

InEDIC Ecodesign Manual

Tool 9: Ecodesign Checklists for Ceramics

The Ecodesign Checklists for Ceramics constitute a qualitative tool, which allows an easy integration of eco-efficiency criteria in the product development process. The following 8 lists are organized according to the life cycle stages and address the more relevant issues a designer needs to consider in the sustainable product development process.

In each strategy a group of relevant criteria for ecodesign in ceramics were identified and each one is explained in the introduction column. The evaluation is structured according with an ABCD scoring scheme for each criterion, allowing the user to quickly identify the profile of the product. The team should evaluate each criterion according to the following scoring:

- A** – Ideal situation
- B** – Potential improvement
- C** – Urgent need for action
- D** – Not applicable

After the evaluation the team should list in one table all criteria identified as needs for urgent action, “C”, and in the other table the criteria scored with “B” (as per the tables shown in page 28 of this tool). These two tables, (firstly the one with “C’s” and secondly, the one with the criteria scored with “B”), will act as a starting point for the discussion in the brainstorming session during which the team should try to find improvement options to solve each identified problem.

After the evaluation, the team can develop a spider diagram representation that is a conceptual and graphical model to illustrate the evaluation attained with the checklists. For this representation each strategy must have an evaluation score ranging from 1 to 5. To attain the final score, the following scale has developed: A – 5 points, B – 3 points, C – 1 point, and D – no scoring. The final score of each checklist (i.e., ecodesign strategy) will be the average of the applicable criteria.

Strategy @: Develop new concepts

The first strategy is symbolized with @ because it is the most innovative and far-reaching strategy and may lead to discovering alternative ways to fulfill the needs of users. In this sense, it is not connected to any particular life cycle stage as it questions the product and its function as a whole. It is a complex strategy, and perhaps the reader should go through all the strategies and then come back to this one: it will make more sense and will be easier to apprehend. In a brainstorming session, though, it's useful to start by thinking "out of the box" and this is what strategy @ is about.

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
@.1 Consumer needs and expectations/ integration of functions	<p>In industrialized countries the satisfaction of consumers' needs and expectations continues to be predominantly associated to the increase of the use of products per capita, resulting in the continuous creation of new needs where they, perhaps, don't even exist. There are opportunities to revert this trend, designing products to perform more functions in a better way and/or avoiding more needs.</p> <p>One example is the "From Freezer to Table" concept, in which the product can be used to store food in the freezer and refrigerator, to cook in the microwave, oven, and stove (with direct flame) and to serve the food on the table. One product replaces the functions that are normally performed by three different products (requiring three times as many washing operations). Another example of function integration would be tiles that remove pollutants in outdoor environment, especially nitrogen oxides, using sunlight, humidity and the titanium oxide-based glazed surface of the ceramic tile. There are also examples of tiles with pathogen reduction, hydrophobic and self cleaning tiles.</p>	<p>A - The product exceeds consumer's expectations without creating additional needs</p> <p>B - There are good opportunities of improvement, incremental (better products) or radical (new products)</p> <p>C - The use of the product requires additional needs</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	

<p>@.2 Dematerialization: From products to services</p>	<p>The company may satisfy consumers' expectations in a more adequate way, changing or reformulating its existing products, in order to integrate or reinforce the products' service component, or to favour the sale of the functions provided by the products. More information about this criterion can be found in chapter 13 – Ecodesign and design for sustainability.</p> <p>One example of this approach could be a renting service of ceramic table ware for special occasions. This improvement option assumes that when several people make joint use of a product without actually owning it, then the product is used more efficiently. Another case would be the leasing of pavement, including elements such as the initial installation of the pavement, tile renewal or replacement, flexibility to reconfigure the interior scheme and end-of-life responsibility for the used tiles. This service is already available in soft pavements.</p>	<p>A - Consumers needs are already being met by services</p> <p>B - Consumers needs are already being met by product-service systems</p> <p>C - Consumer needs are not being met by services</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>@.3 Product system</p>	<p>In the perspective of increasing the value of products, they must be considered in the context of the global system in which they are inserted. Sometimes a product may be considered harmful in itself, but its performance in the system context may provide benefits in terms of sustainability and vice-versa. Therefore, one needs to guarantee that the product development is linked with the entire system, within which the product will be used. One example is the solar tiles project: Photovoltaic film in roof tiles for energy generation.</p>	<p>A - The system allows the increase of products' value</p> <p>B - There are opportunities for improvement</p> <p>C - The product system is not considered in the design</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>A – Ideal situation - 5 Points B – Potential improvement - 3 Points C – Urgent need for action - 1 Point D – Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>	<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>	<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 1: Select lower impact materials

The environmental aspect at stake is the use of hazardous, non-renewable or scarce materials. On the basis of the materials used in the reference product and the processes necessary to produce them, the possibility of using alternative materials with lower environmental impact is analyzed. The implementation of this strategy is complemented by the InEDIC materials database

Criteria	Introduction	Evaluation	Evaluation	
			Score	Justification
1.1 Avoid hazardous substances in glazing and decoration processes	<p>The components of glazes represent the main hazardousness problems in ceramic products¹. Glazes are composed of frits, inorganic raw materials and pigments. In some cases glazing may not be necessary; it depends on the aesthetical requirements of the final product. In frits, the most hazardous elements are lead, boron compounds and cadmium; thus whenever it is possible, frits without the elements of lead and cadmium should be used.</p> <p>The inorganic raw materials of ceramic products can be divided in:</p> <ul style="list-style-type: none"> • Substances that do not raise major concerns (quartz, feldspar, kaolin and talcum, although some of them present risk of silicosis in their handling) and, • Substances with labeling requirements. <p>Even if hazardous substances used in glazing and decoration are made inert through the firing process, companies should bear in mind that their use in production should be avoided, because their prior processing and transportation presents environmental impacts and risks to human health and ecosystems. Designers, in cooperation with the people responsible for materials' choice and the suppliers of frits and glazes, should search for less hazardous raw materials to be used in the decorating process. The consultation of safety datasheets of these materials provides</p>	<p>A - Only glazes and decorations without harmful substances are used</p> <p>B - The use of hazardous substances in glazes and/or decorations is minimized</p> <p>C - The hazardousness of glazes and decorations has not be considered</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	

	<p>valuable information. It should be mentioned that this information has been revised and updated due to the entry into force of the REACH Directive², whose aim is to improve the protection of human health and the environment, through the better and earlier identification of the intrinsic properties of chemical substances.</p>			
<p>1.2 Avoid other hazardous substances in the product</p>	<p>Apart from those used in glazing and decoration, there are no other hazardous substances in ceramic products. But they may include parts made of materials other than ceramics and in this case the design team should be aware of their hazardousness (for instance, a chromium plated tea pot handle or fondue set base) and avoid them (in the mentioned example, an option would be to choose metal parts without surface treatment such as stainless steel). If the product is mono-material (ceramic only) this measure/criterion does not apply.</p>	<p>A - Other hazardous substances are not used in the product</p> <p>B - The use of other hazardous substances is minimized</p> <p>C - The hazardousness of other substances has not been considered</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A-5</p> <p><input type="checkbox"/> B-3</p> <p><input type="checkbox"/> C-1</p> <p><input type="checkbox"/> D</p>	
<p>1.3 Use of sufficiently available resources</p>	<p>Scarce resources are:</p> <ul style="list-style-type: none"> • Non-renewable resources whose availability is considered to be insufficient to meet their rate of depletion • Renewable resources whose exploitation rate is higher than their renewing rate <p>In any case, there are advantages in considering their substitution by sufficiently available resources whenever economically and technically feasible alternatives do exist.</p> <p>Clay is a material in abundance, so this criterion becomes an issue for ceramic products, only when other materials or parts are incorporated in the product. If the product is mono-material (ceramic only) this measure/criterion does not apply.</p>	<p>A - Available resources are widely used</p> <p>B - Available resources are partly used</p> <p>C - Available resources are not used</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A-5</p> <p><input type="checkbox"/> B-3</p> <p><input type="checkbox"/> C-1</p> <p><input type="checkbox"/> D</p>	

<p>1.4 Use of renewable resources</p>	<p>A natural resource is a renewable resource if it is replaced by natural processes at a rate comparable or faster than its rate of consumption by humans. Solar radiation, tides, winds and hydroelectricity are in no danger of a lack of long-term availability. Renewable resources may also mean <u>commodities</u> such as <u>wood</u> and <u>leather</u>, if harvesting is performed in a sustainable manner.</p> <p>Ceramic raw materials are non renewable by nature. The use of renewable resources is an option to be considered in multi-material or complex products, in which other materials are used, like wood, cork and other. If the product is mono-material (ceramic only) this measure/criterion does not apply.</p>	<p>A - Renewable resources are widely used in the non-ceramic part of the product</p> <p>B - Available resources are partly used in the non-ceramic part of the product</p> <p>C - Available resources are not used in the non-ceramic part of the product</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>1.5 Use of local raw materials</p>	<p>The origin of raw materials is an important factor, due to the environmental impacts of transport, namely those associated to the consumption of fossil fuels and the emission of exhaust gases. Preference should be given to raw materials that are extracted near the ceramic factory.</p>	<p>A - Raw materials are extracted or produced near the ceramic factory</p> <p>B - The distance between the extraction or production of raw materials and the ceramic factory is lower than 200 km.</p> <p>C - The distance between the extraction or production of raw materials is higher than 200 km.</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>A – Ideal situation - 5 Points B – Potential improvement - 3 Points C – Urgent need for action - 1 Point D – Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p> <p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>		<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 2: Reduce the use of materials

Reduction of material use means using the least possible amount of material, by developing lean but strong product designs. This includes also the improvement of efficiency of materials' use having in mind subsequent purposes, such as resource cascading; or reducing the use of virgin materials through recycling. For more information see the InEDIC materials database.

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
2.1 Optimizing the products' shape, size and/or weight	<p>Using less material is a simple, direct means to decrease environmental impact, i.e., fewer resources extracted, less waste, less fuel consumption during firing and drying and lower environmental load during transportation. Products are often deliberately designed to be heavy or large in order to project a high quality image; however, this can also be achieved through other techniques, i.e., creating a lean but strong design. Adjusting the products' or components' dimensions to their function will result in a savings potential that is possible to explore through ecodesign.</p> <p>A successful example is the production of ceramic floor tiles with reduced thickness. Another good example is the production of plates, dishes, saucers, jars, etc, with reduced thickness, without any loss to their mechanical resistance.</p> <p>Regarding the shape of the ceramic piece, this will influence the losses at polishing, handling and demolding, amongst others. More linear shapes make large scale production easier; with fewer losses, less material is wasted.</p>	<p>A - The product has the minimum size to fulfil its function in a proper way</p> <p>B - Actual size allows exploring opportunities of reduction</p> <p>C - The over-size of the product wasn't considered in the design</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	

<p>2.2 Resource cascading</p>	<p>Resource-cascading, the sequential exploitation of the full potential of a resource during its use is one of the ways to improve efficiency of raw materials use. This means that the design team should consider these sequential applications, when designing the primary product, thus significantly extending a resource's useful life through repeated utilization. Further use of materials and/or components for two or more applications should be considered when designing the product.</p> <p>Example: In the cascade of paper (for packaging) certain additives and inks prohibit the reuse of the fibres in products of a higher quality</p>	<p>A - A cascade of more than two products is taken into consideration</p> <p>B - Two products are taken in consideration</p> <p>C - Attention is only paid to the first use of resources only</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>2.3 Adequate quality of raw materials</p>	<p>The quality of raw materials should be adequate for their function in the product system. Very pure or high quality materials should not be used in products with lower quality requirements.</p> <p>Example: Purity or colour uniformity of the paste in bricks production is not a very important feature; therefore a "lower quality" paste in this sense may be used, saving higher quality paste for more demanding purposes. This strategy is already quite optimized in the structural sub-sector.</p>	<p>A - The quality of the raw materials is adequate to the function of the product</p> <p>B - The relation between the quality and the function of raw materials can be improved</p> <p>C - The quality of raw materials exceeds the requirements for the product</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>2.4 Optimizing glazing and decorative materials</p>	<p>Glazing is done to provide the fired product with technical and aesthetical properties, such as impermeability, easiness of cleaning, gloss, colour, surface texture and chemical and mechanical resistance.</p> <p>Glazing involves the consumption of raw materials and water. In the cases were the glazing process cannot be avoided, reducing the glazing area or the thickness of the glaze (while retaining the technical quality) allows for the reduction of materials consumption. For example, in ornamental ware, the designer can choose not to glaze (part of) the product.</p>	<p>A - The product is not glazed</p> <p>B - Glazing is minimized</p> <p>C - Glazing is not minimized</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	

<p>2.5 Reducing the use of plaster moulds</p>	<p>The consumption of plaster moulds can be reduced through the design of the product: either by reducing the number of moulds needed to produce one product or by extending the life time of the moulds.</p>	<p>A - The need of plaster moulds is minimized and their durability is maximized</p> <p>B - Moderated use of plaster moulds</p> <p>C - Plaster moulds are overly used</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>2.6 Use of in-house recycled materials</p>	<p>Use of recycled material from internal sources may be a way of saving natural resources, decreasing the volume of production waste and reducing costs. Recycled materials may, to a certain extent, replace raw materials without compromising good quality. Most sectors of the ceramic industry recycle materials such as off-cuts, trimmings and substandard articles back to the raw material preparation stage.</p> <p>Other examples in the ceramic industry are the valorization of waste water (generated in cleaning operations, mainly in glaze preparation and glazing sections) or sludge coming from the waste water treatment plant. Normally this sludge or waste water is re-introduced in the milling process in the raw material preparation stage (spray drying plants or atomizers). Air emissions should be monitored as they can be worsened due to the use of recycled materials in the product, especially in the case of sludge.</p>	<p>A - High percentage of recycled materials (more than 60%)</p> <p>B - Medium percentage of recycled materials (30-60%)</p> <p>C - Low percentage of recycled materials (less than 30%)</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>2.7 Use of recycled materials from external sources</p>	<p>The use of recycled materials from external sources is also an option for saving natural resources and decreasing costs, although the environmental impact and costs of transport may outperform their benefit. Also air emissions should be monitored as they can be worsened due to the use of recycled materials in the product. Nevertheless it is an option to be considered.</p> <p>An example is the use of plaster to make moulds for decorative ceramics and table ware. The</p>	<p>A - High percentage of recycled materials (more than 40%)</p> <p>B - Medium percentage recycled materials (10-40%)</p> <p>C - Low percentage of recycled materials (less than 10%)</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	

	<p>plaster, after use, can be recycled by the supplier, who collects used moulds when delivering a new lot of plaster.</p> <p>Examples of this measure are the incorporation of marble and granite sludge generated in the ornamental stone industry, and the integration of bricks and tiles from demolition waste in the ceramic body, use sludge from paper and pulp industry in the thermo blocks manufacturing process, etc.</p>			
<p>2.8 Use of recyclable materials</p>	<p>The choice of recyclable materials in mono-material ceramic products is not an option for the design team therefore in this case this measure/criterion does not apply.</p> <p>In the case of complex products, the choice of other materials should be done in such a way that they result in high quality recycled materials. Regarding metals, for instance, iron and steel are the world's most recycled materials, and among the easiest one to reprocess, as they can be separated magnetically from the waste stream. Aluminium is also one of the most efficient and widely recycled materials. As for plastics, designers should avoid multiple types of plastics or choose those that are compatible for recycling. For further information consult tables of compatibility of materials for recycling.</p>	<p>A - High percentage of recyclable materials in the non-ceramic parts (more than 60%)</p> <p>B - Medium percentage of recyclable materials in the non-ceramic parts (30-60%)</p> <p>C - Low percentage of recyclable materials in the non-ceramic parts (less than 30%)</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>A – Ideal situation - 5 Points B – Potential improvement - 3 Points C – Urgent need for action - 1 Point D – Not applicable</p>	<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>		<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>	<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 3: Reduce the environmental impact of production

The application of good practices and Best Available Techniques (BAT) in the ceramic industry has a high potential to reduce the environmental burden of the sector and there are several references on this matter, namely the BAT Reference Document (BREF for ceramics³). For further information see the InEDIC technologies database. In this chapter the focus is on the role of design and development in improving the environmental profile of production solely.

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
3.1 Reducing the energy consumption of the firing process	<p>The most important energy use in ceramic tile manufacturing is thermal energy during the firing stage; it represents approximately 55% of the total thermal energy consumed in the tile manufacturing process, so the company should adopt measures to minimize this consumption. The designer may influence the firing times and promote the reduction of energy consumption through the shape of the product and by reducing its thickness and overall mass, if technically feasible.</p> <p>In some cases, decorations applied after firing (second firing products) entail another thermal treatment, so avoiding this type of decoration will lead to a decrease of the total environmental impact and costs related to energy consumption.</p>	<p>A - Energy consumption is minimized through judicious design options</p> <p>B - The use of energy is moderated, according with the actual process and products of the companies</p> <p>C - There are wide opportunities of reducing the energy used in production through an adequate design process</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	

³ European Commission, August 2007. *Reference Document on Best Available Techniques on Ceramic Manufacturing Industry.*

<p>3.2 Reducing the energy consumption of other production processes</p>	<p>The primary energy use in ceramic manufacturing is for kiln firing but, many other processes, such as raw material preparation, and drying of intermediates and/or shaped ware, are also energy intensive. Through product design it is possible to influence not only the need and duration of drying operations, but also the number of finishing operations (which consume energy too), thus influencing the energy consumption of the entire process.</p>	<p>A - Energy consumption is minimized through judicious design options</p> <p>B - The use of energy is moderated, according with the actual process and products of the companies</p> <p>C - There are wide opportunities of reducing the energy used in production through an adequate design process</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>3.3 Reducing air emissions</p>	<p>Whenever possible, the company should adopt measures to prevent or minimize air emissions outdoor and indoor. Generally speaking in all process stages generate some kind of emission; pollutants will depend mainly on whether they come from combustion processes or dust extraction systems.</p> <p>Product design can influence these aspects, through the reduction of firing cycles or through the reduction of glazing as explained in previous checklists. In addition, the selection of materials influences air emissions during the production. For example, the chemical composition of the decorating materials (glazes, pigments and others) will influence the chemical profile of the emissions generated during the firing process; the introduction of organic materials in the ceramic body, such as natural fibers, cork powder or others, while it brings potential benefits such as increased porosity, reduction of weight, etc., it may on the other hand lead to the production of volatile organic compounds and particles in the firing process.</p>	<p>A - Air emissions have been minimized or prevented as much as possible through a cautious product design</p> <p>B - It is possible to minimize or prevent air emissions through a better product design</p> <p>C - This criterion has not been considered in the product design</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	

<p>3.4 Valorisation of waste from production</p>	<p>Some waste generated in the production process can also be perceived as a by-product, because it can be re-introduced in the process as raw material in very early stages (milling process). This strategy does not only prevent waste disposal, but also saves input materials and is already known to the ceramic industry. One example of this type of valorization is the sludge produced in the wastewater treatment plants (WWTP), which may be used for in-house production or by other ceramic companies.</p>	<p>A – All waste from production (including sludge from the WWTP) is incorporated in the original product or in new products (produced in-house or externally)</p> <p>B – The incorporation of production waste in the original product or in new products could be expanded</p> <p>C – Most of waste is not incorporated in the products, but is sent to final disposal</p> <p>D – Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>3.5 Waste prevention</p>	<p>Waste in production can be prevented when products are designed in such a way that losses and finishing processes are avoided or minimized. For example, simpler shapes should be preferred over complex ones, due to production losses. Another example pertains the plaster moulds waste, one of the most important types of waste produced in the ceramic industry. Ceramic product design can have a significant impact on the quantity and /or size of plaster moulds necessary for production.</p>	<p>A – This criterion has been considered in design</p> <p>B – This criterion has been considered in design, but could be improved</p> <p>C – This criterion has not been considered in design</p> <p>D – Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>A – Ideal situation - 5 Points B – Potential improvement - 3 Points C – Urgent need for action - 1 Point D – Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>	<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>	<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 4: Promote environmentally friendly packaging and logistics

This strategy is to ensure that the product is transported from the factory to the retailer and end user in the most efficient manner. This relates to the packaging and the mode of transport and logistics. If a project also includes a detailed analysis of the packaging, the packaging should be regarded as a product itself, with its own life cycle.

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
4.1 Avoid or minimize packaging	<p>In ecodesign, the need for packaging at all is questioned. Designers should consider its function and avoid, as much as possible, the use of packaging material as well as decoration and/or excessive labeling.</p> <p>For example, individual house ware products can be sold without packaging. In this case, a special package for the transport from the producer to the retailer is needed, but it can be integrated in a reusable system.</p> <p>The design of the ceramic products influences the need of packaging. For instance, stackable ceramic tableware sets reduce the amount of package needed. Also, minimizing the ratio weight/volume will reduce the amount of packaging material.</p>	<p>A – Packaging has been eliminated or minimized</p> <p>B – Moderate use of packaging</p> <p>C - Excessive use of packaging</p> <p>D – Not applicable</p>	<input type="checkbox"/> A – 5 <input type="checkbox"/> B – 3 <input type="checkbox"/> C – 1 <input type="checkbox"/> D	
4.2 Returnable package system	<p>In case the packaging cannot be avoided, a reusable package or returnable packaging system should be considered. Companies should adopt single use packages only when all other options are not feasible.</p> <p>In the case of returnable packaging, this is a system in which the packaging is sent back to the producer for a new utilization with the same or another purpose. Normally the transport is assured by the producer or by the distributor. For example: products that are sold individually in supermarkets can have a reusable packaging</p>	<p>A - Reusable or returnable Packaging system implemented</p> <p>B - Reusable or returnable packaging system was considered but not implemented</p> <p>C - The implementation of a reusable or returnable packaging system was not considered</p> <p>D – Not applicable</p>	<input type="checkbox"/> A – 5 <input type="checkbox"/> B – 3 <input type="checkbox"/> C – 1 <input type="checkbox"/> D	

	system established between the producer and the supermarket.			
4.3 Reusable package system	In this system the packaging is designed to be used again with the same or another purpose, without having to be returned to the producer. In this case, equilibrium should be promoted between the package durability and weight/volume allowing for optimization of the distribution system's performance.	<p>A - Implemented system</p> <p>B- The system can be implemented, but not done yet</p> <p>C - System was not considered</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
4.4 Avoid the use of harmful substances in packaging	The designer should favour the use of packaging materials with no harmful substances (such as printing inks, adhesives, etc.), because, they not only do they have a detrimental impact on human health and environment, but also their presence creates difficulties in the recycling process and hinders an adequate final disposal.	<p>A - Used materials contain no hazardous substances</p> <p>B - The use of harmful substances can be prevented/reduced</p> <p>C - Used materials contain harmful substances</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
4.5 Use of recyclable materials in packaging	When selecting materials, designers should also be concerned with their potential for recycling. The use of recyclable materials in packaging is a complementary strategy to the reusable package system and the use of recycled materials. Single-material packaging should be preferred as it facilitates the recycling process. In addition, the diversity of colours in packaging should not hinder the recycling process.	<p>A - Recycling with quality at accessible costs</p> <p>B - Recycling with quality at acceptable costs</p> <p>C - Recycling with no quality or with high costs</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
4.6 Use of recycled materials in packaging	Recycled materials, with a good quality/price ratio should be used as much as possible. The use of recycled materials in packaging will reduce the environmental impact of the product, because it saves natural resources. The fact that there is more demand of recycled paper fibers than is available, may hinder the implementation of this criterion.	<p>A - High percentage of recycled materials used (70-100%)</p> <p>B - Medium percentage of recycled materials used (30-70%)</p> <p>C - Low percentage of recycled materials used (0-30%)</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	

<p>4.7 Use of biodegradable materials in packaging</p>	<p>If biodegradable materials based on renewable resources are selected for packaging, then the disposal process will be easier. For instance, uncoated cardboard with minimal printing is biodegradable.</p>	<p>A - Packaging is fully biodegradable</p> <p>B - Packaging is partly biodegradable</p> <p>C - No biodegradable packaging</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>4.8 Optimizing transport of products</p>	<p>In order to optimize the use of pallet space during transportation of all products, the sizing of the products plus their packaging should be done according to the standard pallet.</p>	<p>A - The dimensioning of the product plus packaging is optimized for transport</p> <p>B - The dimensioning of the product plus packaging could be improved, from the transportation point of view</p> <p>C - The dimensioning of the product plus packaging is very inefficient from the transportation point of view</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	
<p>4.9 Use standard packaging</p>	<p>The diversity of packaging formats creates waste and problems of space and inventory to packaging producers and ceramic manufacturers. If the dimensions of standard packaging are well suited to the product, designers should use it.</p>	<p>A - Standard packaging is used for the product being analysed and for other products of the company</p> <p>B - A standard packaging is used for the product being analysed, but not for other products of the company</p> <p>C - Product specific packaging is used</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A - 5</p> <p><input type="checkbox"/> B - 3</p> <p><input type="checkbox"/> C - 1</p> <p><input type="checkbox"/> D</p>	

<p>4.10 Information on packaging waste management</p>	<p>The objective of this criterion/measure is to provide information so that the consumer or end user is able to deal appropriately with the packaging of the product at the end-of-life. The design team should consider all the information that should be displayed in the packaging for that purpose (e.g. type of material, recyclability, disposal information, etc.).</p>	<p>A – The packaging includes all necessary information regarding waste management</p> <p>B – Few information is displayed on the packaging</p> <p>C – Packaging has no information</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>A – Ideal situation - 5 Points B – Potential improvement - 3 Points C – Urgent need for action - 1 Point D – Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>	<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>	<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 5: Reduce the environmental impact in the use phase

This strategy concerns both the use of ceramic products and their application, in the case of construction materials, such as tiles. The objective is to reduce the associated environmental impacts through design options

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
5.1 Reducing indirect energy consumption	Recent legislation in the EU and the increasing awareness of consumers have promoted the development of energy efficient products in the construction sector, one of the main concerns in the last years. Ceramic products such as structural elements and wall, floor and façade tiles can have a very important role in the energy performance of a building. Although the product in itself, for instance a brick, does not consume energy during use, it affects the energy consumption within the product system. In the design of this kind of products, this is an important factor to address and a potential distinctive feature highly appreciated by those implicated in the construction business. Another example is that of ventilated façades, an external building cladding method with various elements, among which ceramic tiles play a vital role. The ceramic tiles form the ventilated air chamber, which allows the upward movement of air, significantly improving the climatic performance of the building.	<p>A – The product has a significant positive impact on the energy consumption of the system</p> <p>B – The product doesn't have any impact on the energy consumption of the system</p> <p>C – The use of the product leads to an increase of energy consumption of the system</p> <p>D – Not applicable</p>	<input type="checkbox"/> A – 5 <input type="checkbox"/> B – 3 <input type="checkbox"/> C – 1 <input type="checkbox"/> D	

<p>5.2 Reducing indirect water consumption</p>	<p>Sanitary ware may be designed in such way that the water consumption is reduced or grey water is reused.</p>	<p>A – The product has a significant positive impact on the water consumption of the system</p> <p>B – The product doesn't have any impact on the water consumption of the system</p> <p>C – The use of the product leads to the increase of water consumption of the system</p> <p>D – Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>5.3 Reducing the environmental impact of cleaning and washing</p>	<p>The surface, the material and the shape of a ceramic product can have a direct impact in the cleaning process. If a product is easy to clean or wash, the consumption of water and cleaning agents and it is better suited for its use, be it sanitary, culinary or any other.</p> <p>For instance, glazed and porous tiles with irregular surfaces are very difficult to keep clean, especially outdoors. Mugs with hollow handles or tableware in general with complicated shapes and curves are very difficult to wash as well.</p>	<p>A - Very easy cleaning and washing of the product</p> <p>B - Moderately easy cleaning and washing of the product</p> <p>C – Difficult cleaning and washing of the product</p> <p>D - Not applicable</p>	<p><input type="checkbox"/> A – 5</p> <p><input type="checkbox"/> B – 3</p> <p><input type="checkbox"/> C – 1</p> <p><input type="checkbox"/> D</p>	
<p>A – Ideal situation - 5 Points B – Potential improvement - 3 Points C – Urgent need for action - 1 Point D – Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>	<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>	<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 6: Increase product durability

The objective of this strategy is to extend the technical and aesthetic lifetime of the product, so that it will be used for as long as possible. Ceramic products are durable products, but further improvements can be achieved through design to this regard. While this strategy may seem unattractive for companies because they would “sell less”, it can be interesting and competitive for certain types of products and market segments where high quality and durability are a strong sales argument.

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
6.1 Reducing wear and any other loss of properties	Product design should consider the minimization of product wearing, through the use of more resistant materials and structures, thus increasing the life span of the product. Ceramic products are very resistant to wear, but in the case of complex products designers should be aware of the technical lifetime of other materials used (for instance, metal, wood and other parts used in tableware ceramics), so that the technical life span of the product as a whole is not reduced. The manufacturer should also provide information on the most appropriate uses for the product, so that its properties remain intact as long as possible.	<p>A - Low wear of product through design</p> <p>B - Medium wear of product through design</p> <p>C - High wear of product through design</p> <p>D – Not applicable</p>	<input type="checkbox"/> A – 5 <input type="checkbox"/> B – 3 <input type="checkbox"/> C – 1 <input type="checkbox"/> D	
6.2 Easy replacement of ceramic pieces	It is sometimes difficult to ensure the homogeneity of ceramic products and therefore if a piece of tableware or a tile is broken the entire set sometimes needs to be substituted. This results in pointless consumption of resources and production of waste. Designers can overcome this problem by choosing a stable color like white, using non-plain colors or taking advantage of the heterogeneity of colors or glazes as an aesthetical added value.	<p>A – Easy replacement of pieces</p> <p>B – Moderate possibility to replace pieces</p> <p>C – Difficult/impossible replacement of pieces</p> <p>D – Not applicable</p>	<input type="checkbox"/> A – 5 <input type="checkbox"/> B – 3 <input type="checkbox"/> C – 1 <input type="checkbox"/> D	
6.3 Use of modular systems	The design of modular systems, such as floor tiles that can be jointed without adhesive materials saves resources, reduces building waste and facilitates the replacement of pieces. One example is the raised technical floor, a construction system installed on a metallic substructure at a certain height over the substrate that exempts mortar or cementitious adhesives. Another way of installing ceramic materials on floors is designated as “dry installation”. The	<p>A - Modular structure</p> <p>B - Semi modular structure</p> <p>C - Complex structure</p> <p>D – Not applicable</p>	<input type="checkbox"/> A – 5 <input type="checkbox"/> B – 3 <input type="checkbox"/> C – 1	

	<p>method consists of a system where a sheet of a plastic material is stuck or adhered in the back of the ceramic tile. Then, each piece can be connected with other pieces in multiple unions, avoiding in this way, the use of adhesives and facilitating dismantlement in case of future reforms or repairs. Nevertheless, it is necessary to emphasize that the fact of using diverse materials in a piece, hinders separation processes during its recycling, but in turn, facilitates enormously the reutilization of the same pieces in other places.</p>		<input type="checkbox"/> D	
<p>6.4 Timeless design</p>	<p>The objective of this measure is to avoid designs that may cause the user to replace the product as soon as the design becomes unfashionable. Products' design should be as timeless as possible in order to fully reach its technical potential, avoiding a premature disposal due to fashion related reasons.</p>	<p>A - Timeless design B - Contemporary design C - Fashionable, short-lived design D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
<p>6.5 Strong product-user relation</p>	<p>Good design transcends changes in the technologies of production. On a societal level, however, ideas of good design are dependent on the culture of the time. The challenge for many companies and designers is to create products which users will find attractive to purchase, use and maintain. The psychological life span is the time in which products are perceived and used as worthy objects. Products should have the material ability, i.e., technical and aesthetic life span, as well as the immaterial opportunity to age in a dignified way. Most products need maintenance and repair to remain attractive and functional. Users are only willing to spend time on such activities if they care about a product. This measure aims at giving the product an added value in terms of design and functionality so that the user will be reluctant to replace it.</p>	<p>A - There is a strong product-user relation, e.g. products are collected B - The product-user relation is medium C - The product is easily discarded or replaced, even if it is still functional D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
<p>A - Ideal situation - 5 Points B - Potential improvement - 3 Points C - Urgent need for action - 1 Point D - Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>		<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p> <p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

Strategy 7: Optimize the end-of-life system

Scrapped products constitute a valuable source of raw materials and therefore this strategy addresses design options that facilitate material recycling at the end of the product life time. This strategy applies to complex ceramic products, i.e., those that are made of other materials besides ceramics, such as metals, plastics, wood, etc., and includes criteria or measures to facilitate the recycling of those materials.

Criteria	Introduction	Evaluation	Evaluation	
			Scoring	Justification
7.1 Choice and variety of materials for easy recycling	All materials other than ceramics should be chosen bearing their recyclability in mind. Most materials, especially different plastics, cannot be combined in material recycling, hence the designers should consult compatibility information, so as not to impair the recycling process.	<p>A - Close to single-material product</p> <p>B - Multi material according with the function of the product</p> <p>C - High variety of materials, not required to the function of the product</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
7.2 Easy disassembly	The actual recycling of recyclable materials used in the product is only possible if they are easy to disassemble in the end-of-life. The consumer should be informed so that he/she can easily separate a plastic or metal part, for example, and dispose of it in the respective waste container. For example in the case of ceramic tiles the new system of installation (technical raised floor, see <i>chapter 1 - Introduction</i>) would allow to reuse them at the end of their lifetime for example as aggregates or material filler.	<p>A - Easy disassembling process</p> <p>B - Medium effort to disassembling the product</p> <p>C - Difficult disassembling process</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
7.3 Marking of materials for recycling	In order to guarantee problem-free sorting and recycling of materials, it is necessary to be able to identify materials and packaging without time-consuming checking methods. Clear marking will allow quick separation of materials.	<p>A - Marking allows automatic reading</p> <p>B - Identification of some/all materials</p> <p>C - No marking</p> <p>D - Not applicable</p>	<input type="checkbox"/> A - 5 <input type="checkbox"/> B - 3 <input type="checkbox"/> C - 1 <input type="checkbox"/> D	
<p>A - Ideal situation - 5 Points</p> <p>B - Potential improvement - 3 Points</p> <p>C - Urgent need for action - 1 Point</p> <p>D - Not applicable</p>		<p>This checklist's evaluation = Sum of scores divided by the number of applicable criteria</p>	<p>Score <input type="checkbox"/></p> <p>Nº criteria <input type="checkbox"/></p>	<p>Total Score (score/nº of criteria)</p> <p><input type="checkbox"/></p>

The spider diagram representation is a conceptual and graphical model illustrating the evaluation of the Ecodesign Checklists for Ceramics clustered in the eight eco design strategies mentioned above, and linked to the eight axis of the diagram.

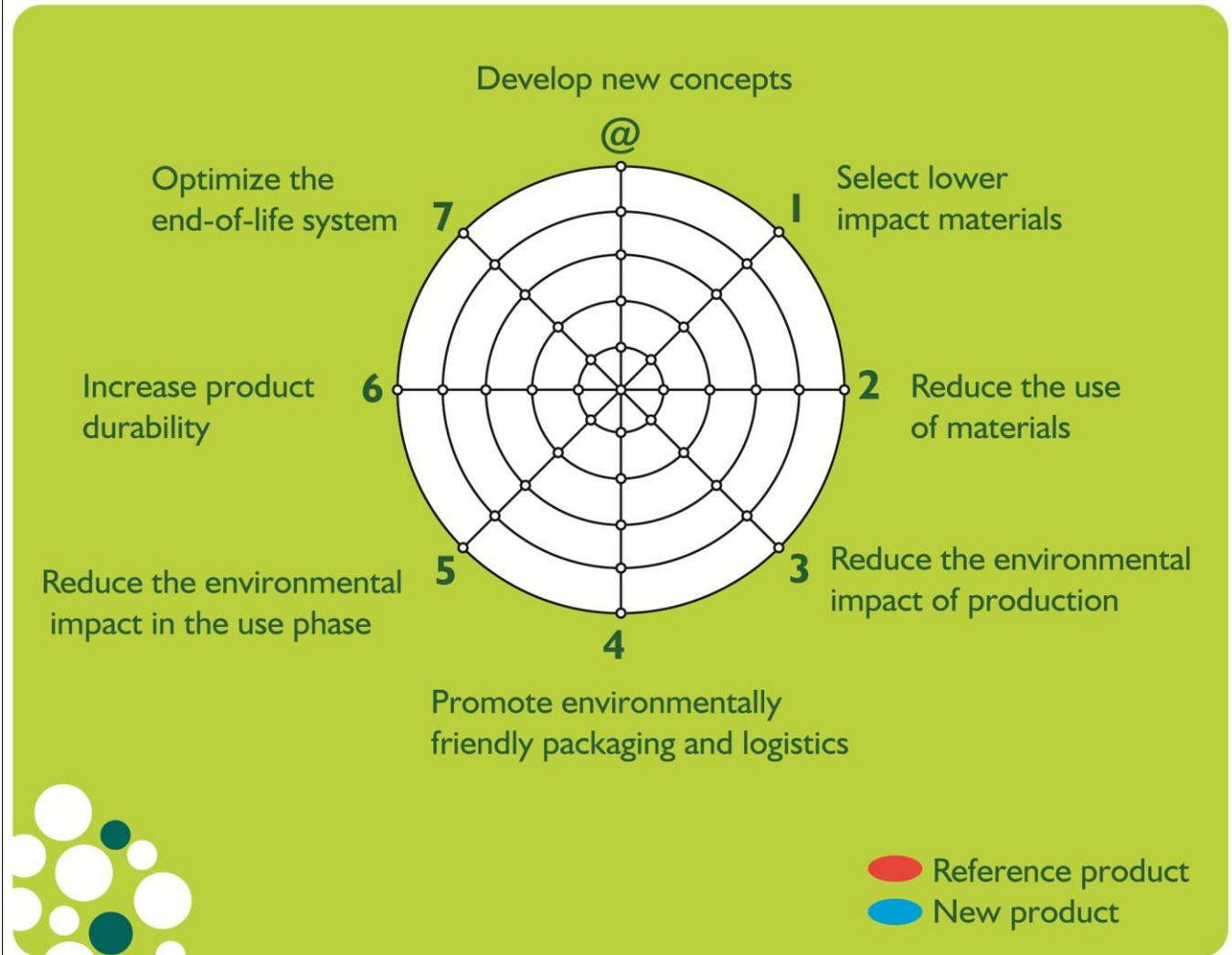
The spider diagram can be used for different purposes and at different times in the eco design process:

- To illustrate the evaluation attained in the checklists
- To compare different evaluations; for example the evaluation of the reference product and the evaluation of the final improved product
- To establish a reference frame for the eco design strategy
- To visualize a product's current, desired and expected environmental profile; in this case the diagram is used to indicate which strategies should be focused on in both the short and the long term.
- To create a stepping-stone towards an eco design oriented creativity technique
- To create as a graphical communication element showing the reference product and the improvement options or different scenarios.

How to use it?

Based on the scoring of each checklist, ranging from 1 to 5, the project team will mark the score in each corresponding axis and draw a polygon in the matrix. The larger the polygon area, the better the environmental profile will be. In the same diagram more than one situations can be represented by using different colours, as shown in the example below.

Spider diagram representation



Spider diagram with representation of a hypothetical reference product and a second polygon related to a new improved product:

