A six-step model to transform an ergonomic work analysis into design guidelines for engineering projects

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A six-step model to transform an ergonomic work analysis into design guidelines for engineering projects

Abstract

BACKGROUND: Ergonomic work analysis (EWA) is an ethnographic-like method that can produce highly detailed accounts of real work in work systems. Such knowledge is valuable for designers when they are designing new work systems. However, rich data derived from EWA should be transformed into more designer-friendly guidelines to have an impact on engineering design projects.

OBJECTIVE: We propose a six-step model to transform EWA into ergonomic design guidelines (EDG). This model can be applied by ergonomists and researchers when taking part in projects with the aim of transferring operational experiences into engineering design.

METHODS: Based on previous experiences using EWA, we establish a model for transforming the outcome of EWA into EDG. We illustrate the model through a case study based on the offshore oil industry.

RESULTS: This paper describes how EWA rich data is transformed into EDG following the proposed six-step model, including the concepts of characteristic situations and settings of usage.

CONCLUSIONS: Based on preliminary testing and validation by designers, EWA can be transformed into useful EDG by following the six steps of the proposed model.

Keywords: Ergonomic design guidelines; ergonomic work analysis; workspace design; offshore oil industry
1 Introduction

Ergonomic work analysis (EWA) is a method that can highlight ergonomic considerations and recommendations when designing new workspaces. However, because of the ethnographic-like characteristics of EWA, the challenge is how to systematize and present the rich material in a format that is applicable to designers. Therefore, the question arises how the outcome of EWA can be transformed into suitable ergonomic design guidelines (EDG) for engineering projects. This paper addresses this research question by presenting a model for transforming a detailed EWA into EDG, which enables designers to understand and use ergonomic knowledge. We illustrate this model through a case study in the offshore oil industry, where we introduce the booklet format of the EDG.

2 Ergonomic work analysis in engineering design projects

Ergonomic factors are always present in engineering projects, where a holistic approach is increasingly necessary because of the complexity of work systems. The range of ergonomic considerations is substantial, and the impact of a project that does not meet these considerations may significantly affect costs, working conditions, and overall safety [1, 2]. The earlier such considerations are addressed in the design process, the greater the possibilities of influencing project objectives and improving the work environment in a cost-efficient way [3-6]. The design of workplaces can directly influence users' future activities in terms of efficiency, reliability, health, and work conditions. However, design processes are not often based on a deep analysis of real users’ activities [7]. Reference situations are workspaces with similar characteristics to the one being designed, and can be used to “predict” some of the characteristics of the future work activities in new workspaces [9]. EWA [8] in reference situations increases the level of knowledge about work practices relating to the new workspace being designed.

The foundations of EWA lie in the French-speaking ergonomics approach. In many ways, the method is similar to what is referred to in international literature as ‘job analysis’ or ‘task analysis’. However, it has different historical roots and a very specific approach to the concept of ‘work activity’ [9]. This paper is based on this particular approach, using the terms coined by the French ergonomists and researchers [8-14] relating to ergonomic analyses.

According to Béguin [13], EWA is a “kind of ethnographic way of studying work” that aims to solve concrete problems. The goal is to contribute to the design of work situations and workspaces that will serve as a starting point for the development of future users’ activities [11, 15]. The fundamental principle of EWA is to
emphasize “real work” (work activities) in contrast to the formal organization, meaning prescribed work tasks [8]. This requires an explanation of the informal knowledge (tacit skills) of users, the criteria that guide their actions, and the conflicting goals that shape their behavior at work. In general, such knowledge is only accessible after lengthy observation, and experience working alongside users in natural situations (in the context where they perform their daily activities). Both the means and tools to accomplish the tasks, and the ways individuals actually use them (strategies, knowledge, decision criteria, and real operational methods) are part of this everyday life. This methodology (Figure 1) combines observations of the work situation, interviews, and verbalizations at different hierarchical levels, to examine activities in detail, and in physical, cognitive, mental, and social dimensions. In the context of EWA, verbalizations [8, 10, 14] mean verbal feedback from users when confronted with pictures, videos, or other media related to their work activities.

[Figure 1]

The analysis begins by identifying the main challenges in reference situations, and by analyzing the different working tasks and activities involved. Once the challenges have been identified, analysis requires investigation of the overall functioning of the work system. This is achieved through interviews and analysis of documents pertaining to different work processes and tasks involved in the reference situation. With this overall understanding, the ergonomists can then identify the characteristic situations of action [11, 12, 14] that will guide both open and detailed observations, providing the core data from this methodology.

During this process, the ergonomists formulate an initial diagnosis of the reference situation [8,11], which identifies normal and adverse work conditions, and is based on the challenges that are being investigated. Then it is validated with the users, to provide more detailed observations and a final description of the characteristic situations. This final description contains at least the following elements: the objectives to be achieved (tasks to perform), the people involved, requirements (such as time, quality, and security) that must be respected, and the variable factors likely to influence the development of the situation (including raw material properties, day/night, and weather). Each identified characteristic situation accounts for situations of normal functioning, and inevitable variations that users encounter, providing a sound basis for developing appropriate design guidelines.

3 Methods

The research question was investigated using a case study of the offshore oil industry. Based on previous experiences with EWA, and a detailed EWA of offshore oil rigs, we developed a model to transform
EWA results into EDG. In this section, we present the following: 1) an overview of the oil company case study, 2) details on the EWA carried out during the case study, and 3) development of the requirements for the EDG, and how we decided to elaborate them.

3.1 Case setting and procedure

A two-year research project was conducted in collaboration with a Brazilian oil company, with the objective of developing ergonomic guidelines for different functional areas of oil rigs. During this project, the research team studied 20 functional areas of offshore units to develop the guidelines. The research team included the following eight researchers: a professor as the coordinator, three experienced researchers, a postdoctoral researcher, two PhD students, and a master's degree student.

It was agreed with the company that a recently designed floating, production, storage, and offloading (FPSO) unit would be the main reference situation for the project. FPSOs are floating production units located either on a modified ship’s hull (usually an oil tanker), or on a purpose-built ship. FPSOs have the capacity to process and store oil, beyond providing the transfer of oil and natural gas to the mainland. These units consist of different functional areas divided into two main zones: the accommodation module, and the processing and production facilities. The accommodation module, also known as the living quarters, includes both living and working spaces divided into functional areas such as the control room, laboratory, and dormitories. The processing and production facilities include the processing plant on the ship’s deck (to treat the fluids produced by the wells), and functional areas such as the main production deck, electrical systems, and a cargo handling area. When the research was conducted, the crew included 180–200 rig workers who stayed onboard during the whole 14-day working period.

Five members of the research team (excluding two of the experienced researchers and the postdoctoral researcher) visited the FPSO (used as the main reference situation) on 13 occasions. Each visit comprised an average of two to three researchers, who were onboard for three to seven days. During the project, the coordinator and the two PhD students also visited five other offshore units for data validation. These onboard visits lasted for three days, with two researchers. This validation supported the investigation into whether the scenarios observed in the main reference situation could be generalized to other units. The researchers interviewed the rig workers and took pictures for comparison.

In this paper, we report on the data pertaining to 49 work activities from the 10 functional areas of the accommodation module. To illustrate the developed model, we use specific examples from one of these
functional areas (the food sector). The intention was for the developed guidelines to be used by designers during basic design stages, which is the phase where basic specifications are prepared and a first general arrangement and layout are established by defining the positions of the different functional areas. In this project, the designers were naval architects and design engineers from different disciplines involved in the process of designing new workspaces; in this case, the different modules and components of oil rigs.

3.2 Ergonomic work analysis

We performed an EWA for different work activities in the 10 functional areas of the accommodation module (Figure 2). First, we identified typical work activities and their challenges, and then mapped the most critical work activities that were key to the overall operation of each functional area. We studied 12 work activities in the food sector that illustrate this case study.

[Figure 2]

This mapping was the input for a more in-depth analysis of the work activities. The mapping started with data collection through interviews with the rig workers (who were the users of the functional areas). The notes from the interviews were used for a first round of validation with the users.

The next step consisted of identifying the characteristic situations to be observed in detail. The researchers carried out detailed in situ observations of the work activities in these areas, taking detailed notes with time registration for the different actions during the work, taking pictures and, in a few cases, video recording some activities (Table 1). A full working shift was not observed without interruptions; instead, observations happened when a “new” work activity was also occurring (the same activity was not observed multiple times) and the researchers could be present. In each observation, the users were shadowed continuously, and time was noted at the start of any new part (or repetition) of the activity. The duration of the observations varied from 30 min to 4 h, depending on the duration of each observed work activity.

[Table 1]

Verbal feedback in the form of verbalizations from the users was sought to validate the findings from the observations, and to understand variabilities while performing different activities more fully. It also helped the researchers to gain a thorough understanding of the work. The field notes were used as documentation for this validation. The two PhD students were responsible for the detailed observations and the overall EWA, and were assisted by the coordinator, one experienced researcher, and the master's degree student in some of the visits. All data were entered into detailed spreadsheets.
3.3 Development of the ergonomic design guidelines

Design guidelines can be useful tools when they include adequate recommendations. They can be considered an intermediary interface between the designer and the knowledge required about the use of the intended workspace [16]. However, there are many challenges in developing these recommendations, which includes making the findings of a rich ethnographic analysis manageable and valuable for designers [17], preventing their use from becoming both demanding and time-consuming [18–22], and identifying the respective needs of the designers in relation to language, communication style, and methods of engagement [23]. Such ergonomic tools should avoid recommendations that are too general, and avoid design criteria that increase the documentation [6, 24, 25]. Designers usually prefer a less scientific form of text and language that more closely resonates with that used in projects [26], and use visual and associative thinking processes. Aas and Skramstad [27] suggest that guidelines should be informative rather than normative, and descriptive rather than imposing solutions. In addition, Visser [28] suggests that such a tool should require little or no instruction and be ready to use, while also merging with the existing characteristics of the design process and the creative work practices of the designers [29]. Based on an assessment of the existing literature and guidelines, Table 2 presents the preferred main characteristics of the guidelines that we identified.

[Table 2]

The development of the guidelines started by screening the existing standards and guidelines for an offshore unit design to identify the following: 1) existing restrictions for the design, and 2) pros and cons of these documents. However, it is important to distinguish between the many ergonomic principles mentioned in different studies, which have a very general formulation (making it hard for designers to find the relevant information) [21, 22, 30–33] and what we propose here, with insights generated from detailed analysis of work practices. Another distinction is what we refer to and discuss here as ergonomic principles and guidelines, versus existing norms and standards, which are internationally recognized regulations with mandatory design criteria and restrictions.

The guidelines were gradually developed in a participative manner. The aim was to make the material available as it was prepared so that it could serve as the basis for analyses, discussions, suggestions, and validations. The guidelines were validated with designers from the oil company (who were participating in the basic design of new rigs), through interviews and critical evaluations based on their accumulated experience. The guidelines were initially validated by four experienced architects in three meetings that considered a single functional area as reference (the food sector). These architects were asked to read the guidelines and comment...
on the following: 1) what they thought about the content, the amount of information, and the formatting of the information; and 2) in which phase of the design process they thought the guidelines would be useful. Ultimately, two architects read all the guidelines as if they were going to use them in their current project. They commented on the content and format, which helped to identify what they thought would be useful during the basic design stages of the design process.

4 Results

To transform the rich EWA data into EDG, we propose a six-step model (Figure 3). We illustrate the model by applying it to the food sector. This functional area is part of the accommodation module, and includes four different working spaces: the galley, mess room, bakery, and dry/freezer provisions. Seven different users work in this area preparing six meals a day: the chef, cook, baker, butcher, pot washer, galley hand, and provision storekeeper.

[Figure 3]

The starting point for the transformation process is the raw data from an EWA, in a level of detail dependent on each case. The first step is to systematize these data. The second step is to structure the characteristic situations identified and detailed by the EWA. The goal is to develop a systematic and sequential description of all characteristic situations. The third step is the passage from characteristic situations into settings of usage [34, 35]. Here, the aim is to provide the designers with enough information to understand the activities that take place in each working space, and thus understand the reasons to implement the proposed guidelines. The fourth step addresses the overall structure of the guidelines. Here, the goal is to attain applicable and easy-to-retrieve guidelines, with relevant information that can help designers understand the different spaces they need to design. The fifth step is to define the format and content of technical recommendations, which will provide specific guidance for the designers. The goal in this step is to provide information regarding what should be done, the rationale, and insights and ideas on how it can be achieved. The final step before finalizing the transformation process refers to validation and testing of the guidelines with users and designers. The overall output is a set of EDG in the form of a booklet targeting the design of new workspaces similar to those studied in the EWA.
4.1 Systematic data

The first step of the transformation process is to structure the raw data from the EWA. For each functional area, we described the general determinants of the activities divided into two levels. The first is a summary of the general functioning of that area, describing the main purposes, and including 1) the timing of the main activities, and 2) the different users and their functions. The second level is a description of the main physical structure, with the different work spaces belonging to that functional area and their features. To conclude, some insights based on the analysis were considered for retaining some of the design characteristics, and which characteristics were to be transformed in future workspaces, creating a good basis for the next steps of the process.

4.2 Characteristic situations

Systematizing the raw data from the EWA makes it easier to structure the characteristic situations identified within the analysis. Each characteristic situation is based on the overall tasks for each individual worker. This includes the task to be performed, its objective and frequency, the critical factors for performing this task, and a detailed description of the activity based on observations and verbalizations. The term critical factors refers to the special/design conditions that are critical for that activity to be performed, such as complexity or specific location. In the case of the food sector, we had descriptions for 12 characteristic situations out of a total of 27 h of detailed observations. These characteristic situations were as follows: main dishes preparation, side dishes preparation, supper and breakfast preparation, meat preparation, barbecue preparation, bread preparation, snacks and desserts preparation, tableware and cookware washing, mess room organization, food ramp reposition, cleaning and organization of the freezers and dry provisions storage rooms, and receiving the provisions. Table 3 displays a structured characteristic situation description.

[Table 3]

4.3 Settings of usage

Based on the detailed description of the characteristic situations, we developed the concept of settings of usage to describe and generalize the activities taking place in each physical space. The definition of a setting of usage is always a combination of physical–technological aspects (such as environment, space, instrument, object, and equipment) and social context and activities (such as transporting of food, washing pots and utensils,
and preparing meals). The settings of usage include the following: 1) the location where the activity happens, 2) the work activity happening in that space, and 3) the description of how this activity is performed.

The main unit of reference for a setting of usage is the physical space where the activity takes place. This means that one characteristic situation may be equivalent to one or more settings of usage, requiring the information to be organized in a way that makes more sense for the designers, who can look at each specific working space when it is being designed. Table 4 shows three settings of usage related to the characteristic situation presented in Table 3. In this case, the work activity described in the characteristic situation takes place in three different locations, which is the reason why it resulted in three settings of usage. These examples illustrate how the locations where the work activities are held guide the descriptions of the settings of usage. In the example presented, even where a single person is performing the daily meat preparation work activity, the worker uses (and needs) distinct places.

[Table 4]

4.4 Guidelines structure

The guidelines took the form of a booklet with one chapter for each functional area studied, making it easier for the designers to access required information at any given time. In the case of the accommodation module, the EDG included 10 chapters. The structure of each chapter is presented in Figure 4.

[Figure 4]

Each chapter started with a general overview of the area it addressed, presenting its purpose, the main activities, and who works there. Further, it presented the general location of the functional area in existing units, and whether it has physically separated (but connected) working spaces, and/or working spaces that are directly related to this functional area. We also included the main goals for the design of each area. After a general overview, the first section included settings of usage, presenting the typical use situations in the working spaces to be considered in the design. The second section included conditioning factors and design variables, presenting the main aspects that should be considered in the design of that functional area. In addition, it contained a brief explanation of why these aspects should be considered and what influence they would have. These aspects may vary from one project to another, but they are important for dimensioning and, sometimes, for defining the layout of each area. In the case of the food sector, the conditioning factors and design variables referred to the number of meals to be served per day (which influences the dimension of the whole area), the location of the space where the food supplies will arrive (which determines the equipment needed for
transporting the food supplies), or the frequency of grocery supplies to the rig (which defines the size of the provisions storage rooms). The third section included reference norms and standards, presenting the main documents that designers should consult. The final section presented technical recommendations.

4.5 Format and content

The final section of each chapter of the guidelines booklet contained specific recommendations for the designers. To fulfill the requirements presented in Table 2, in terms of format, the technical recommendations contained specific guidance on different aspects of a project. To align with the order of the design process and address the information needed at different time points, these recommendations were presented in hierarchical order, from the most general to the most specific. First, guidelines regarding the layout of each functional area were presented, followed by guidelines pertaining to ambiences. Overall, designers need broader information regarding the positioning of a functional area and its layout before they address the specific details regarding furniture and equipment. In terms of content, an important characteristic of each guideline was the incorporation of a brief explanation why the guideline should be taken into account. In addition, drawings, pictures, and schemes were included to facilitate understanding.

The first recommendations addressed the location of each working space of the food sector. Figure 5 shows two examples of these first recommendations. The first explains the overall connection between the different working spaces as a basis for decisions on location, and the second provides more detailed insights on how to plan access between these different spaces.

[Figure 5]

With regards to the layout, the recommendations provided information such as the use of each working space of the functional area, giving a brief summary of the main work activities to be taken into account. These provided further textual and pictorial details to exemplify the positioning of the different equipment needed (see Figure 6 for examples).

[Figure 6]

4.6 Validation and testing

The final step of the transformation process was to validate and test the guidelines. All guidelines were presented and discussed with architects who worked on the design of accommodation modules in new offshore units. They appreciated having the visual help of the pictures, drawings, and diagrams, rather than just text.
Their main comments related to the extra information, together with the guidelines, which presented the reasons behind the recommendations. The architects found it interesting to have complete information about the actual work activities through the settings of usage, as well as several examples and explanations. Furthermore, Cordeiro et al. [19] and Oggioni et al. [36] simulated use of the guidelines during the detailed design of two new rig projects, indicating that their applicability is high. The designers participating in these two projects recognized the importance of meeting ergonomic and other technical requirements from other disciplines.

5 Discussion

This paper presents a six-step model to transform EWA into EDG. This model can be applied by both practitioners (ergonomists) and researchers who aim to integrate ergonomics into recurrent engineering design projects. This applies to the offshore oil sector, and can apply to the railway and aircraft sectors, among others. EDGs already exist, but they are usually generic and infrequently used by designers [32]. However, by proposing a different method of developing such targeted guidelines, it is possible to meet designer needs more effectively. Applying the model requires time and involvement of a group of researchers and/or ergonomists. Nevertheless, it may ultimately save time, which is usually limited during design projects, while also providing the opportunity to make available and apply ergonomic knowledge in these projects. Furthermore, in the offshore sector (and other engineering design projects) design projects often happen without an existing designated crew (work force) for the new workspace, meaning there are no clear end users to assist with a more participative user-centered design process [4]. The design guidelines can provide relevant knowledge from ergonomic analyses to the design of new workspaces.

According to Caple [23], one of the domains covered by ergonomics research regards methodologies within the field, which examine the analysis of work situations toward the design of more suitable outcomes (meaning the analysis of work in reference situations toward the design of new workspaces). This is in line with the model presented in this paper, as the outcome (EDG) aims to improve work conditions in new workspaces. An ergonomist can be a participant in the design process, which is highly desirable. However, this type of intervention necessitates several conditions, such as the opportunity to engage the design team at an early stage of the project, and spending significant time in their company to understand the project and perform an EWA [7]. Unfortunately, it is very rare that these conditions are met in practice, which is when the need and justification for developing valuable and adequate design guidelines arises.
It is important to consider that not all designers are skillful researchers, nor do they have time to analyze the data from first principles. The aim is to understand how to present the required information, with some inspiration for design, but still allowing the freedom to interpret and discuss new solutions [28]. The guidelines we presented here follow these principles by avoiding imposing restrictions, or by offering solutions to be copied. This gives designers the freedom to develop the best solutions for each case. Moreover, when presenting the reasons behind the guidelines, we wanted to provide evidence to support their decision-making for the appropriate design solutions to take place (as seen in the examples in Figure 5 and Figure 6). This is also in line with Aas and Skramstad [27] who suggested that general recommendations should be made, but decisions regarding the details should be left to the designers.

5.1 Limitations and further research

The study was based on a single case only. This is a limitation of the study, and indicates possible avenues for further research. One possibility is to use the model to develop EDG for sectors other than offshore, to confirm its applicability in other engineering design projects. The model could also be considered for smaller scale and less complex projects that still have similar characteristics regarding the design process. However, the transfer of operational experience is most striking in the cases of geographical separation, given the difficulties designers have in managing to be on-site. In other large-scale projects, access to the project site is easier. However, the collection of information about the use of these spaces is not always simple or straightforward.

6 Conclusion

EWA can be transformed into useful EDG, providing relevant knowledge for designers. Based on an in-depth case study, we have developed a six-step model to address the transformation process from EWA into EDG. Given the possibilities of applying this model in different engineering design projects by both practitioners and researchers, it helps to fill the existing gap in transforming ergonomic knowledge into adequate design guidelines.

Acknowledgments

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References


Table 1 Observation tool used onboard during the EWA

Table 2 Requirements for format and content of the EDG

Table 3 Example of characteristic situation, part of the systematized data from the EWA

Table 4 Examples of three settings of usage written from one characteristic situation
<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial mapping</strong></td>
</tr>
<tr>
<td><strong>Task</strong></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
</tr>
<tr>
<td><strong>People involved</strong></td>
</tr>
<tr>
<td><strong>Requirements</strong></td>
</tr>
<tr>
<td><strong>Variation factors</strong></td>
</tr>
</tbody>
</table>

| **Detailed observations** |
| **Time** | **Activity** | **Displacement** | **Interactions** | **Tools** | **Observations** |
| **What is the worker doing?** | **Where is the worker moving to?** | **Who is the worker talking to or working with (even if by phone)?** | **Which tools or equipment is the worker using?** | **Any extra comments or questions that the worker can be asked afterward** |
Table 2

<table>
<thead>
<tr>
<th>Format</th>
<th>Present guidelines from the more generic to the more specific</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Divide guidelines according to designers’ needs</td>
</tr>
<tr>
<td></td>
<td>Include pictures, drawings and diagrams</td>
</tr>
<tr>
<td>Content</td>
<td>Avoid imposing restrictions on the designers</td>
</tr>
<tr>
<td></td>
<td>Avoid offering solutions to be “copied”</td>
</tr>
<tr>
<td></td>
<td>Present the reasons behind the guidelines</td>
</tr>
<tr>
<td>Task</td>
<td>Meat preparation</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Objective</td>
<td>Prepare meat for all meals</td>
</tr>
<tr>
<td>Frequency</td>
<td>Daily</td>
</tr>
</tbody>
</table>
| Critical factors | Space in the counters  
                      | Location of the freezers  
                      | Temperature for handling the meat |

**Task description**

The butcher undertakes the preparation (and pre-preparation) of the meat for all the meals. This preparation starts at the beginning of the shift at 6 a.m. The butcher picks up the containers of defrosted meat in the freezers and places them on the workbench. He then starts cleaning and cutting the meats, which will be prepared for the next day's meals. The butcher does this two days in advance only in the weeks before the crew change.

Then he prepares meats for the same day's lunch. The preparation of meats on the grill is always done by the butcher, and then the dish is finished by the chef.

During lunch hours (11 a.m. to 1:30 p.m.), the butcher prepares chicken, eggs or steak on the grill whenever necessary. These options are offered every day. The butcher already has some pre-prepared food before lunch time, and over the course of the meal, he prepares more according to the demand.

In the afternoon, the butcher starts again to clean and cut the meats that will be used for dinner in the same way as for lunch.

This preparation ends before 5 p.m., when there is a daily safety talk before the end of the shift at 6 p.m.
<table>
<thead>
<tr>
<th>Location</th>
<th>Work activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galley—workbenches for meat, chicken and fish preparation</td>
<td>Pre-preparation of meat, chicken and fish (butcher)</td>
<td>The butcher pre-prepares different meats, anticipating stages according to the dishes planned in the menu. The butcher has to look for the meats in the freezers, defrost, clean and cut, and reposition in the freezers or grill. The handling of red meat and poultry occurs on the same workbench, but fish is handled on a separate countertop.</td>
</tr>
<tr>
<td>Galley—cooking island</td>
<td>Use of stove and grill</td>
<td>Some foods already prepared for cooking are placed in containers, which become quite heavy, especially those containing meats.</td>
</tr>
<tr>
<td>Freezers and dry provisions storage rooms</td>
<td>Galley supplies</td>
<td>Each galley worker goes to the provisions rooms to pick up the supplies needed to complete his/her work. This flow between galley and provisions is constant, and cargo transportation is intense. The loads can be heavy, like the containers with meats, and require the use of trolleys.</td>
</tr>
</tbody>
</table>
Figure 1—General overview of the EWA, adapted from Guérin [8, p. 128]

Figure 2—The different steps of the EWA performed and their outcomes

Figure 3—Six-step transformation model from EWA into EDG

Figure 4—Overall structure of each chapter of the EDG

Figure 5—Guidelines examples: positioning, access and flow

Figure 6—Guidelines examples: dimensioning and layout; furniture, equipment, devices and installations
Figure 1
Figure 2
Figure 3
Figure 4
- There is a need for the areas that make up the food sector (galley, mess room, bakery, and freezers and dry provisions rooms) to be designed in an integrated way, considering their functioning. The galley is the central environment, to which direct access, free of obstacles, from all other environments should be provided.
- Priority should be given to solutions that place these areas on the same floor, with common flow, thus avoiding constant movement and transportation of provisions up and down stairs and the need to use a food lift, which is necessary when the provisions rooms and the galley are on different floors.

- Provide quick and unobstructed access (steps, sills, pipes etc.) between:
  * external area and provision rooms;
  * galley and provision rooms;
  * galley and messroom; and
  * in case of obstacles, they must be transposed by ramps.

Ramps in access paths of the receiving from the victuals

Figure 5
The food sector should be composed of the following areas:

**Galley**
- Main area - where most cooking activities are carried out, with separate spaces in the same area for cooking (central) and for preparation of the various types of food (peripheral), since these activities are interdependent.
- Bakery - the preparation of breads, cakes, pastries and pasta requires an exclusive area due to the use of its own equipment and the specific temperature and humidity needed for the preparation of breads.

(...)

Provide support counters for pans, monoblocs and/or utensils near the cooking island (stove, plate, fryer, boiler etc.).
- It is recommended that this counter is located between the stove and the grill plate/fryer, since in addition to serving as support for cooking, grilling and frying, the distance between the stove and other equipment prevents the condensation of vapors from generating grease splashes in the grill plate and fryer. When no counters are provided in the cooking island, the supports are improvised with empty monoblocks.

<table>
<thead>
<tr>
<th>STOVE</th>
<th>SUPPORT</th>
<th>FRYER</th>
<th>GRILL</th>
</tr>
</thead>
</table>

Schematic plan with positioning of the support counter on the cooking island

Grill plate used as support

Support counter

Positioning of the support counter at the end of the cooking island and using other nearby surfaces as support