Strategic outlook in industrial design assessment based on product category

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Abstract. Assessing industrial design is an intricate process of product analysis which aims to establish the quality degree of a product and considers all its implications from technical restrictions to appearance. Industrial design is related to mass produced articles obtained through industrial processes and whether products are articles of adornment or machines, both technical and aesthetic dimensions are relevant and influence the design process. All types of industrial products can be assessed using a numerical method based on the same criteria, however the same principles have a different impact on various types of products. The author proposes a customized approach in order to achieve an objective assessment for different concepts of design.

1. Introduction
The major dilemma in assessing the design of industrial products is given by the ambiguity of setting the general domain to which the design section belongs to. Being associated with industrial processes, design tends to become an integrant part of the technical aspects of production. At the same time, the term design is often used when referring to the appearance of a product considering the aesthetics or the significance of its shape or color.

Product design is strongly correlated with the industrial domain and thereby with mass production, a product is considered industrial due to the processes through which it is obtained, regardless of the parameters related to its typology, the exterior appearance or its components. A reference representation of the types of industrial products is the Locarno classification, where the products are divided into thirty-two classes and include both decorative products and industrial machines.

Regardless the nature of the product, it is meant to fulfill a well-defined purpose. There are design assessment methods meant to determine the suitability of the product attributes in correlation with the purpose given to the product [1]. Most methods are focused on aesthetic aspects, involving the analysis of visual elements [2], establishing the attributes involved in the product aspect [3], or simply studying the aesthetics of products form [4]. Also, the relationship formed by the product and its context of use is analyzed, the connection between them is examined [1], or there is the case where the areas of interest and the given context are established [5].

Based on all the aspects involved in the user experience, the quality of the product as well as the quality of the experience itself and the factors that determine the purchase decision, the author considers that the design assessment of industrial products needs to take into account principles regarding functionality, technical specifications, ergonomics, symbolistic and aesthetic aspects, referenced in this paper as design assessment dimensions.
2. Importance ratios of design dimensions

The author proposes a coherent design assessment method that implies understanding all the parameters involved in product design, based on exhaustive analysis of user experience that starts from safety and the implicit technical restrictions, the details that facilitate the use process as much as possible, symbolic implications in the product-user relation, as well as the aesthetics of the product interface. All the considered aspects in the assessment method are applicable on any product category, yet the differentiation between the type of products must also be reflected in their approach in design assessment.

Considering the design dimensions proposed by the author, Functional, Technical, Ergonomic, Symbolistic and Aesthetic, when assessing design for different product categories, the proposed method consists of a five steps structure of importance relevant to each type of category separately, whereas for a certain product category, a dimension such as Aesthetic or Ergonomic may be of much greater importance than for other category.

In order to determine the ratio values for each dimension, as seen in figure 1, a medium value of importance \( p_3 \) was established by dividing the total importance \( P \) to the number of design assessment dimensions \( n \), as in equation (4), the value \( P \) being set to 100%, and represents the sum of all ratios, as observed in equation (1) or (2).

\[
P = \sum_{n=1}^{5} p_n = 100\% \quad (1)
\]

\[
P = \frac{(p_1+p_5) \times n}{2} \quad (2)
\]

\[
p_n = \frac{p_{n-1}+p_{n+1}}{2} \quad (3)
\]

\[
p_3 = \frac{P}{n} = \frac{100\%}{5} = 20\% \quad (4)
\]

\( P \), the total importance value, \( n \) is the total number of assessment dimensions and \( p_3 \) represents the medium ratio.

The mean value of the series is considered the average value between the minimum and maximum ratio, in this case \( p_3 \). In order to keep the ratio constant, a \( p_n \) value represents the average between the two adjacent ones as observed in equation (3).

Considering the medium value of importance of a ratio \( p_3 \) and the relations between the terms of the sum, as in equation (3), all other values for the ratios were determined and presented in figure 1.

![Factors of importance for the five assessment dimensions.](image)

It is relevant to have an importance difference between the dimensions but the gap should not be too extensive as all the proposed dimensions are relevant in the actual assessment. As seen, the maximum importance of a dimension is established at 30% and the minimum at 10%, for all these ratios, in order to carry out the assessment it is necessary to establish the correlation with the proposed dimensions.
3. Dimensions hierarchy for the Locarno classes
Starting from the proposed assessment dimensions, using the Locarno classification, the correspondent structure according to the importance degree of the dimension is established for each class. All the proposed dimensions have an impact on the assessment of an industrial product, however the extent to which they impact the product differs.

3.1. The structure of design assessment dimensions
The functional assessment involves the actual testing of the product and establishes the degree to which the product is adequate to the use experience. Therefore, functionality is the most important aspect in product design, it is essential to be considered a primary dimension regardless of the product class.

When calculating the number of variations, $D_1$ is represented by the functional dimension, its ratio $p_1$ being a constant (30%) and not a variable as is the case for the other dimensions. Established according to importance, the position of only the four dimensions may vary, as presented in figure 2. Based on Functional as primary design dimension, there are twenty-four possibilities for ranking the assessment dimensions as seen in equation (5).

$$C_4^1 + C_3^2 + C_2^3 = 24$$ (5)

3.2. Corresponding classes for each importance layout
Considering the nature of industrial products, these being articles designed with a well-defined purpose, the aspects of functionality are of major importance, any other dimension involved in the design assessment being secondary.

In the proposed method, the hierarchy for a particular class of products involves analyzing the product typology and establishing the aspects with the greatest impact on the design for the given category. The thirty-two classes were divided into four categories for the secondary dimensions, in three remaining categories for the tertiary dimensions and so on until the remaining fifth dimension and for each variation of importance the corresponding classes were established.

![Figure 2. The hierarchical structure of the assessment dimensions, proposed by the author.](image-url)
3.2.1 **Technical as a secondary dimension**

As presented in table 1, the industrial products that are defined by technical as secondary dimension are mainly products used in the industrial field such as Tools and hardware (Class 8), Means of transport or hoisting (Class 12) or Machines (Class 15). The classes of products corresponding to this category are easily identifiable because the technical aspects are all the more obvious as the product is related to the technology and the designer must have engineering knowledge, therefore, aspects related to sizing tolerances, material properties or standard colour coding must be considered as they have a direct impact on safety in use.

**Table 1.** Hierarchy of classes with secondary Technical dimension

| Third dimension | Fourth dimension | Fifth dimension | Corresponding Locarno class |
|----------------|-----------------|----------------|-----------------------------|
| Ergonomic      | Symbolistic     | Aesthetic      | 8, 12, 13, 22, 29           |
|                | Aesthetic       | Symbolistic    | 15, 16, 23, 24, 31          |
| Symbolistic    | Ergonomic       | Aesthetic      | -                           |
|                | Aesthetic       | Ergonomic      | -                           |
| Aesthetic      | Ergonomic       | Symbolistic    | -                           |
|                | Symbolistic     | Ergonomic      | -                           |

3.2.2 **Ergonomic as a secondary dimension**

Ergonomic dimension is strongly correlated with the actual process of use of a product and facilitating that certain experience as much as possible. Products defined by great importance in ergonomics primarily involve a proper sizing compared to the dimensions of the human body and take into account the entire experience of use from the effective handling of the product to the direct impact on the user's well-being during use experience. As seen in table 2, among the classes of products corresponding to this category are listed Household goods (Class 7) or Packages and containers for the transport or handling of goods (Class 9).

**Table 2.** Hierarchy of classes with secondary Ergonomic dimension

| Third dimension | Fourth dimension | Fifth dimension | Corresponding Locarno class |
|----------------|-----------------|----------------|-----------------------------|
| Technical      | Symbolistic     | Aesthetic      | 9, 18                       |
|                | Aesthetic       | Symbolistic    | 4, 14, 21, 25, 28, 30       |
| Symbolistic    | Technical       | Aesthetic      | -                           |
|                | Aesthetic       | Technical      | 3                           |
| Aesthetic      | Technical       | Symbolistic    | 6, 20                       |
|                | Symbolistic     | Technical      | 7, 19                       |

3.2.3 **Symbolistic as a secondary dimension**

Symbolism prevails over other proposed dimensions if the products are defined by historical elements with a strong symbolism already established. The specific products can determine the creation of other elements of artistic nature or they could be intended for hobbies. This is the narrowest category mainly because this type of products is usually obtained by handicraft and not industrial design as is the case with Musical instruments (Class 17), presented in table 3.
Table 3. Hierarchy of classes with secondary Symbolistic dimension

| Third dimension | Fourth dimension | Fifth dimension | Corresponding class | Locarno |
|-----------------|------------------|-----------------|---------------------|---------|
| Technical       | Ergonomic        | Aesthetic       | 17                  |         |
| Aesthetic       | Ergonomic        | -               | -                   |         |
| Ergonomic       | Technical        | Aesthetic       | -                   |         |
| Aesthetic       | Technical        | Ergonomic       | 32                  |         |
| Ergonomic       | Technical        | Technical       | -                   |         |

3.2.4 Aesthetic as a secondary dimension

Although they are produced through industrial processes, for certain articles, aesthetics is defining and has the greatest impact on the purchase decision. Aesthetic as a secondary dimension is specific for products such as Articles of clothing and haberdashery (Class 2) or Textile piece goods, artificial and natural sheet material (Class 5), as presented in table 4.

Table 4. Hierarchy of classes with secondary Aesthetic dimension

| Third dimension | Fourth dimension | Fifth dimension | Corresponding class | Locarno |
|-----------------|------------------|-----------------|---------------------|---------|
| Technical       | Ergonomic        | Symbolistic     | 10                  |         |
| Symbolistic     | Ergonomic        | 26              | -                   |         |
| Ergonomic       | Technical        | Symbolistic     | 1                   |         |
| Symbolistic     | Technical        | -               | -                   |         |
| Symbolistic     | Technical        | Ergonomic       | -                   |         |
| Ergonomic       | Technical        | Technical       | 2, 5, 11            |         |

4. Hierarchical structure of the dimensions in correlation with the corresponding ratios of importance

In order to carry out the assessment, as in equation (6), the proposed ratios \( p_n \) must be correlated with the corresponding dimensions \( D_n \), and, for each dimension, its hierarchy is established within the assessment according to the product category.

\[
T_D = \sum_{n=1}^{5} D_n p_n = D_1 p_1 + D_2 p_2 + D_3 p_3 + D_4 p_4 + D_5 p_5
\]  

\( T_D \), the total value of design assessment, \( n \) is the total number of assessment dimensions, \( D_n \) represents the assessed dimension with its corresponding ratio \( p_n \). The total value of the assessment represents the sum of all the dimensions \( D_n \) related to the corresponding ratio \( p_n \). The \( D_n \) values are given in the actual assessment of the product and if all the qualitative requirements of the product are met and the dimensions obtain maximum value, \( T_D \) can take values up to 100, which represents the total agreement in meeting the design requirements.
### Table 5. Dimensions hierarchy and corresponding ratios for the ten most common Locarno classes

| Class | Class description                                      | Functional | Technical | Ergonomic | Symbolistic | Aesthetic |
|-------|--------------------------------------------------------|------------|-----------|-----------|-------------|-----------|
| Class 2 | Articles of clothing and haberdashery                  | 30%        | 10%       | 15%       | 20%         | 25%       |
| Class 6 | Furnishing                                              | 30%        | 15%       | 25%       | 10%         | 20%       |
| Class 7 | Household goods                                         | 30%        | 10%       | 25%       | 15%         | 20%       |
| Class 9 | Packages and containers for the transport or handling of goods | 30%        | 20%       | 25%       | 15%         | 10%       |
| Class 11 | Articles of adornment                                  | 30%        | 10%       | 15%       | 20%         | 25%       |
| Class 13 | Equipment for production, distribution or transformation of electricity | 30%        | 25%       | 20%       | 15%         | 10%       |
| Class 15 | Machines                                               | 30%        | 25%       | 20%       | 10%         | 15%       |
| Class 21 | Games, toys, tents and sports goods                    | 30%        | 20%       | 25%       | 10%         | 15%       |
| Class 26 | Lighting apparatus                                     | 30%        | 20%       | 10%       | 15%         | 25%       |
| Class 30 | Articles for the care and handling of animals          | 30%        | 20%       | 25%       | 10%         | 15%       |

The proposed method applies for all the subclasses corresponding to a certain class, even if the products in the subclasses have differentiations in the product typology, the ratios remain valid, Locarno being a classification of industrial products according to the destination of use.

### 5. Conclusions
The author has developed a new approach in industrial design assessment starting from establishing the importance ratios for the five dimensions and their hierarchy according to the product typology, which resulted in a strategic method of industrial design assessment that addresses all categories of industrial products depending on the impact of a dimension on the overall design.

When differentiating the ratios of dimensions for certain classes, a specific pattern can be observed for certain dimensions with high importance, for example there are far fewer classes with a very high degree of importance in symbolism and also the classes defined by high ratios for technical aspects are strongly correlated with ergonomics and less with aesthetics or symbolism. Also, if the product is assessed in the development stage, as observed, the product features correlated with the high ratio dimension prevail over those with low importance, for example, when a product from the Machines class is assessed in the concept phase, as seen in table 5, it is recommended that the features related to functionality and technical aspects must be fulfilled first, then the ergonomic details are established, followed by the aesthetics and only at the end improvements regarding the symbolism can be made. The proposed approach thus aims to ensure the high quality of any industrial product both by addressing all its key aspects as well as considering them in a systematic way that takes into account the specifics of the product according to its typology and the destination of use.

### 6. References

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