

Sebastiano Bagnara
Riccardo Tartaglia · Sara Albolino
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Editors

Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018)

Volume VII: Ergonomics in Design, Design
for All, Activity Theories for Work Analysis
and Design, Affective Design



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Preface

The Triennial Congress of the International Ergonomics Association is where and when a large community of scientists and practitioners interested in the fields of ergonomics/human factors meet to exchange research results and good practices, discuss them, raise questions about the state and the future of the community, and about the context where the community lives: the planet. The ergonomics/human factors community is concerned not only about its own conditions and perspectives, but also with those of people at large and the place we all live, as Neville Moray (Tatcher et al. 2018) taught us in a memorable address at the IEA Congress in Toronto more than twenty years, in 1994.

The Proceedings of an IEA Congress describes, then, the actual state of the art of the field of ergonomics/human factors and its context every three years.

In Florence, where the XX IEA Congress is taking place, there have been more than sixteen hundred (1643) abstract proposals from eighty countries from all the five continents. The accepted proposal has been about one thousand (1010), roughly, half from Europe and half from the other continents, being Asia the most numerous, followed by South America, North America, Oceania, and Africa. This Proceedings is indeed a very detailed and complete state of the art of human factors/ergonomics research and practice in about every place in the world.

All the accepted contributions are collected in the Congress Proceedings, distributed in ten volumes along with the themes in which ergonomics/human factors field is traditionally articulated and IEA Technical Committees are named:

- I. Healthcare Ergonomics (ISBN 978-3-319-96097-5).
- II. Safety and Health and Slips, Trips and Falls (ISBN 978-3-319-96088-3).
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- X. Auditory and Vocal Ergonomics, Visual Ergonomics, Psychophysiology in Ergonomics, Ergonomics in Advanced Imaging (ISBN 978-3-319-96058-6).

Altogether, the contributions make apparent the diversities in culture and in the socioeconomic conditions the authors belong to. The notion of well-being, which the reference value for ergonomics/human factors is not monolithic, instead varies along with the cultural and societal differences each contributor share. Diversity is a necessary condition for a fruitful discussion and exchange of experiences, not to say for creativity, which is the “theme” of the congress.

In an era of profound transformation, called either digital (Zisman & Kenney, 2018) or the second machine age (Bnynjolfsson & McAfee, 2014), when the very notions of work, fatigue, and well-being are changing in depth, ergonomics/human factors need to be creative in order to meet the new, ever-encountered challenges. Not every contribution in the ten volumes of the Proceedings explicitly faces the problem: the need for creativity to be able to confront the new challenges. However, even the more traditional, classical papers are influenced by the new conditions.

The reader of whichever volume enters an atmosphere where there are not many well-established certainties, but instead an abundance of doubts and open questions: again, the conditions for creativity and innovative solutions.

We hope that, notwithstanding the titles of the volumes that mimic the IEA Technical Committees, some of them created about half a century ago, the XX Triennial IEA Congress Proceedings may bring readers into an atmosphere where doubts are more common than certainties, challenge to answer ever-heard questions is continuously present, and creative solutions can be often encountered.

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Ergonomics in Design: The Human-Centred Design Approach for Developing Innovative Motor Caravans Systems

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Abstract. Ergonomics and Design, precisely the relationship among Human-centred design (HCD) approach and Design for Innovation methods, represent a concrete growth strategy. European Union suggests design as a key discipline and activity to bring new ideas to the market, transforming them into user-friendly and appealing products or services. Though still often associated solely with aesthetics, the application of design is much broader. A more systematic use of design as a tool for Human-centred and market-driven innovation in all sectors of the economy, complementary to R&D, would improve European competitiveness. The paper presents the early results of the POR CReO-FP7 project “Triaca” developed with Trigano SpA. In Italy, recreational vehicles sector has always been present and active, however, in recent years motor caravans industry recorded a strong decrease of orders due to the economic downturn and a flattened supply. In this context, the project aim is the development of innovative solutions in terms of environmental sustainability and quality of the user experience. Our contribution is focused on the experimentation of the HCD approach, especially its investigation methods based on the direct involvement of users and its evaluation methods for usability and safety to the development of good design solution.

Keywords: Human-centred design · Recreational vehicles · Human factors
Usability · User-environment interaction

1 Introduction

The Ergonomics and Design approach exploits the multidisciplinary knowledge of human factors comprised in ergonomics as a valid means for defining design solutions that meet the real needs and expectations of the users of a particular product, environment or service in relation to the reference context. The European Union describes design as “a key discipline and activity to bring ideas to the market, transforming them into user-friendly and appealing products or services. Though still often associated solely with aesthetics, the application of design is much broader. A more systematic use

of design as a tool for human-centred and market-driven innovation in all sectors of the economy, complementary to R&D, would improve European competitiveness [1].

This contribution is part of a research pathway launched by the DIDA Department of the University of Florence aimed at sustaining innovation in the recreational vehicle sector (Green Camper and REICA). The project was developed by the researchers of the LED workshop implementing the ergonomics and design approach.

The recreational vehicle sector has always been actively present in Italy, and especially in Tuscany. Recently, however, the motor caravan manufacturers have recorded a sharp drop in demand due, on the one hand to the severe economic crisis, and on the other to an uninspiring supply. The constantly growing market trend that the sector enjoyed up to the crisis of 2008 led to a neglect of research aimed at innovation in terms of technology, form and performance [2]. Now such research clearly represents a factor of competitive advantage for the manufacturer.

The fact that consumers are now aware and informed about issues such as environmental sustainability, new lifestyles and the various socio-cultural and technological trends in progress should definitely offer food for thought in the development of solutions conceived to meet the needs of new user profiles. The reports of the most important European trade fairs (“Caravan Salon” in Dusseldorf and the “Salone del Camper” in Parma) indicate that the recreational vehicle user profile is changing. This finding is confirmed by the surveys carried out by bodies such as the APC-Association of Caravan and Motor Caravan Manufacturers, representing Italian and foreign manufacturers in the caravanning sector. Consumers are indeed increasingly demanding, conscious and attentive to what is happening around them. They like to personalise their own spaces, and they expect from a vehicle the same comforts they enjoy at home.

In this context design for innovation strategies and the Human-centred Design approach constitute a powerful tool for analyzing and interpreting users’ demands and expectations. Moreover, they are also fundamental for defining and developing solutions that can guarantee maximum levels of safety and of formal and functional quality in different situations of use to enhance the overall experience. Such suggestions foster reflection on the strategic role played by Human-centred design in the competitiveness of an enterprise.

Our contribution is focused on the experimentation of the HCD approach, especially its investigation methods based on the direct involvement of users and its evaluation methods for usability and safety to the development of good design solution. The processing of collected data and thoughts about contemporary lifestyles and people’s approach to motorcaravan, allowed us to define new concepts. The latter involved solutions relating to the vehicle’s internal environment, as for example solution for facilitate spaces transformation and promote efficient behaviors to saving resources. Finally, this experimentation produced a final concept of motorcaravan which was then translated by the company into a marketed product.

2 Methodology

Within the framework of the Triaca project, our contribution was organised in specific activities broken down into three main phases: a focus survey aimed at demarcating the issue, an evaluation phase and a design phase (see Fig. 1).

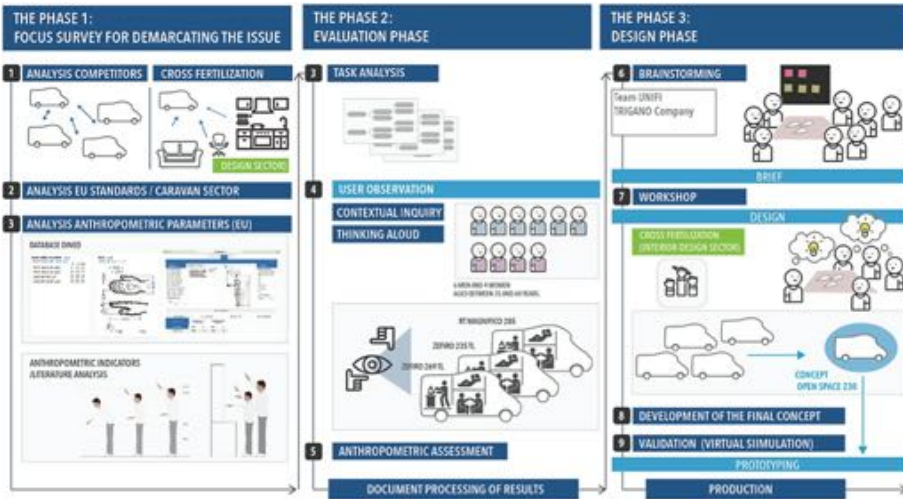


Fig. 1. Representative sketch illustrating main research stages in the framework of Triaca project.

2.1 Focus Survey for Demarcating the Issue

The first step in developing the focus survey for demarcating the issue was to identify the European standards for the sector of operation in question. In general, specific standards are defined for every type of recreational vehicle. For the motor caravan category the reference standards identified are: UNI EN 1646-1:2012; UNI EN 1648-2:2012; UNI EN 1646-2:2009; UNI EN 13878:2007 and UNI EN 721:2005.

In terms of the macro objectives of the research, the standard examined was UNI EN 1646-1:2012 [3]. This standard defines the internal habitation requirements that the vehicle ought to meet in order to ensure the health and safety of the passengers, and also contains the evaluation indicators. Since the accommodation is of reduced dimensions and subject to particular living conditions, there are many aspects that need to be taken into consideration to ensure conditions of safety and wellbeing. Among these the standard specifies: entry points, the doors, the beds, the storage units, the floors, the kitchen equipment and the systems for water supply, storage and discharge.

The anthropometric parameters of interest were identified based on the environmental requirements established by the standard, and referring to the European population bracket potentially corresponding to the company target (Italy, England, France and Germany). The parameters relating to the static and dynamic dimensions of the

human body, paying particular attention to the limits of the user range, proved useful in defining the dimensional constraints of the environment, performed subsequently also through virtual simulations.

In liaison with the company, competitors and representative benchmark models were defined to develop a comparative analysis by type. This made it possible to highlight the similarities and differences and the criticalities and strong points of the Trigano vehicles in terms of innovative solutions, such as equipment, organization of space, degree of transformability etc.

In addition to the comparative analysis by type, a study of the state-of-the-art in sectors similar to that under investigation was performed. From the aspect of cross-fertilization, indeed, the most recent trends in product and interior design can furnish numerous stimuli and suggestions for the motor caravan sector in terms of intervention on models of internal organization and on formal and technical solutions that are by now outdated. This phase proved particularly useful for transferring to motor caravan design structured ergonomic knowledge of a functional and dimensional character that has by now been applied in the home environment for many years. Consequently, for the analysis and subsequent development of the services in the living cabin, kitchen and bathroom, the aspects that determine the height and depth of work surfaces, the accessibility of the storage areas and the visibility of the most-frequently used components had to be taken into consideration.

The material collected up to this point made it possible to plan the following phases of the work and to define the operational strategy for the evaluation phase.

2.2 Evaluation Phase

The evaluation phase involved the study of the human-product-system interaction. To plan this phase was done reference to the ISO 9241-11 standard [4] and to the following methods for the usability assessment: Task Analysis (TA), Contextual Inquiry, Observation and Thinking Aloud. Since it is a complex system, the motor caravan can be conceived as a micro-environment within which various activities are performed. Based on this notion, the decision to rationalize the space through a conceptual breakdown enabled definition of the modes of use and relations characterizing the person-system interaction within the living cabin. This provided a starting-point for the application of usability evaluation methods [5, 6].

For each of the identified macro-areas (living area, sleeping area, kitchen & bathroom) the TA was applied, paying greater attention to the activities considered more complex, such as the movement of the various components to transform the layout of the spaces and the use of the services. The TA is a method utilized by ergonomists and designers for the analytic study of the activities connected with the use of a product-system [7]. The tasks to be performed to complete a certain activity or series of activities can be identified and described. In this phase, using the TA the foreseen or foreseeable tasks to be performed by users to achieve their objectives were identified and the product-system requisites defined, along with potential criticality's and design solutions. Although the activities related to each macro-area were individually analyzed, the possible overlapping of actions was also considered. The results furnished by the

comparative analysis by type (2.1) and by the Task Analysis provided indications for planning and designing the tests with users, a crucial phase of the research.

In line with the principles of HCD, studying the way people interact with products and systems constitutes a valuable and valid contribution to the collection of specific information that is functional to all the phases of the design process. Depending on what phase of the design process one is engaged in, different investigation techniques can be adopted. Survey methods involving users differ primarily in terms of what their use is intended to achieve, and hence on how the researchers interact with users during the collection of information. They can be broken down into methods in which the researchers communicate with the users (usability questionnaires, structured interviews etc.), methods in which the researchers observe what the users do (user testing, observations in a lab setting or in the natural context etc.) and hybrid methods that involve both observation and communication.

Observation is a useful technique for the collection of information in any phase of the design process [8]. It can take place in a controlled environment, such as a laboratory, or in the field. The observation methods involve a researcher observing the users during the performance of an activity and taking notes on what happens.

In the TRIACA project, user involvement pursued two specific objectives: validation and further exploration of the usability analysis launched during the expert evaluations and the parallel collection of further data functional to the development of the new concept. In this regard it was considered expedient to experiment a hybrid method, simultaneously developing Contextual Inquiry, Observation and Thinking Aloud and following a heuristic approach.

As stated by Norman (1998), development centred on human beings calls for a variation on traditional ethnography, which he defines as rapid ethnography [9]. This is a technique that allows researchers to meet the potential users of a product or system in the real use context, to observe their activities and understand how their background influences the interaction. Norman sees contextual research as an applied form of rapid ethnography. Contextual Inquiry, is a method that permits the collection of information about the interaction between the user and the product or system involved, and subsequently to map out a more or less uniform schedule of the significant aspects to be considered in the phase of synthesis [10, 11].

In operational terms, in the development of the sessions with the users the optimisation of the material produced during the expert evaluations proved to be of fundamental importance. In fact this allowed the construction of a pilot outline to guide the performance of the activities. Based on the results emerging in phase 2.1, and by agreement with the company, three vehicles were selected that were different in terms of size, internal organisation of the space and optional features. To enhance the impression of real use conditions, the three vehicles were equipped with kitchen utensils and food, products for the bathroom, linen etc. In conclusion, the on-site observation was oriented principally to an understanding of the dynamics that may occur in the living cabin of the motor caravan, rather than on consideration of the relationship with the external environment; since this is extremely variable, it was omitted in this phase.

2.2.1 The Involvement of the Users

The activity was planned establishing the targets to be reached. In other words: understanding what type of relationship users in general had with the category of product analysed; understanding the process of interaction established on each occasion with the macro-areas identified; understanding the strong and weak points of the system; stimulating users to reflect on issues that are unclear; grasping intuitions and desires, both expressed and unexpressed.

Although it is possible to trace a profile of the typical camper, in terms of the values that lead him/her to embrace this type of tourism (the relation with nature, freedom, life in the open air etc.) it is not always simple to arrive at a clear picture of the potential types of user. Consequently, for the performance of the sessions various types of user were selected in terms of anthropometric characteristics, indicatively belonging to the 5th, 50th and 95th percentiles. Also taken into consideration were aspects such as: gender, provenance, habits, capacities, lifestyle and knowledge of the product.

A total of 10 persons attended the sessions: 6 men and 4 women aged between 35 and 60 years. The sessions were performed over two days and each one had a duration of about 1 h. The procedure was repeated in the same way on all the three vehicles (RT Magnifico 285 TL, Zefiro 269 TL, Zefiro 235 TL placing greater emphasis on the aspects retained more relevant on each occasion.

In operational terms each test session followed these steps:

1. Introduction to the activity: the test objectives and methods were illustrated, together with the general purpose of the research.
2. Personal data and disclaimer: request for consent to take photos and make recordings. In this phase the participants were invited to behave as naturally as possible, and were reassured about the fact that we were not expecting answers or right or wrong behaviour but simply wished to observe their experience in this context. This allowed us to create an informal and relaxed atmosphere.
3. Test session: observation inside the living cabin followed a pilot outline containing the questions and the details of the aspects to be explored in each of the macro-areas identified in phase 2.1; for each question, the interviewee was invited to physically perform the requested operation and to comment on any problems encountered or positive aspects. During the performance of the more complicated activities, such as, for example, the transformation of the dinette from the daytime to the night-time layout, the participant was asked to explain out loud the various steps taken to perform the requested activity. This investigative method is defined in literature with the term Thinking Aloud [12]. It is a method that requires the subjects to speak out loud while they are solving a problem or performing a task; it is a very direct method that makes it possible to understand how the activities are accomplished. It can be employed to gather information about the cognitive processes that guide the gestures and actions, and is useful for constructing new systems based on the information collected.
4. Conclusion: finally, the interviewee was asked to compare the three vehicles analysed, to reflect on the differences observed and identify which solution seemed to be the best based on his/her own demands and expectations. This phase also scheduled the research team offering further food for thought to the interviewee, illustrating possible alternative solutions to those that had been tested, with the aim

of acquiring immediate feedback on the considerations that emerged during the expert evaluations formulated in phase.

2.2.2 Anthropometric Assessment: Virtual Simulations for the Definition of Dimensional Constraints

Each session began with a measuring phase, during which the necessary anthropometric data of the users was collected (height, and measurements of length and circumference of torso and arms and legs) as well as their age and weight [13]. With the aid of virtual simulation software, the data collected made it possible to define the dimensional constraints inherent to the living cabin: the spaces for movement and hence the ideal positioning of the elements such as work surfaces, storage areas and transformable systems. This was useful for defining the dimensional constraints in the concept development phase, as well as its validation.

3 Results

The results obtained in the Focus survey for demarcating the issue and the subsequent evaluation phase are reported below.

3.1 Results of the Focus Survey for Demarcating the Issue

Following the comparative analysis by type it was possible to map out a reference framework for the motor caravan sector, in terms of technological innovation, formal innovation, internal layout of the spaces and transformability of the components. This framework was useful for grasping certain limitations in the company's production, and that of the sector analysed in general, as well as potentially innovative insights casting light on which directions the intervention ought to aim at.

Although motor caravans are broken down into types depending on the structure of the living cabin itself (van; semi-integral; overcab; motorhome); each type also determines the price bracket. No notable characterisations are to be observed, and all the vehicles are very similar to each other, as regards both the aesthetic aspect resulting from the materials and finishes and in terms of the interior transformability. Many of the systems adopted to transform the layout of the internal areas are analogous and are differentiated substantially only by the utilisation of electronics. In general, it is noted that the layout of the interior of the living cabins does not follow a clearly-defined logic; on the contrary each manufacturer proposes "infinite" variants. This can turn out to be a double-edged sword; while on the one hand it offers the customer a greater freedom of choice, on the other it means that the product is not characterised and cannot communicate in a strong manner the added value that a specific composition can guarantee in terms of the best utilisation of the space.

Nevertheless, certain representative cases were identified among the competitors, which are distinguished by interesting experimentations: systems for the rapid transformation of the bathroom, depending on the activity to be performed; systems that foster the use of the external area, by exploiting moveable components that can be repositioned; technological aspects conceived to enhance comfort and sensory

experience, for example though an intelligent use of lighting. In short, the comparative analysis by type already led to the identification of certain design insights, including the inclusion of specific accessories for the kitchen and the adoption of systems for the mobility of the dinette components.

3.2 Results of the Evaluation Phase

During the sessions with the users the aim was, in the first place, to understand what sort of relationship there was between the persons and the product analysed. Therefore, before getting down to detail arguments of a general nature were addressed. It emerged that most of the users involved travel in their motor caravans occasionally, that is, at least once a year, and that they generally associate this type of holiday with a sense of freedom. Travelling in a motor caravan does in fact allow you to decide your own destination, and to set off without any need for booking and without any temporal restrictions, in search of a more direct contact with the environment. It emerged that many of the users prefer using the vehicle in the summer season, within campsites, and they confirm that this choice greatly conditions their habits in the use of the vehicle itself during their stay in the campsite. For example, the kitchen is used almost exclusively to prepare breakfast or lunch, which is normally eaten in the open air, and the use of the bathroom is sporadic, except when small children are present. In various cases there is the impression that these habits are the result of the fact that some parts of the vehicle do not perform their functions adequately. In general, people naturally tend to adapt to certain situations, making up for the criticalities deriving from poor design. It is examples of this kind that bring forth the essence of the working method adopted, which by involving people brings one face to face with the real situations in which products and systems are utilised.

After this phase, more specific issues were addressed in greater detail. Attention was focused on understanding the interaction set up each time with the identified macro-areas: daytime area (entrance and dinette); night-time area (beds at the back and/or overcab and/or dinette); services (kitchen and bathroom). In order to grasp the strong and weak points of the system and stimulate users to reflect on issues that are unclear, specific actions were identified for each of the above areas. Performance of the tasks referred to each action – and in some cases the application of the Thinking Aloud method – made it possible to collect detailed information. Reported below are the significant data that emerged for each of the areas, identified as follows: collected data (D); user observations (UO); researcher observations (RO); potential design insights (I).

3.2.1 Daytime Area: Entrance

(D) During the door-closing phase, most of the users interviewed remain standing on the floor of the motor caravan and have to lean outwards to a considerable degree: it could be necessary to reposition the handle. The rubbish bin incorporated into the door is not easily accessible and is inconvenient to reach because it is located too low down. Moreover, when the vehicle is parked and the door is open, users have to get out of the vehicle to throw away the rubbish. (RO) It could be more useful to position the rubbish bin inside the kitchen area. (I) it could be more useful to incorporate other containers in the entrance door.

3.2.2 Daytime Area: Dinette

(D) The size of the table is not appropriate to the arrangement of the seating. During use, when all the seats are occupied, not all the users can reach and use the table comfortably. Access to the containers under the seats, where present, is not very practical, since all the cushions have to be removed and a complex system of opening activated. (UO) Many participants point out the problems connected with the installation on the seat of the high chair for infants. (RO) Is the mechanism for moving the table really necessary? When all the seats are occupied, not all the users can conveniently reach and use the table. If the surface is moved closer to one of the seats then this makes the situation worse for whoever is seated opposite. (I) If the cushions were less bulky it would facilitate the operations of assembly/dismantling; it is important to convey the concept that the comfort of the seat is not necessarily due to the thickness of the cushions.

3.2.3 Night-Time Area: Elevating Bed

(D) The components of the manual system for locking/unlocking the elevating bed are not easy to identify and access. Despite the fact that there are only two possible positions, the point at which the bed locks into place is not clearly perceptible: a form of visual or auditory feedback would be useful. (UO) During the access phase, most of the users prefer to lower the bed to its maximum extension, since this gives more room for action, even though it is first necessary to remove the cushions from the dinette area beneath. (RO) In the case of less expert users or anomalous situations, there are no instructions present about the operations to be performed to transform the elevating bed. (I) The access ladder, which is stored in the garage, could be integrated into the bed, or there could be a special storage area for it inside the driving cab.

3.2.4 Services Area: Kitchen

(D) There is no work surface for food preparation. The chopping-board provided does not fit neatly onto the sink so that the surface is unstable. In various cases the hob cover is used as an additional surface in the preparation phase, raising the preparation level to the detriment of posture. The storage units are not completely accessible, so that the rear section remains unused. In the wall cupboards there is a shortage of dividing elements which could enhance the optimization of the space. (RO) The linear layout proves to be very practical, since the hobs and sink are well arranged and proportioned. Despite this, the lack of a work surface means that users prefer the L-shaped kitchen. However the users also recognize the limited practicality of this arrangement. The storage units ought to be studied with a view to the types of utensils they are to contain. (I) A linear arrangement of the hobs could be considered, inserting a work surface in front of them, calibrating the depth of the counter, or envisaging two different height levels.

3.2.5 Services Area: Bathroom

(D) The hinged bathroom door does not open completely and obstructs the kitchen area. When users are inside the bathroom, especially taller users, the door is an obstacle; for example in the case of washing one's face one has to bend the torso over the basin, but in doing so the buttocks collide with the door, making it impossible to bring the face close to the washbasin. The washbasin itself is too small, and users

observe that during use a lot of water is splashed out, wetting the surrounding area. The wall units positioned above the washbasin and the WC, represent an obstacle for the heads of the taller users, and there is a distinct danger of hitting the head. In order to use the containers positioned under the washbasin, users have to adopt extremely uncomfortable postures. When taking a shower, because of the lack of vertical space taller users are forced to use the seat that is built into the frame; this operation turns out to be rather impractical, since the tap is then behind the user's back, making it difficult to adjust the jet and the temperature, as well as the fact that the contact between the back and the mixer tap is not very pleasant. (UO) Inside the shower, the suspended element conceived for hanging towels and/or bathrobes is appreciated by the users. Some think its function should be optimized. (I) Solutions could be studied for the rapid transformation of the space depending on the activity to be performed. Closure solutions not involving a hinged door could be studied.

3.3 Summary and Preliminary Design Phase

Summarizing what is set forth in the preceding paragraphs, it was possible to map out a sort of profile of the user sample involved. An interesting point to stress is that the users who had greater experience with the use of the motor caravan, because they owned a vehicle or hired one on a regular basis, proved to be more accommodating towards potentially critical situations, demonstrating a more marked spirit of adaptation which was lacking in the novice users. These less expert users proved to be more critical, very probably because they had a more generic vision and made reference to their domestic experience.

In addition to their familiarity with the areas of the living cabin and the respective equipment, the more expert users also expressed a greater knowledge of the functional aspects. They had less difficulty in identifying the position of the controls for switching on or off the water and gas, and also of the electricity switchboard. As regards this aspect, all the users – and the more expert in particular – remarked on the need to have more immediate feedback on the state of the utility resources, especially in travelling situations in which stops at campsites are not scheduled.

Through the synthesis of the data obtained from the focus survey aimed at demarcating the issue (Sect. 3.1) and an evaluation phase (Sect. 3.2) it was possible, in agreement with the company, to define a project brief. The operational contribution of LED in the design phase was to transfer the data that emerged during the “Evaluation Phase” and to contribute to the development of the project brief. Through a design workshop led by the UNIFI working group¹, a new concept of camper was developed: “TRIACA Open space Concept 230” (see Fig. 2).

¹ The research group of the University of Florence (DIDA Department) involved in the project is led by Frances-ca Tosi (scientific coordinator), Giuseppe Lotti, Vincenzo Legnante. Collaborators: Alessia Brischetto (LED), Irene Bruni (LED), Marco Mancini, Marco Marsegli (LSD) and Andrea Martelli.

PRELIMINARY DESIGN PHASE- WORKSHOP



Fig. 2. Preliminary workshop solutions by UNIFI team.

The concept has been validated and implemented through virtual simulations for the validation of the following aspects: space for movement and maximum reachability and consequently the ideal location of the elements, such as work surfaces, containment compartments and transformable systems (see Fig. 3).



Fig. 3. Process of transferring design requirements emerged in the “Evaluation Phase” within the design phase. Kitchen and bathroom area

4 OPEN SPACE 230 Project

The main objectives of the project proposal phase were primarily finalized to increase the usability degree and the perceived well-being by potential users of the camper system. Similarly, environmental sustainability and management energy savings issues were taken into account. The study of the available space led to a reorganization of all the interiors of the vehicle and its equipment. Notably, significant efforts were dedicated to the improvement of the living area, internal transformability, well-being and comfort.

The internal volume of the camper was designed to be extremely ergonomic, accessible and exploitable to the widest extent. To this end, it was necessary to adopt smart solutions by implementing baskets and drawers as well as cabinets and furnishings mounted with hinged tops that allow for varying the internal volumes to provide greater stowage flexibility. Functional access from both inside and outside of the wardrobe proved to be particularly effective.

The living area is characterized by floor planes inspired by contemporary housing models, which are widely known as “open space”. The kitchen and the bathroom are located at the back of the camper, the dinette at the front.

The design of the dinette’s space was developed by considering the concept of “functional flexibility” in which all the elements are transformable. Thus, the sofas become “chaise long”, the seats may assume a relax position and the dinette transformed in a bed for two people.

In detail, the dinette, located in the front part of the vehicle, is characterized by convertible sofas which allow, thanks to the introduction of innovative mechanisms, to have in a single solution three compositional modes: day mode, relaxation mode, night mode. Moreover, it is possible to create a reading area featured by a reclining position, where there is a pouf and an extra containment drawer that acts as a stool or as footrest. The day mode and the relaxation mode are designed to increase the comfort level and thus the habitability of the camper.

Compared to existing systems, the hob has been redesigned by introducing free-standing induction plates, which allow the user to customize the organizing structure of the cooking area. The latter, if needed, can be freed and used as a breakfast table or as a work surface by removing the induction plates and storing them inside a special compartment located under the top. Most importantly, the induction cooktops can also be eventually used for cooking in the open air, a vital advantage for campers.

The compact spaces of the toilet have been the subject of ergonomic studies to achieve maximum freedom of movement, without sacrificing stowage and functionality of the sink and concealed modular boxes. In this regards, the anthropometric evaluation phase, performed by considering a user population ranging from the 5th to the 95th percentile, revealed to be crucially important to better design the optimal movement space.

The overall volume of the bathroom is characterized by a single coating of pRaL®, inside which a reclining sink and a series of concealed containment elements were mounted. The WC bowl is raised up respect to the ground plane and is rotating, as to be easily used both by adults and children. The concealed sink is part of the column that welcomes it (see detail in Fig. 4).



Fig. 4. The final version of the prototype developed from the concept Open Space 230.

The project activity involved also typological transfer activities, in particular the transfer of trends and functional solutions of the domestic sphere within the new concept. A study on the materials and the life cycle of the product, in terms of reducing the environmental impact during production and use, was also carried out.

The intention to encourage responsible and sustainable behaviors of management and resources saving was materialized in the elaboration of an interactive control panel (see Fig. 5).

Through a smart user interface the control panel provides information on the status of any aspect of the camper resources (water, electricity etc.). This was possible through the development of a dedicated section, which allows the activation/management of the lighting sources inside the vehicle, through a series of preset scenarios that suggest the optimal lighting mode, in relation to the external lighting condition. Moreover, in the event that the user activates several lighting scenarios at the



Fig. 5. Details of the developed interactive control panel. (Color figure online)

same time, the system communicates, through a dedicated icon, the type of behavior the user is following (green if positive, red if negative). In this way the user perceives his choices and is encouraged to optimize the energy resources as better as possible.

A similar system was developed for the management of water, which has to be intended as board diary. On the basis of preloaded information (number of passengers, days spent on the camper) returns a prediction on the amount of water available daily in relation to travel days. In the case in which the daily quantity of water is not exhausted, the system will communicate to the user that has optimized the resources at its disposal. Consequently, the user will benefit from a greater quantity of water during the trip, which is redistributed on the days later. Oppositely, in case of excessive consumption of daily water amount, the system will communicate to pay attention, and scale the residual quantity for the following days. In this way the user is encouraged to assume correct and sustainable behaviors through a constant perception of his habits, otherwise it would have to rethink the duration of his travel.

5 Conclusion

TRIACA project produced significant outcomes in the field of interest, as it strongly contributed to the development of innovative solutions in relation to delicate issues, such as environmental sustainability and quality of use experience. The experimentation of the Human-centred design methods and its iterative approach proved to be effective. It made possible to collect useful data, partly based on the direct and active engagement of the users, to create new use scenarios and to improve eco-efficiently the product.

The design action and the multidisciplinary dimension of the research project allowed also to test and transfer formal, technological and environmental innovations of the Concept Open Space 230 project within the productive sector of Trigano SpA. These innovations are now available within the company offer. Finally, the Concept Open Space 230 was marketed under the name Triaca 230 TL and recently, a new version, named Triaca 232 TL motorhome, has been proposed.

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DICHIARANO

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sono il risultato di un finanziamento della Regione Toscana - POR CREO FESR 2007 – 2013. LINEA D'INTERVENTO 1.5.a - 1.6. BANDO UNICO R&S ANNO 2012, titolo del progetto TRIACA - Soluzioni Tecnologiche per la Riduzione dell’Impatto Ambientale del camper nella fase di utilizzo” in collaborazione con l’azienda Triganò.

In particolare, il contributo riporta i risultati degli output Ergonomics in Design di cui l’Università di Firenze, nella persona della prof.ssa Francesca Tosi, è responsabile.

Premesso quanto sopra, riguardo la pubblicazione specifica, Francesca Tosi e Giuseppe Lotti hanno svolto un ruolo di supervisione, in qualità di responsabile scientifico del progetto la prima e di coordinatore del output Design per la Sostenibilità il secondo. Alessia Brischetto ha collaborato allo sviluppo del degli output Ergonomics in Design e sintetizzato i risultati ottenuti all’interno del suddetto contributo in qualità di assegnista impegnata per due anni sulla ricerca.

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