



Validation of a New Evaluation Method of Modular Design Focused on the Prosumer

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Abstract

The modular design harbors a potential development in the prosumer scope that has hardly been previously exploited. Their joint application can lead to products focused on user participation through modular design. This work proposes and validates a concept evaluation metric in the design phases that meet these characteristics. To do this, 24 external designers and prosumers evaluate five products using this method. The results and conclusions contribute to the improvement of the method and provide information on how to approach it to the prosumers.

Keywords: conceptual design, modularisation, design evaluation, prosumer, modular design

1. Introduction

Modular design is based on the construction through independent modules that combined achieve the variety of the product. It has developed exponentially in many areas, providing new tools that aim to modularize products (Ma and Kremer, 2016). However, its scope is often focused on the development and manufacturing phases, making it unnoticeable to the end user. This fact contrasts with the current evolution of consumers towards prosumers who seek to participate in the process of creating their products (Halassi *et al.*, 2019) through its design, manufacture or assembly. Their participation may be due to a need, such as adapting the product and lowering costs, or a want, such as having a unique product. Modular design has been shown to bring significant advantages in customization, adaptation and upgrade, features directly related to prosumer users. There is a need to bring modular design and its benefits to prosumers to meet their current needs. This perspective has not been previously covered from the field of research, where the relationship between modular design and user has focused on other aspects such as massive customization (Wang *et al.*, 2014) or permanent adaptation (Zheng *et al.*, 2017).

The present work is part of the development of a modular design method focused on the prosumer that will be applied in the conceptual phases of product design. It is necessary for the user and/or designer to know how to identify and evaluate modular design, so a new method of evaluating modular products for the prosumer is presented and validated. The objective is that prosumers can use it to evaluate and optimize their own modular products under a design method. Due to the non-specialized user to whom it is directed, the method is intended to be understandable and easily applicable, while being objective and convergent. In addition, the evaluation method will be aimed at the evaluation of concepts. This proposal is a novelty among the developed methods because, although there are already methods that evaluate modular design (Shan and Chen, 2009), none do so from the perspective of the end user. In addition, it is necessary to evolve the modular design methods to apply them to the prosumer field.

Next, it is presented how the validation of the method has been developed, the results obtained from it and the conclusions reached after this test. This validation has been carried out through the individual

evaluation of five products by 24 external professionals. The results provide information on how to bring the design method closer to the prosumers, which are the characteristics evaluated clearer and understandable by the evaluators, and which characteristics and products present greater difficulties. The final conclusions contribute to the improvement of the method and the design guide.






2. Methodological description

The objective of this work is to obtain a series of results and conclusions that contribute to the improvement of the method and the future creation of a modular design guide focused on prosumer. The research is established on a previously defined evaluation method based on a checklist that assesses compliance with the characteristics of modular design. This checklist was evolved to also include characteristics of the prosumer field (Asión-Suñer and López-Forniés, 2019, 2021a) and of both fields at the same time (Asión-Suñer and López-Forniés, 2021b, 2021c). The result was developed to make it understandable to a non-specialized audience, so that each characteristic was posed as a question and each level to evaluate as an answer. In this way, the work begins from this previously developed method that evaluates 9 characteristics (three of modular design, three of modular design and prosumer, and three of prosumer) based on five levels ranging from 0 to 4 (Appendix A).

With the method defined, tested and optimized by the researchers, we proceeded to its validation by professionals. So that the evaluators could apply the method correctly, a user guide and an introductory video were developed. Both introduced a series of key concepts: modular design, prosumer user and method functioning. In addition, the guide also included a list of references with real examples of each level of evaluation to facilitate their choice. Finally, the method was transferred to an online form so that each evaluator could respond individually, thus ensuring correct usability and data collection.

The next step was to select the products to evaluate. Taking as a reference the previous evaluation, it was decided to select five products based on the results obtained. The objective was to validate the initial hypotheses by matching the professional evaluation with the researchers' proposal. The products chosen for the evaluation are detailed in Table 1.

Table 1. Products to be evaluated by the professionals.

Product	Image + URL	Previous evaluation	Description
ROOM Collection (Olovsson and Cho, 2021), Olovsson and Cho (Sweden)		High compliance with all characteristics	Set of 25 blocks for different furniture configurations. Each user can create their own organizer by combining the available modules or manufacturing new ones.
Project Ara (Wikipedia, 2021), Google (USA)		Medium compliance with all characteristics	Initiative to manufacture modular mobiles. Each user can configure their mobile by purchasing each component separately and joining them on the same motherboard.
Neuron Inventor Kit (Makeblock, 2021), Makeblock (Spain)		Low compliance with all characteristics	Toy based on multifunctional electronic blocks that can be connected to each other magnetically. It can be used online and offline to set up different projects.
BESTÅ (IKEA, 2021), IKEA (Sweden)		High level of modular design, low level of prosumer	Furniture modules that allow the end user to configure the set according to their desires, space and needs. BESTÅ is not just a living room organizer, it is for all rooms in the house.
Organizer cabinet, Ollaris (Hungary)		Low level of modular design, high of prosumer	Organizer to store tools and papers. The product is self-made and has different storage sections joined by glue.

Although the evaluation method is designed to be used in the conceptual design phases, it was decided to evaluate products already finished and/or marketed. The reason is that it would be easier for the evaluators to understand them, thus reducing the level of individual interpretation and therefore increasing the objectivity of the test. In addition, the concepts can be undefined or even have different levels of definition between them, so to validate the metric it is more correct to do it with finished products.

To conclude, the method was emailed to the evaluators. As a selection criterion, it was imposed that all of them must have more than 5 years of experience in the product design sector or in the maker field. In the case of prosumers, the evaluator also had to belong to a maker organization, whether a physical space or a digital platform. All the evaluators were of Spanish nationality and the ratio between female and male sex was 50%. Instructions for performing the method were specified in the email, including the user guide, the video and the form to be completed. The work ends with the collection and processing of data from the 24 evaluations and the extraction of a series of conclusions based on these results, as well as the feedback from the evaluators. It is important to obtain qualitative results due to this validation is a first test with the objective users. For this reason, the feedback of the evaluators is considered of great relevance to improve the method and bring it closer to non-specialized users.

3. Results

The results are shown in three sections according to the development of the validation:

1. **Guide and form.** The guide and the form used to carry out the evaluation method are briefly presented. It is the first result of this work in the way of representing the method to make it understandable and bring it closer to non-specialized profiles. This result is the first step for the future development of a complete design guide.
2. **Products' evaluation.** The results of the evaluation carried out by the 24 professionals are presented using two tables. The first shows the average of the results obtained in each of the characteristics of the five products, as well as the total for each area (modular design, modular design + prosumer and prosumer). The second table shows the convergence of the results according to the percentage of votes at each level.
3. **Evaluators' feedback.** Finally, the perception that users have had of the method in terms of the level of difficulty and its practical interest is detailed. In addition, common comments and perceptions about the test are also collected.

3.1. Guide and form

The guide was presented to users in a user-friendly and easy-to-understand format (Figure 1). The information was synthesized in reduced texts where the use of pictograms predominated to explain the key concepts. All the information regarding the method was structured in the following sections:

- **Introduction and objectives.** The method and the context in which it is developed are presented, explaining that it is an individual evaluation of five products.
- **Modular design.** The term and its key characteristics that define it are explained. The definition of product platform and module are also provided. The difference between modular design, module design and parametric design is established to avoid possible confusion.
- **Prosumer user.** The term prosumer, its main characteristics and its link to modular design are defined. It is also explained how the user can intervene on the product and the different moments of intervention both before and after the purchase.
- **Evaluation method.** It is detailed how the method should be used through the form that includes the evaluation by levels of all the characteristics. They are given the option to choose between one and two levels for each characteristic when in doubt.
- **Level guide.** Real examples are provided along with the definition of each level to facilitate their choice in case the evaluator has any doubts.

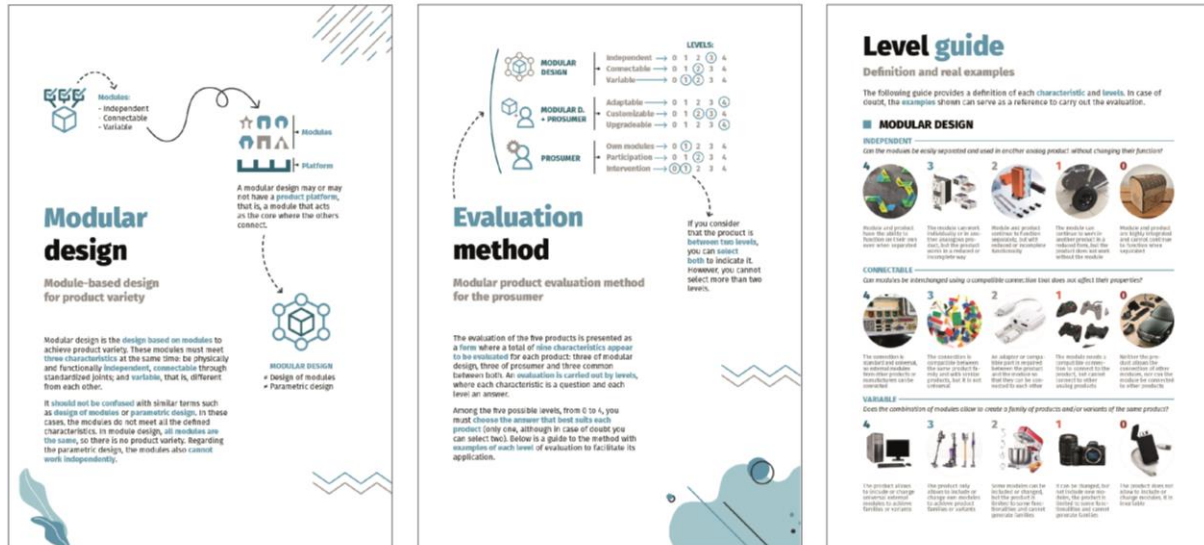


Figure 1. Corresponding pages to the user guide. From left to right: Modular design, Evaluation method and Level guide.

The method was initially presented as a metric in a table form that included the definition of each characteristic and level. This format presented too much information to the evaluator, and could seem an excessively complex method. To facilitate its visualization and use, the method was transferred to an online form due to the familiarity of the users with these elements. In this way, the information is presented on five pages, one for each product. For each one, a summary, an image, and a link with more information are first provided. Subsequently, each characteristic is presented as a question on the form and each of the five levels as a possible answer that the evaluator must choose (Figure 2). Evaluators can respond to the form along with the usage guide to view reference examples for each characteristic and facilitate their final choice.

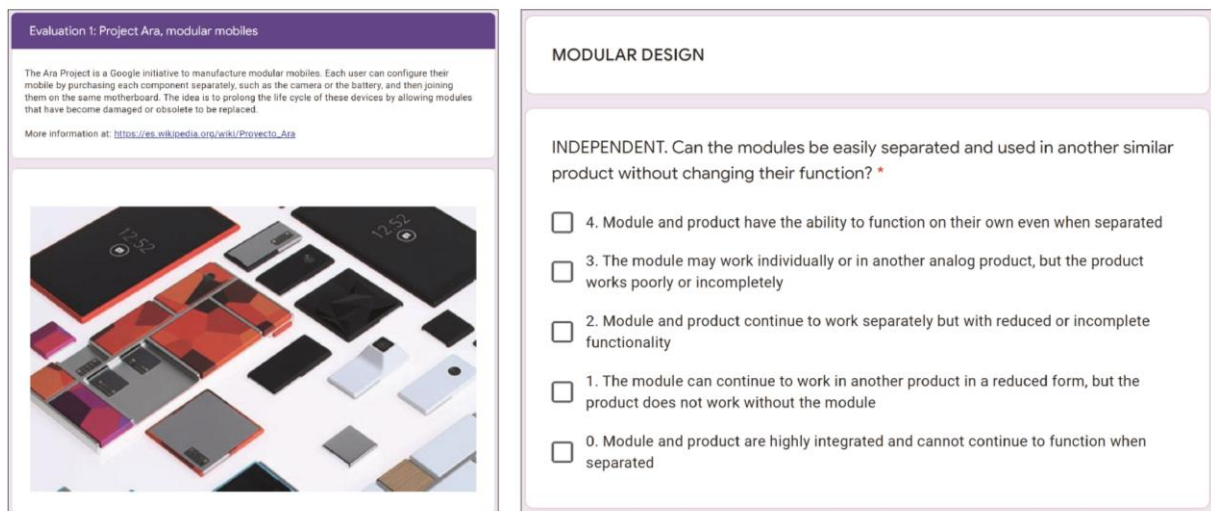


Figure 2. Evaluation form: description of each product (left) and evaluation of one of the nine characteristics (right).

3.2. Products' evaluation

Table 2 presents the results of the evaluation of each product. For each characteristic, the level corresponding to the mean of the results obtained and the rounding to the nearest level are shown,

presenting the result as an intermediate level if applicable. All characteristics show a rating from 0 to 4, with 0 being the lowest level and 4 being the highest level of compliance (Appendix A). The table also shows the total assessment of each of the three areas out of a maximum of 12 points, 4 for each characteristic evaluated. Those where the result should be higher according to the previous evaluation of the researchers have been highlighted in **bold**.

Table 2. Summary of the evaluation results of each product.

Area	Characteristic	ROOM Collection	Project Ara	Neuron Inventor Kit	BESTÅ of IKEA	Organizer cabinet
Modular design	Independent	3,95 → 4	2 → 2	2,12 → 2	3,95 → 4	1,58 → 1,5
	Connectable	3,83 → 4	2,92 → 3	2,88 → 3	3,83 → 4	2,46 → 2,5
	Variable	3,38 → 3,5	3,04 → 3	3,08 → 3	3,38 → 3,5	2,79 → 3
	<i>Total Modular design</i>	11,16 → 11	7,96 → 8	8,08 → 8	11,16 → 11	6,83 → 7
Modular design + Prosumer	Adaptable	2,88 → 3	4 → 4	3,5 → 3,5	3,54 → 3,5	2,71 → 2,5
	Customizable	3,79 → 4	3,54 → 3,5	3,33 → 3,5	3,71 → 3,5	3,46 → 3,5
	Upgradeable	3,04 → 3	3,16 → 3	2,54 → 2,5	2,92 → 3	3,29 → 3,5
	<i>Total Modular design + Prosumer</i>	9,71 → 10	10,7 → 10,5	9,37 → 9,5	10,17 → 10	9,46 → 9,5
Prosumer	Own modules	2,66 → 2,5	0,21 → 0	0,63 → 0,5	0,66 → 0,5	3,66 → 3,5
	Level of participation	2,79 → 3	1,12 → 1	1,20 → 1	1,29 → 1	3,75 → 4
	Moment of intervention	3,33 → 3,5	2,88 → 3	2,33 → 2,5	2,79 → 3	3,66 → 3,5
	<i>Total Prosumer</i>	8,78 → 9	4,21 → 4	4,16 → 4	4,74 → 4,5	11,07 → 11

According to the results obtained, we can conclude that the evaluation carried out by the researchers and the evaluation of the 24 professionals coincide in the most outstanding points of each product. We see that ROOM Collection continues to be the highest rated product globally, while BESTÅ has obtained the highest rating for modular design and Organizer cabinet in the prosumer area. Despite these coincidences, we see that there is still some lack of precision in the results. Looking at the products Project Ara and Neuron Inventor Kit both have a similar valuation, there should be a greater difference between the results with lower values in Neuron Inventor Kit so that it fits the initial selection of the products. On the other hand, it is also observed that all the products have the same valuations in the field of Modular design + Prosumer. This is because all five products were good in this area. However, there should be more difference between the results, especially in ROOM Collection on the rise and the Neuron Inventor Kit on the decline.

To objectively know if the tool has been applied correctly, we must analyze the convergence in the results. This analysis will reveal whether there is consensus in the perception of the products, as well as in the understanding and application of the method. Table 3 shows the level of convergence between the results of the 24 evaluators for each of the nine characteristics. This level has been assessed as follows:

- "✓✓" if the majority response has obtained more than 70% of the evaluations.
- "✓" if two consecutive levels add up to more than 70% of the ratings.
- "-" if the majority response has obtained between 40% and 70% and does not meet the previous condition.
- "X" if the majority response is less than 40% and does not meet any preconditions.

Table 3. Assessment of the convergence index of the results.

Area	Characteristic	ROOM Collection	Project Ara	Neuron Inventor Kit	BESTÅ of IKEA	Organizer cabinet
Modular design	Independent	91,7% ✓✓	33,3% X	25% X	87,5% ✓✓	50% -
	Connectable	58,3%+50% ✓	75% ✓✓	45,8%+29,2% ✓	75% ✓✓	33,3% X
	Variable	50%+37,5% ✓	79,2% ✓✓	70,8% ✓✓	70,8% ✓✓	50%+29,2% ✓
Modular design + Prosumer	Adaptable	54,2% -	79,2% ✓✓	62,5%+20,8% ✓	70,8% ✓✓	45,8% -
	Customizable	75% ✓✓	50%+41,7% ✓	45,8%+41,7% ✓	70,8% ✓✓	66,7%+12,5% ✓
	Upgradeable	62,5% -	37,5% X	58,3%+12,5% ✓	45,8% -	58,3% -
Prosumer	Own modules	37,5% X	91,7% ✓✓	75% ✓✓	79,2% ✓✓	83,3% ✓✓
	Level of participation	41,7% -	58,3%+33,3% ✓	41,7%+41,7% ✓	54,2+45,8% ✓	83,3% ✓✓
	Moment of intervention	54,2+20,8% ✓	45,8% -	66,7%+16,7% ✓✓	33,3% X	75% ✓✓

If we analyze the columns of Table 3, we can see which products have been easier for the evaluators to rate. At this point we find that BESTÅ and Neuron Inventor Kit have obtained the most consensual evaluations compared to ROOM Collection and the Organizer cabinet that have generated more dispersion in their results. This may be due to the fact that the last two are own unmarketed creations, so the possibilities of each characteristic may be more open to interpretation. However, BESTÅ and Neuron Inventor Kit are already marketed products, allowing evaluators to better understand their capabilities and limitations when evaluating them.

On the other hand, the rows in Table 3 provide us information on which characteristics are best defined by the convergence of their results. We found that *variable* and *customizable* are the clearest characteristics for the evaluators, while *independent*, *upgradeable* and *moment of intervention* are the ones that have generated the most doubts. These last three characteristics will require an improvement in the evolution of the method to achieve a greater degree of objectivity. This optimization can be covered in two ways: improving the definition of its levels or providing more information to the evaluator at the beginning of the test. Moreover, it will also be necessary to analyze whether the type of product to be evaluated can influence the understanding of each characteristic.

3.3. Evaluators' feedback

At the end of the form, the evaluators were asked what level of difficulty they would assign to the method according to their experience. The majority assigned it a medium level of difficulty (66,7%), while 25% considered that the method had a high level of difficulty. Only 8,3% valued the level of difficulty as low, so we can conclude that the perception of users is that the method has a medium-high level of difficulty.

Regarding the profile of the evaluators, we find that 70,8% are designers, while 20,8% are prosumers and 8,3% are makers. This data contrasts with previous surveys, where the level of prosumers was minimal compared to makers (Asión-Suñer and López-Forniés, 2021c). This is because the term prosumer is not widespread enough and there is even some confusion around its meaning. However, this time the term was explained at the beginning of the test both in the video and in the design guide, so many users felt identified with it.

Half of the users considered that the evaluation method was of practical interest to them, while 41,7% answered that they would use it depending on the circumstances. We can say that most evaluators find practical interest in the method after using it for the first time. No designer responded that they would not use the method, confirming its potential application in product design. However, these results show that it is necessary to work on the method to bring it closer to non-specialized fields such as prosumer.

Among the evaluators' opinions, several of them commented that the method required more attention than they expected, especially when interpreting and understanding the levels. In this regard, they considered that the design guide and the introductory video greatly facilitated this work and that the way of presenting them was optimal to understand it. However, some found it difficult to differentiate certain elements, such as modules. Some evaluators also made reference to the fact that a greater explanation or a deeper analysis of the products is required to evaluate them correctly, so having more information would help them to improve their evaluation. Finally, they also felt that the method would be a good guide for the ideation and design phases, which supports the potential use that it is intended to give it.

4. Discussion

The purpose of the validated method is to use it as part of a design model to create modular products focused on the prosumer. For this reason, its final use is focused on the conceptual phases of product design, allowing to evaluate and choose between several concepts that have a common theme and objective. However, could it serve to improve an already finished product? In the present work, it has been used with commercialized products with the only objective of not generating doubts and thus reducing the subjectivity due to the evaluators' interpretation. However, if certain guidelines were defined for its use in finished products, the evaluation could generate variants that optimize some of the evaluated characteristics.

The results show that the initial hypotheses are fulfilled. However, there is a compliance discrepancy that is high for the featured product in all areas (ROOM Collection), for the featured product only in the modular design area (BESTÅ) and for the featured product in the prosumer area (Organizer cabinet). But it is also high for products that should have a medium (Project Ara) and low (Neuron Inventor Kit) valuation in all areas and differentiated between them. They obtain a valuation equal to the rest in the Modular Design + Prosumer area, so the metric is not correctly understood when evaluating products from different sectors or maybe it requires a higher development in the definition of its levels.

Table 3 discriminates the products with respect to the consensus of the evaluators. There are products with greater convergence that are easily understood as modular but show difficulty for the prosumer (ROOM Collection or BESTÅ) or that allow the prosumer to intervene easily but have greater modular complexity (Neuron Inventor Kit or Organizer cabinet). It is observed that it may be a mistake to introduce modular design and prosumer features into the same metric when evaluating products from different industrial sectors. For this reason, it is necessary to review the metrics and evaluate products belonging to the same industrial sector in the three areas, verifying that the 5 assumptions of the initial hypotheses are met and that there is convergence of the evaluators.

Evaluators more specialized in areas of design that do not deal with physical products, such as service or graphic design, have found it more difficult to use the method. Although they consider the explanation adequate, they believe that they need more information to apply the method. This aspect is faced with the fact of making the method easier and more accessible for non-specialized users. Can excess information negatively affect its usability? An evaluation method that is framed within a design model, with all the information and context that surrounds it, is not the same as using the method separately. Also, evaluators have only used the method once with five products, so the learning curve can be slow.

In particular, the characteristic that evaluates the moment of user intervention on the product has caused some confusion and discrepancies among the evaluators. This is closely related to the level of intervention, where some evaluators consider that only the design or manufacture are intervention actions, while others call intervention to any modification of the state of the product, including mass customization. The same happens with intervention in the elimination phase. It can be considered that the life of the product ends in its elimination and, therefore, it can no longer be intervened. Or, on the contrary, it can be considered that the product is given a second life or another new use, and that therefore it is being intervened.

5. Conclusions

The use of a getting started guide and an introductory video have greatly facilitated the final application of the method. That all the evaluators had the same information has been key to increasing the convergence index in the results. In addition to the content, the way it is transmitted has contributed to ensuring that users have a correct understanding of the terms covered. After the validation of its application, it is identified the need to continue evolving the design guide with a double objective: to bring it closer to non-specialized users and to expand the information provided. In this last point, it will be necessary to clarify other secondary terms such as product structure or moment of intervention.

On the other hand, it was more difficult for the evaluators to understand the sections of the guide where there was more information. It is concluded that, in order for them to correctly internalize the concepts, it is preferable to provide small doses of information that are easy to understand.

Despite the interest generated by the method in the design field, it is difficult to bring tools like this to the maker field. Non-specialized environments are not used to using design methods, so applying them is often difficult, slow and complex. This fact directly affects the interest of these users by not seeing a clear application for them. A future direction of research may focus on how to approach these methods to makers and prosumers. In this aspect, it may be of interest to collaborate with experts in each part of the metric to validate it separately. Thus, a broad evolution of each part could even give it independence to use it separately. For example, using only the prosumer features to evaluate maker products.

The convergence between the results of the researchers' evaluation and that carried out by the professionals verifies the functioning of the method. The validated method is able to differentiate those products that stand out for the presence or absence of certain characteristics. However, more precise work is required to optimize the levels and detect smaller differences between the characteristics of various products. We must ensure that not only what may be more obvious coincide, but that the method is also capable of detecting aspects that may initially go unnoticed. It is also necessary to expand the sample of professionals surveyed and eliminate the responses that have deviated the statistics.

Design concepts are easier to evaluate on an individual level for the person who creates and knows them. In addition, in the future design model all the concepts will share the same objectives, requirements and limitations because they belong to the same creative process. If it is wanted to make a group assessment using the proposed method, the presence of these concepts can give rise to various interpretations and discrepancies. As can be seen in the evaluation of non-marketed products (Olovsson and Cho, 2021), the level of convergence between the results is lower than in the rest of the cases.

At the current development point, the features clearer to testers are *variable* and *customizable*. However, it is necessary to provide a more precise definition for *upgradeable*, *independent* and *moment of intervention*. The improvement of these characteristics will bring more objectivity to the evaluation method and will reduce its difficulty of understanding, helping to increase its interest for both professional and non-specialized users.

Acknowledgement

This study has been possible thanks to all evaluators who have dedicated their time to test this method.

References

- Asión-Suñer, L. and López-Forniés, I. (2019), "Prosumer and Product Design Through Digital Tools", *International Conference on The Digital Transformation in the Graphic Engineering*, Springer, Cham, pp. 23–30. https://doi.org/10.1007/978-3-030-41200-5_3
- Asión-Suñer, L. and López-Forniés, I. (2021a), "Review of Product Design and Manufacturing Methods for Prosumers", In: L. Roucoules et al. (Eds.), *International Joint Conference on Mechanics, Design Engineering and Advances Manufacturing*, Springer, Cham, pp. 1–7. https://doi.org/10.1007/978-3-030-70566-4_21
- Asión-Suñer, L. and López-Forniés, I. (2021b), "Analysis of Modular Design Applicable in Prosumer Scope. Guideline in the Creation of a New Modular Design Model", *Applied Sciences*, Vol. 11 No. 22: 10620. <https://doi.org/10.3390/app112210620>
- Asión-Suñer, L. and López-Forniés, I. (2021c), "Adoption of Modular Design By Makers and Prosumers. a Survey", *Proceedings of the Design Society*, Cambridge University Press, UK, pp. 355–364. <https://doi.org/10.1017/pds.2021.36>

- Halassi, S., Semeijn, J. and Kiratli, N. (2019), "From consumer to prosumer: a supply chain revolution in 3D printing", *Int. Journal of Physical Distribution and Logistics Management*, Vol. 49 No. 2, pp. 200–216.
- IKEA. (2021), *BESTÅ pre-designed combinations*. [online] IKEA Website. Available at: <https://www.ikea.com/es/en/cat/besta-pre-designed-combinations-700277/> (accessed 09.11.2021).
- Ma, J. and Kremer, G.E.O. (2016), "A Systematic Literature Review of Modular Product Design (MPD) from the Perspective of Sustainability", *International Journal of Advanced Manufacturing Technology*, Vol. 86, pp. 1509–1539. <https://doi.org/10.1007/s00170-015-8290-9>
- Makeblock. (2021), *Neuron Inventor Kit*. [online] Makeblock Website. Available at: <https://www.makeblock.es/productos/neuron/> (accessed 09.11.2021).
- Ollaris. (2018), *Modular Sandpaper Organizer Cabinet*. [online] Instructables. Available at: <https://www.instructables.com/Modular-Sandpaper-Organizer-Cabinet/> (accessed 09.11.2021).
- Olovsson, E. and Cho, K. (2021), *ROOM Collection Furniture System*. Available at: <https://mocoloco.com/room-collection-furniture-system-by-erik-olovsson-kyuhyung-cho/> (accessed 09.11.2021).
- Shan, Q. and Chen, Y. (2009), "Three evaluation method of modular products", *Third International Symposium on Intelligent Information Technology Application*, IEEE, pp. 91–94. <https://doi.org/10.1109/IITA.2009.194>
- Wang, Z., Chen, L., Zhao, X. and Zhou, W. (2014), "Modularity in building mass customization capability: The mediating effects of customization knowledge utilization and business process improvement", *Technovation*, Elsevier, Vol. 34 No. 11, pp. 678–687. <https://doi.org/10.1016/j.technovation.2014.09.002>
- Wikipedia. (2021), *Project Ara*. Available at: https://en.wikipedia.org/wiki/Project_Ara (accessed 09.11.2021).
- Zheng, P., Xu, X., Yu, S. and Liu, C. (2017), "Personalized product configuration framework in an adaptable open architecture product platform", *Journal of Manufacturing Systems*, The Society of Manufacturing Engineers, Vol. 43, pp. 422–435. <https://doi.org/10.1016/j.jmsy.2017.03.010>

Appendix A: Evaluation method

Table 4. Evaluation method used in the validation.

Area	Characteristics	Level
Modular design	Independent. Can the modules be easily separated and used in another analog product without changing their function?	4. Module and product can function on their own even when separated
		3. The module can work individually or in another analogous product, but the product works in a reduced or incomplete way
		2. Module and product continue to function separately, but with reduced or incomplete functionality
		1. The module can continue to work in another product in a reduced form, but the product does not work without the module
		0. Module and product are highly integrated and cannot continue to function when separated
	Connectable. Can modules be interchanged using a compatible connection that does not affect their properties?	4. The connection is standard and universal, so external modules from other products or manufacturers can be connected
		3. The connection is compatible between the same product family and with similar products, but it is not universal
		2. An adapter or compatible part is required between the product and the module so that they can be connected to each other
		1. The module needs a compatible connection to connect to the product, but cannot connect to other analog products
		0. Neither the product allows the connection of other modules, nor can the module be connected to other products
	Variable. Does the combination of modules allow to create a family of products and/or variants of the same product?	4. The product allows to include or change universal external modules to achieve families or variants
		3. The product only allows to include or change own modules to achieve product families or variants
		2. Some modules can be included or changed, but the product is limited to some functionalities and cannot generate families
		1. It can be changed, but not include new modules, the product is limited to some functionalities and cannot generate families
		0. The product does not allow to include or change modules, it is invariable

Modular Design + Prosumer	Adaptable. Can the product perform different functions in different situations (temporary or permanent)?	4. The product integrates several functions; it can be configured to do different ones and increase its functionality with reversible changes
		3. The product can be reversibly configured to perform different functions, but it cannot increase its functionality with extra modules
		2. The product has a unique main function that varies by reversibly changing a specific module
		1. The product has a unique main function that varies when changing a specific module, but the change is permanent and irreversible
		0. The product can only do one function, does not support any change
	Customizable. Can the end user configure the product to satisfy their own wants and needs?	4. The user can customize the functionality, performance and aesthetic aspects of the product by combining or adding new modules
		3. The functionality, performance and aesthetics of the product can be customized through predefined modules, without being able to add new ones
		2. It can only customize the functionality or specific features through some standard module
		1. The product only supports aesthetic customization
		0. The product is not customizable in any way
	Upgradeable. Can the product evolve through the renewal and/or redesign of its modules and structure?	4. It can be completely updated and redesigned: modules, product structure and final design
		3. The product can only be updated (both modules and structure) or redesigned (new module design), but not both at the same time
2. It is only functionally updated by changing the structure or some modules		
1. It is updated physically/aesthetically, without functional improvements		
0. The product cannot be updated because it does not support changes		
Prosumer	Own modules. Can the end user design and/or manufacture their own modules or the structure of the product?	4. The user designs and manufactures the entire product except for standard elements that cannot make, such as electrical material or hardware, etc.
		3. The user designs and manufactures some modules that he can make on his own, those that he does not know how to do, he buys
		2. Only a specific module is designed and manufactured that is characteristic, exclusive and makes the product stand out from others
		1. The user designs and manufactures a module, but only aesthetically
		0. He does not design/manufacture any module, only chooses it from a list
	Participation level. Does the end user participate in all phases of the product life cycle?	4. The user participates in the phases of design, manufacture, assembly, customization and updating of the product
		3. The user participates in the design, manufacturing and assembly phases, but not in the product update
		2. The user participates in a single phase: design or manufacture
		1. The user can only customize the product
		0. The user only makes a mere assembly of components
	Moment of intervention. Can the user intervene before the purchase and during the consumption and disposal?	4. There is intervention before, during and after consuming the product
		3. The intervention occurs before and during the consumption of the product
		2. The user only intervenes during the consumption of the product
		1. The user only intervenes before purchasing the product
		0. No intervention is made on the product at any time