance of the new seat design configuration for cabin crew and passenger activities of a concept test bed, Flying-V aircraft, developed in collaboration between Delft University of Technology (TUDELFT), Airbus and KLM Royal Dutch Airlines [14].

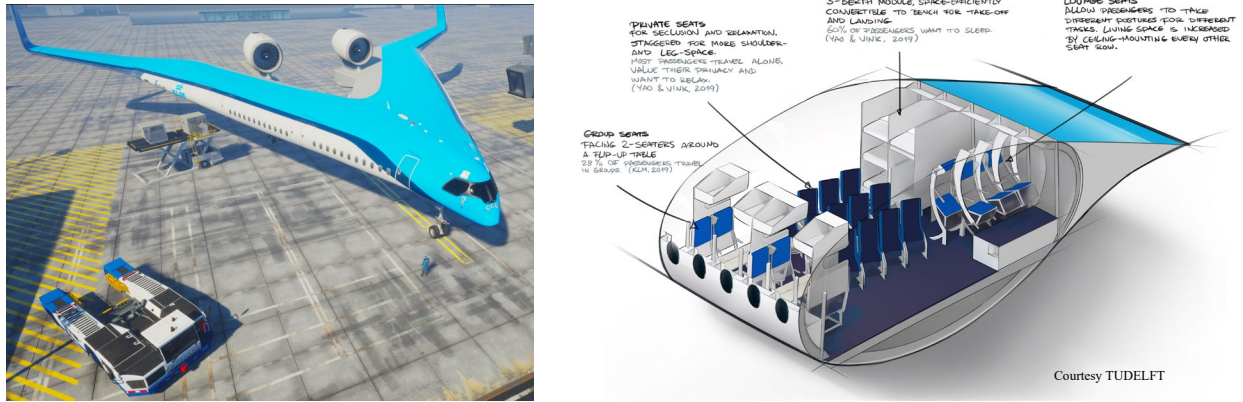


Fig. 3 Flying-V configuration

Flying-V is a new design of an energy-efficient long-distance aircraft with its passenger cabin, cargo hold and fuel tanks integrated in its wing structure creating a spectacular V-shape. Its improved aerodynamic shape and reduced weight contributes for 20% less fuel than the Airbus A350, today’s most advanced aircraft [15]. With its V-shaped configuration as in Fig. 3, the wings of the airplane are at an angle of 26 degrees with respect to the direction of the flight. In addition, the aerodynamic shape of the wing cross section lays out the passenger cabin configuration and is different when compared to the traditionally configured circular fuselage.

The new oval configuration has boosted insights to designers on seat design and innovations inside the Flying-V fuselage. This led to the idea of a new design called “staggered seats” which are designed for more leg room space and individual arm rest making more shoulder-to-shoulder space between passengers. Staggered seats are also placed at an angle with respect to the direction of flight which makes the seats not to fall in a single line but in an angled row [16].

In this context, it was observed that XR platform can be adapted in order to enact and verify certain tasks of the cabin crew and passenger and get the opinions of the users before the manufacturing of the prototype.

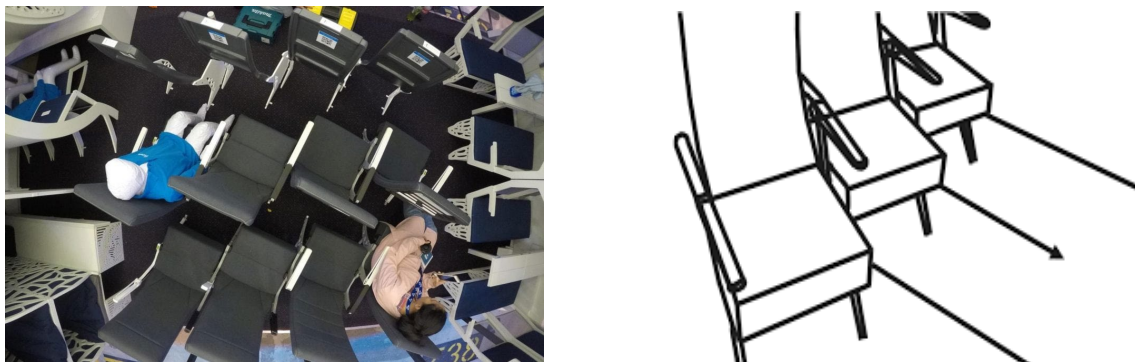


Fig. 4 Flying-V Staggered Seats

The aim of co-creation being shared value and creativity, the XR system is planned to be analyzed for the same user experience by adding the key elements of co-creation. By involving real users in this scenario, qualitative or quantitative data are planned to be collected in the following aspects to strengthen my proposal of XR technology as future innovative co-creation platform:

- a. Does the platform improve the efficacy and efficiency of co-creation and support in creating value?
- b. The impact of the key elements (collaboration, interaction and user experience) of co-creation to achieve a.
- c. By satisfying a. & b., does it help accelerate product development process and product innovation?

Conclusion and Future Work

The PhD study highlights the importance of innovation and the ongoing digital transformation in the aviation industry along with proposing cutting edge technologies for consolidating concepts like co-creation. It emphasizes on Extended Reality (XR) technologies and proposes XR tools as future co-creation environments or platforms. In order to substantiate the proposal, I have developed a multi-user XR system for collaborative and interactive environment in order to improve user experience thus, co-creation experience. This system has been adapted to different scenarios in order to analyze for its effectiveness through appropriate methods and collecting data. It is expected to shift collaboration from a flat one-dimensional experience into a multi-dimensional one accelerating the aviation industry.

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