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DERIVATION OF CRITERIA FOR RADICAL PRODUCT IDEAS

T. Herrmann, D. Roth and H. Binz

Abstract

One of the most important problems concerning the management of radical innovations is that companies do not differentiate between radical and incremental ideas within the design process. Thus companies often do not have an understanding of which product ideas constitute radical product ideas and may result in a radical innovation. This paper analyses relevant literature's perspective on criteria for defining radical product ideas. A basic criteria set is provided and can be used to develop a company-specific definition.

Keywords: radical innovations, radical product ideas, early design phase, innovation management, innovation

1. Introduction and motivation

The importance of radical innovations has been shown in various papers in the past (Leifer et al., 2000; Büschgens et al., 2013; Slater et al., 2014; Story et al., 2014). Radical innovations are particularly innovative products and are essential for a company's long-term success (Chandy and Tellis, 2000; McDermott and O'Connor, 2002; Cheng et al., 2016). However, companies often only pursue incremental improvements (Globerman and Lybecker, 2014) based on market demand. By doing so, problems concerning the realization of radical innovations must be confronted (Stringer, 2000; Dueck, 2013; O'Connor and Rice, 2013; Bessant et al., 2014). These potential problems were analyzed by the authors of this paper in an earlier paper (Herrmann et al., 2017a). One of these main problems is that a distinction between radical and incremental ideas within the design process is not commonly made in practice (Nicholas et al., 2015), particularly in the front-end phase, or that companies face massive problems when doing so (Broennum and Clausen, 2015). This is underlined by Robbins and O'Gorman (2015), who claim that the definition of the degree of radicalness is challenging to define or measure. Although papers exist that claim such a distinction (inter alia Ahuja and Morris Lampert, 2001; Tushman and O'Reilly, 2002; Hartschen et al., 2009) in order to gain business success, a suggestion of how this distinction can be implemented does not exist (see also Dahlin and Behrens, 2005). This difficulty is compounded by the fact that the distinction between radical and incremental is not always clear (Slater et al., 2014), particularly in the early phase of an innovation process, when the initial idea for a later innovation is born and knowledge about the idea is rather rare. Papers exist which even propose an ambidextrous idea-generation step (Hartschen et al., 2009). This means that both radical and incremental ideas are actively generated, thereby impacting the success of the product development (Slater et al., 2014; Gurtner and Reinhardt, 2016). Other scholars demand that radical ideas should be treated differently during evaluation steps (Messerle, 2016) or that different criteria are used while assessing radical ideas than when assessing incremental ideas (O'Connor and Rice, 2001). However, even if it is possible to distinguish between radical and

incremental innovation projects in a design process, designers need to know what makes an idea radical or incremental. In the very early phases, a clear understanding of the radicalness of innovations – in that status called invention – is thus necessary.

2. Problem clarification and goal

As intimated in the first section, the research focus lies on the clear definition of radical ideas. Throughout this paper, radical ideas should be described as radical product ideas, which are ideas for a radically new or a radically adapted – and thus changed – product. A radical product idea should be defined as the precursor of a radical innovation because, by definition, an idea or invention becomes an innovation when it is converted to suit a business or other useful application and is both launched onto the market and diffused throughout the market (Roberts, 2007). In other words, an innovation is the successful implementation of a new idea (García-Granero et al., 2015).
Initial research studies have shown that the concept of a radical product idea does not have a uniform definition and that criteria for identifying radical product ideas are neither existent nor universally defined. An examination should therefore be conducted into how radical product ideas are defined in the context of today's design processes and, furthermore, how radical product ideas can be defined to act as a foundation for managing radical product ideas in the early phases of design processes. Moreover, specific criteria for the definition of radical product ideas should be determined.

3. Method

The Design Research Methodology (DRM) according to Blessing and Chakrabarti (2009) provides the methodological foundation for this paper. The paper's research is clarified (first step of the DRM) in Sections 1 to 3 of this paper. Descriptive Study I is based on a comprehensive literature study into definitions and criteria for radical product ideas. This study should answer the first research question (RQ): How are radical product ideas defined and which criteria are used to define them **(RQ I)**? The detailed procedure of this study is presented in Section 4. After that, Section 5 delivers a set of criteria for defining radical product ideas or, in other words, for measuring the radicalness of ideas. This set functions as a developed concept (third step of the DRM), from which the relevant criteria for each individual application have to be chosen. What must follow is a decision as to which criteria are relevant. This in turn leads to the second research question: From a designer's perspective, which criteria can be used to define radical product ideas that serve as a basis for the early phases of the product development process **(RQ II)**? Thus, in Section 6, the catalogue of criteria for radical product ideas is evaluated by a group of industrial experts working at a company in the consumer industry in order to contribute to the last step of the DRM (Descriptive Study II). This evaluation functions as a template for defining relevant criteria from a designer's perspective. After this, the paper is critically discussed in Section 7 and concluded with an outlook (Section 8). To summarize the procedure, Figure 1 visualizes the entire process pursued within this paper.

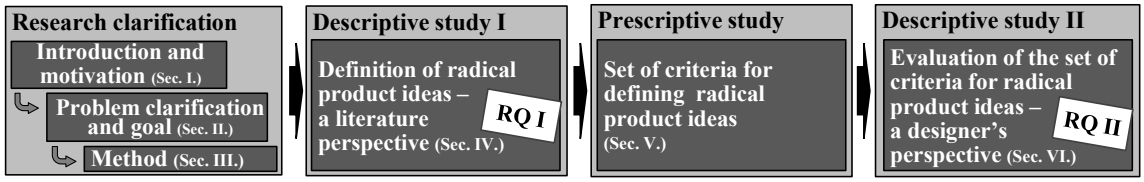

Figure 1. Elaboration and assessment of criteria for radical product ideas

4. Definition of radical product ideas – a literature perspective

In order to learn how literature defines radical product ideas, a systematic literature review was planned and conducted. The following procedure for this literature study was established and divided into four different steps:

1. A preliminary investigation, analyzing relevant synonyms for the term "radical product ideas".
2. Execution of the actual research in four indexed, electronic literature databases with the previously identified, relevant synonyms.
3. Initial selection of the found papers.
4. Detailed analysis of these relevant papers.

The results of the four steps will be presented in the following section. We must add that only a summary of the results can be presented in order to maintain an appropriate framework for the paper.
The first step of the review comprised creating a list of synonyms for the term "radical product idea". This was done using an initial list of synonyms for radical innovations (see Table 1, left-hand column) which are used in relevant papers regarding radical innovations (for references, see Table 1, left-hand column). With these original terms, synonyms for radical product ideas were derived using text modules (see Table 1, central column, bold). The bold text modules were combined with the original terms of the synonyms of radical innovation (see Table 1, left-hand column, bold). By doing so, ten original terms could be combined with 7 different text modules. Thus, 70 synonyms were found. By adding several other specific synonyms for radical ideas found in pertinent references (see last row of Table 1), a total of 77 synonyms were derived.

Table 1. Relevant synonyms for the term "radical product idea" (extract from preliminary investigation)

Original term	Examples for defined search terms	No.
"**Radical** innovation" (Leifer *et al.*, 2000)	"Radical **innovation* idea***"	**1**
"**Disruptive** innovation" (Christensen and Bower, 1996)	"Disruptive **innovation idea***"	**1**
"**Horizon 3** innovation" (O'Connor and McDermott, 2004)	"Horizon 3 **innovation* idea***"	**1**
"**Step-out** innovation" (O'Connor and McDermott, 2004)	"Step-out **idea***"	**2**
"**Blue-ocean** innovation" (Kim and Mauborgne, 2005)	"Blue-ocean **idea***"	**2**
"**Breakthrough** innovations" (O'Connor and McDermott, 2004)	"**Idea* for** breakthrough innovation*"	**3**
"Discontinuous innovation"(Tushman and O'Reilly, 2002; O'Connor and McDermott, 2004)	"Discontinuous **invention***"	**4**
"**Fundamental** innovation" (Lefenda and Pöckhacker-Tröscher, 2014)	"**Invention* for** fundamental innovation*"	**5**
"**Gamechanging** innovation" (O'Connor and McDermott, 2004)	"Gamechanging **innovation* invention***"	**6**
"**Really new** innovation" (Song and Montoya-Weiss, 1998)	"Really new **product idea***"	**7**
Terms as it stands		
"**Radically new idea***" (Lettl *et al.*, 2008) "**Radical new idea***" (Kundt, 2014) "**Radical product idea***" (Messerle, 2016) /"**Radical invention***" (Dahlin and Behrens, 2005) "**First idea* for radical product***" + "**First idea* for a radical product innovation***" (Kundt, 2014) "**Idea for radical product***" (by the authors) * = Both singular and plural form		

After this, four indexed, electronic literature databases were used in the search process, whereby both the singular and plural form of the 77 terms was used:

- Science Direct
- Web of Science
- Engineering Village
- ProQuest

By doing so, we ascertained that 52 of the synonyms were not found on any of the four literature databases used. The other 25 terms delivered the results shown in Table 2. For the following, more detailed database analysis (step 3), 14 terms were selected. A definition was made that only synonyms with at least ten search hits in total across the four databases were to be chosen for the next step. Additionally, at least three of the four databases had to have delivered at least one search hit. The significant issues for not selecting a synonym are marked with an exclamation mark in the right-hand column of Table 2.

Table 2. Search hits during the preliminary investigation of the terms selected (left-hand column) and not selected (right-hand column) for the database analysis

Term (selected)	Science direct	Web of Science	Engineering Village	ProQuest	Total
Fundamental idea*	9343	788	1344	28,988	40,463
Radical idea*	437	239	44	14,709	15,429
Breakthrough idea*	80	33	43	527	683
Radical new idea	114	15	17	493	639
Radical invention*	104	12	9	302	427
Breakthrough invention*	53	24	23	288	388
Really new idea*	64	4	4	267	339
Disruptive idea*	59	5	11	205	280
Radically new idea*	41	11	10	188	250
Fundamental invention*	69	4	3	157	233
Discontinuous idea*	1	1	0	24	26
Disruptive invention*	4	0	1	14	19
Idea* for radical innovation*	1	2	2	5	10
Radical innovation* idea*	8	1	0	8	17
Total search hits	10,378	1,139	1,511	46,175	59,203

Terms (not selected)	Science direct	Web of Science	Engineering Village	ProQuest	Total
Really new invention*	4	!0	!0	13	17
Discontinuous invention*	5	!0	!0	7	12
Really new product idea*	3	0	0	3	!6
Breakthrough product idea*	0	0	1	2	!3
Blue ocean idea*	1	0	0	1	!2
Idea* for breakthrough innovation*	2	0	0	0	!2
Disruptive product idea*	0	0	0	2	!2
Disruptive innovation idea*	2	0	0	0	!2
Step out idea*	2	0	0	0	!2
Breakthrough innovation idea*	0	0	0	1	!1
Gamechanging idea*	0	0	1	0	!1

Synonyms not selected
! = Reason for synonym not being selected
* = both singular and plural form

In order to perform the search analysis, we first added all 14 relevant terms with singular and plural forms to the search string of each database platform. The initial results without using any filters were quite different, although overall very numerous (see Figure 2, left). Different filters for the search process were subsequently defined. Firstly, papers only published between 1980 and the present were taken into account. The second filter involved only considering conference articles and journal articles. Further filters were set individually on every database to define a framework of topics or categories that the papers were addressing. Therefore, all papers not addressing the appropriate topic (for example politics, law or sociology) were excluded and only papers contributing to design or innovation management in the broadest sense were included. The numbers of hits using these filters are shown in Figure 2 (center). In the fourth step comprising the analysis of the relevant paper, all remaining 647 papers were screened by examining the title, keywords and abstract. The criteria for that were as follows:

(1) Relevance to innovation management/idea management
(2) References/information on a distinction between radical and incremental invention/ideas/innovations
(3) References/information on criteria for the distinction of (2)
(4) References/information on a definition of a radical product idea

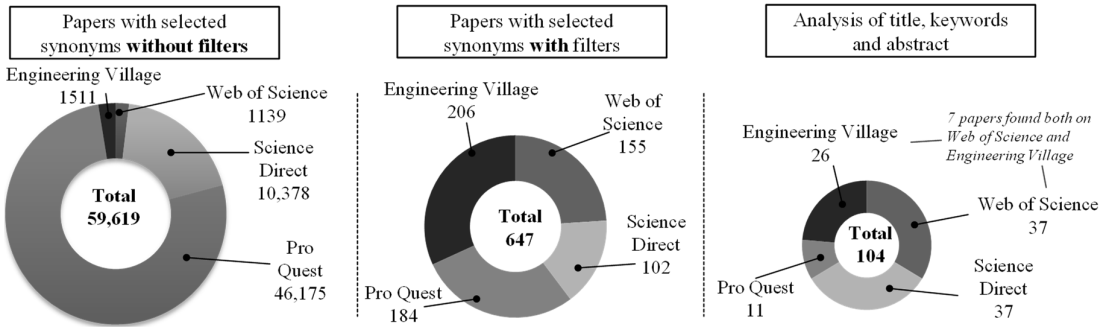

Figure 2. Papers with references to radical product ideas

After the initial analysis, 104 papers remained to be analyzed in more detail (see Figure 2, right). The papers were screened in their entirety for relevant information on how to define radical product ideas and which criteria are used to do so. According to this, only 17 papers included significant definitions or criteria for radical product ideas. 24 papers were of moderate interest, while 60 were not at all helpful. Five papers were not publicly available and were therefore not taken into consideration.

5. Set of criteria for radical product ideas

The analysis of the aforementioned papers on criteria for radical product ideas enabled the following conclusion to be drawn. Several scholars differentiate between a technological perspective and a market perspective (inter alia Ahuja and Morris Lampert, 2001). To broaden this, we distinguish between a micro-perspective (company-internal perspective) and a macro-perspective (company-external perspective).
In a previous paper published at ICED 2017, we derived four different main consideration dimensions addressing different views on radical product ideas: "market", "user/customer" (both macro-perspective), "company's organization/strategy" and "team of designers" (both micro-perspective) (Herrmann et al., 2017b). To follow this logic, the analyzed criteria for radical product ideas are presented in Tables 3 and 4 and assigned to each dimension. Table 3 shows the macro-perspective, whereby a differentiation is made between a market dimension and the user/customer dimension. The latter was strongly recommended for consideration by Ahuja and Morris Lampert (2001). However, the user dimension can be afforded a lower weighting due to a lack of ease of consideration in the initial stages of an innovation process (Magnusson, 2009).

Table 3. Criteria defining radical product ideas from a literature perspective (macro-perspective)

	Addressed dimension	CRITERION: "idea is defined by/based on/delivers/ enables…"	Un, 2010	Kurkkio *et al.*, 2011	Hindle and Yencken, 2004	Harvard Business Review, 2001	Ahuja and Morris Lampert, 2001	O'Connor and Rice, 2001	Sergeeva and Radosavljevic, 2010	Magnusson, 2009	Jung and Lee, 2016	Datta and Jessup, 2013	Dahlin and Behrens, 2005	Schoenmakers and Duysters, 2010	Conti *et al.*, 2014	Deichmann and van den Ende, 2014	Robbins and O'Gorman, 2015	Della Malva *et al.*, 2015	Huang *et al.*, 2016
Macro-perspective (company-external perspective)	Market	a challenge base for existing technological order													x				
		a basis for new technologies, future products, services and/or business development					x	x			x	x	x		x			x	
		new fundamental scientific research			x				x								x		
		a high degree of novel technological content	x	x				x	x		x	x	x	x	x		x	x	
		a high degree of new knowledge	x						x							x			
		a recombination of existing knowledge from several knowledge domains												x				x	
		uniqueness					x					x	x						
		high improvement in performance (by a factor of 5 to 10)						x											x
		a high degree of originality								x									
		extremely good value													x				
	User/ customer	potential reduction of cost						x											
		a meaningful difference in the lives of people				x													
		people to do things they have never been able to do before																	x

Since this paper examines a way of defining radical product ideas from a designer's perspective, the internal perspective (micro-perspective) is represented by a company's organizational or strategic dimension and the team of designers itself (see Table 4). Some criteria could be assigned precisely to each dimension, although some were also placed in between both dimensions because they are able to be assigned to both. Several criteria are even related to both (macro- and micro-) perspectives. These criteria can therefore be found in both tables.
In the following section, the derived criteria will be briefly discussed. One of the most important criteria is the degree of novelty, which can be described from different perspectives in the context of radical product ideas. These ideas deliver a high degree of novelty. This may refer to technological content which is new for the user, new for a market or a market segment, or for the designers who have to deal with that new technology within the respective company. Newness can also affect different organizational structures within the company or, from a macro-perspective, refer to being new for users or markets. Therefore, this criterion can be classified as very generally formulated.

Table 4. Criteria defining radical product ideas from a literature perspective (micro-perspective)

	Addressed dimension	CRITERION: "idea is defined by/based on/ delivers/enables…"	Un, 2010	Kurkkio *et al.*, 2011	Hindle and Yencken, 2004	Harvard Business Review, 2001	Ahuja and Morris Lampert, 2001	O'Connor and Rice, 2001	Sergeeva and Radosavljevic, 2010	Magnusson, 2009	Jung and Lee, 2016	Datta and Jessup, 2013	Dahlin and Behrens, 2005	Schoenmakers and Duysters, 2010	Conti *et al.*, 2014	Deichmann and vanden Ende, 2014	Robbins and O'Gorman, 2015	Della Malva *et al.*, 2015	Huang *et al.*, 2016
Micro-perspective (company-internal perspective)	Team of designers	forms a challenge base for existing technological order													x				
		high complexity		x															
		new fundamental scientific research			x				x								x		
		high improvement in performance (by a factor of 5 to 10)						x											x
		uniqueness					x					x	x						
		high degree of novel technological content	x						x	x	x	x	x				x	x	
		high degree of originality								x									
	Company's organization/strategy	high degree of new knowledge	x						x							x	x		
		a recombination of existing knowledge from several knowledge domains												x				x	
		a basis for new technologies, future products, services and/or business development					x	x			x	x	x		x			x	
		potential reduction of cost						x											
		long time-frames		x															
		high uncertainty		x					x										
		high costs							x										
		a high degree of risk							x										
		extremely good value													x				
		novelty of the process development project/process changes/adaptation	x	x															
		a high degree of change in the existing practices of an organization							x										
		a transformation of a company's competitive position														x			
		a basis for strategic renewals														x			

It should be defined in greater detail by specific criteria. Several scholars define "radicality" using degree of knowledge. Radical innovations require more new knowledge than incremental innovations do (Dewar and Dutton, 1986; Henderson and Clark, 1990). Opinions in literature differ from completely new knowledge and the new combination of existing knowledge, possibly even from different knowledge domains. Radical ideas are only rarely based on completely new knowledge (Hargadon and Sutton, 1997). Most of the time, they arise from a new combination of previously existing knowledge (Hargadon and Sutton, 1997). Uniqueness, a high degree of originality and a potential reduction of cost are further criteria. Additionally, if the product idea delivers a basis for new technologies, future products, services and/or business development, or a challenge base for the existing technological order, it can also be defined as radical. A radical product idea also enables a high improvement in performance (by a factor of 5 to 10, see O'Connor and Rice, 2001), delivers extremely good value or is based on fundamentally new scientific research. Different criteria exist, e.g. the opportunity to enable people to do things they have never been able to do before, or making a meaningful difference in the lives of people, which have to be considered from a user's perspective. These criteria thus have to be assessed from a macro-perspective.

Other criteria such as the novelty of the process development project, longer time-frames, high complexity, high uncertainty, high costs, high degree of risk, originality, organizational changes and the effects on a company's competitive position or the company's strategy only affect the micro-perspective and therefore have to be assessed by the company, its designers and managers.

One important factor must also be mentioned: The point of time when an idea is declared as radical or not is decisive for the decision as to whether a product idea is radical or not. The period of time in which such a decision can be made starts from an initial drawing or verbal description and runs until the point in time when the idea is distributed onto the market. Consideration must be given to the fact that several of the aforementioned criteria are difficult to assess ex ante (Verhoeven et al., 2013) because certain criteria often change or can only be assessed roughly. This is particularly true for

market effects. A clear description of all criteria a designer will use for declaring radical product ideas is thus mandatory. Additional difficulty is generated by the fact that ideas evolve during the idea process, thus the amount of information and knowledge also grows. During development, a radical idea can become an incremental idea and vice versa. Another issue elucidated by the analysis is that many of the screened papers do not concretely define a radical product idea. It is frequently only defined as the root or the origin of a later radical innovation (inter alia Cheng et al., 2016), albeit not equipped with a criteria-based definition. However, a clear understanding of the determinants of radical product ideas is often emphasized (Ahuja and Morris Lampert, 2001).
In order to contribute to these remarks, the results from a further literature study are presented to expand the results of the analysis of radical product ideas. This study analyzes different definitions of radical innovations and gives further input on the ex-ante and ex-post topic described previously.
The following study is based on a student's literature study published in a student research thesis (Schenek, 2017). This thesis was supervised by the main author of this paper. The results of Schenek's study (Schenek, 2017) were extended in particular by aspects found in the 104 screened papers (see Section 4) which were not part of Schenek's study. Table 5 shows extracts of different definitions presented by various authors. The different extracts were assigned to the various aforementioned consideration dimensions of the macro- and micro-perspectives. As Table 5 shows, most of the authors address the macro-perspective with their definition.

Table 5. Extracts from definition of radical innovation (according to Schenek, 2017)

	Macro-perspective	Micro-perspective	
User/customer	• Basic technology, substantially new (Chandy and Tellis, 2000); • Totally new combination of technologies (Gemünden and Kock, 2010); • Creates new categories, species or classes of products (Godoe, 2000); • Significantly new (Chandy and Tellis, 2000; O'Connor and Rice, 2001; McDermott and O'Connor, 2002; Reichwald et al., 2009); • New S-curve (Garcia and Calantone, 2002); • Pace-setter technology (Vahs and Burmester, 2005); • Product dramatically changed (Leifer et al., 2000); • Radically different from competitor's products (Motte et al., 2011); • New product solutions (Kundt, 2014); • Serious change from customer's perspective (Kundt, 2014); • Innovation leads to obsolescence of existing products (Afuah, 2003); • Deviation from an original path, or a rapid or unexpected change in the archetypal configuration of a product (Baumard, 2014); • Important antecedent for later innovation (Datta and Jessup, 2013); • Different/new set of capabilities necessary (McDermott and O'Connor, 2002; Robbins and O'Gorman, 2015); • Create demand previously unrecognized by the consumer (Garcia and Calantone, 2002); • Performance benefits (Leifer et al., 2000; Slater et al., 2014); • Requires a significant change of consumer behavior (Ziamou, 1999);	• Revolutionary change in technology (Dewar and Dutton, 1986); • New technology or new product architecture (Scigliano, 2003);	**Team of designers**
Market	• Existing markets change dramatically (Leifer *et al.*, 2000; Garcia and Calantone, 2002; McDermott and O'Connor, 2002; Scigliano, 2003; Meyer, 2011; Kundt, 2014; Stilianidis, 2015); • Market is non-existent so far, so it is reconstituted (Leifer *et al.*, 2000, 2000; Scigliano, 2003; Meyer, 2011; Stilianidis, 2015); • Results in a new market infrastructure (Song and Montoya-Weiss, 1998); • High market and technological uncertainty (Robbins and O'Gorman, 2015); • New market creation (Robbins and O'Gorman, 2015);	• Range of services significantly improved (Chandy and Tellis, 2000; Leifer *et al.*, 2000; Savioz *et al.*, 2002; Tatarczyk, 2009) or reconstituted (Leifer *et al.*, 2000; O'Connor and McDermott, 2004; Hartschen *et al.*, 2009; Gemünden and Kock, 2010; Stilianidis, 2015); • Major contributor to company's survival and growth (Christensen and Bower, 1996; Chandy and Tellis, 2000); • Might cannibalize a company's prior business model (Robbins and O'Gorman, 2015);	**Company's organization/strategy**

Within the macro-perspective, the consideration dimension of the user/customer plays an important role. This confirms the thesis that radicality is often assessed ex post, i.e. when an idea is already distributed as an innovation in the market and "in contact" with the user/customer. Furthermore, some aspects of the set of definitions can only be considered ex post. To give one example of this, Datta and Jessup (2013) claim that a radical innovation is an "important antecedent for later innovation".
What also has to be considered is that a macro-perspective of an innovation often contains parts of the micro-perspective, even though this is not explicitly mentioned. So, if a criterion addresses the macro-perspective, it often also affects the micro-perspective. The criterion "innovation leads to obsolescence of existing products" (Afuah, 2003) can be mentioned as an example here.
To contribute to the set of criteria given in Tables 3 and 4, some further criteria derived from Table 5 and based on the references given there can be added to the macro-perspective (Table 3):

- Radical product ideas are able to create new categories, species or classes of products.
- Radical product ideas can lead to the obsolescence of existing products.
- Radical product ideas create a previously unrecognized demand among consumers.
- A market for such an idea is non-existent so far and is created or the market reconstituted.

The other criteria are already presented among the previously shown criteria (Tables 3 and 4). The problem of the four added criteria is again the ex-post issue, as data for an ex-ante assessment might be missing in the early phases of the product development process.

6. Evaluation of the set of criteria for radical product ideas – a designer's perspective

To evaluate the previously compiled set of criteria, a group of seven designers from a consumer goods manufacturer took part in an evaluation workshop. This company is cooperating with us in order to gain new models and methods for the idea process. Two of the seven designers are head of their respective department, while another two are head of a team within one of these departments. The other three were designers from one of the two teams. After an introduction to and a clarification of the topic, the designers were given the set of criteria for radical product ideas (Tables 3 and 4, and additional criteria derived at the end of Section 5) while discussing the following question: Which criteria can be used to define radical product ideas? To give this question a framework, initial discussions focused on the situations for which a set of criteria can be used. The group agreed that such a set can be used for the project classification at the first or a later evaluation milestone of a product idea or project. A project can therefore be consciously desired to be a radical project, which means that the project starts with a radical need or problem idea and should be solved by a radical solution idea. A criteria set can also help to handle both kinds of idea within a specific radical or incremental idea process if the idea process demands such a separation of radical and incremental product ideas, which may be desirable for several reasons (see Section 1). Another agreement was that the term "radical" should be defined for the company in question. This should serve as a basis for the early phases of the product development process and thus the steps of evaluation within these phases. As the group of experts itself classified the organization as very conservative, a clear understanding of a radical product idea helps to counteract the problems of product idea evaluation. At the moment, more incremental product ideas are chosen while radical product ideas are dispensed with. Thus, only the most uncritical ideas are followed up, or radical ideas are changed to the extent that they are no longer radical at all. After clarifying those needs for working on that topic, the designers discussed the set of criteria previously given. The criteria they chose as most relevant are shown in Table 6 with the appropriate comments.

Table 6. Criteria selected as relevant by the designers (evaluation group)

Perspective	Criteria selected as relevant	Comments of the designers
Micro (Table 4)	idea forms a basis for technologies, future products, services and / or business development	• new products and business models can base on that idea (successful innovation) • idea is based on a new business model or can be a base for that
Micro (Table 4)	idea is defined by a high degree of novel technological content	• If the newness / degree of novelty is high, the idea can be classified as radical. But newness can be seen from different perspectives: new for the customer, new for the company, new for the market; thus, it has to be classified from different perspectives.
Micro (Table 4)	idea is defined by a high degree of originality	• idea forms a unique selling point
Micro (Table 4)	idea can be defined by uniqueness	
Micro (Table 4)	idea is defined by a high degree of risk	• idea has to face high internal resistors; • it is complex and elaborately; BUT risk can also create opportunities, if conquered;
Micro (Table 4)	idea is defined by a high degree of new knowledge	---
Macro (Table 3)	idea is based on new value	• idea can lead to a product with cult status; • later product can be characterized by extreme positive emotions on the product
Macro (Table 3)	idea enables people doing things they have never been able to do before	• idea changes customer`s / user´s habits
Macro (Table 3)	idea delivers high improvement of performance	• especially time-affecting; • user is able to do things faster or different things at the same time

As mentioned during the discussion, the newness (degree of novelty) of a product idea, or in other words the newness of the technology expressed in a product idea, is one of the most important aspects. This statement confirms the literature view presented in Section 5. However, the designers also agreed that the term has to be substantiated and a solution should be found to measure it. Furthermore, Table 6 shows that most of the criteria address the micro-perspective. The group agreed that it is first important to see how radical a product idea is for the company itself (i.e. organization, strategy, designers). However, the possible effect of a later product for the user must have been taken into account. One more fact with which the group agreed is that aspects concerning a market change can only be assessed vaguely. It is not that relevant for an initial identification step of radical product ideas and should be postponed for a later assessment step. The overall assessment of the group was that the given criteria set is helpful for defining radical product ideas. They agreed that this list may be a good auxiliary tool, although each company would need to adapt the criteria application specifically.

7. Conclusion and outlook

It should have been mentioned at the beginning of this section that the goal of the paper was not to present a definition of a radical product idea written down in prose text. The goal is rather to sharpen and create a deeper understanding of radical product ideas. According to He et al. (2008), an object – in our case a radical product idea – is better described than defined. It is not possible to create an all-encompassing definition for each business, company, industrial sector or specific application (see also Haustein and Maier, 1980). What we want to achieve is to assemble a relevant set of criteria which can be used when defining radical product ideas; however, this would need to be adapted according to the purpose of such a definition or clarification (according to Haustein and Maier, 1980).

The motivation for developing a clear understanding of radical product ideas initially led to the step wherein literature's understanding of this term was analyzed. The results were intended to serve as a foundation on which future research – not only by the authors, but also by the whole design community – can be built. The derived set of criteria can help to define the term "radical product idea", as we learned from Section 6. Future research should dig deeper into that matter, thereby resulting in a methodological support concerning how radical product ideas can be defined concretely with a significant measurement logic. This should also contribute to the research question asked by Eling et al. (2016): Should a formal process be used for selecting both incremental and radical new product ideas for advancement to increase a company’s overall idea success rate? This paper contributed to answering the question by presenting an initial framework.

Furthermore, the criteria set presented here has to be evaluated in further companies to confirm the initial evaluation and to contribute to the question of whether the criteria set is useful and applicable.

What we additionally learned from the literature study presented in Section 4 is that further synonyms for radical product ideas or innovations exist, such as "blockbuster products" (Slater et al., 2014), "high-impact ideas" (Schilling and Green, 2011), "emerging technologies" (Schoenmakers and Duysters, 2010), "ground-breaking ideas" (Aven, 2016) "major innovation" or "revolutionary innovation" (Markovitch et al., 2017), among others. The study scope of this paper can thus even be extended, thereby contributing to the question of whether other criteria for defining radical product ideas exist in the pertinent literature.

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Thorsten Herrmann, M.Sc.
University of Stuttgart, Institute for Engineering Design and Industrial Design
Pfaffenwaldring 9, 70569 Stuttgart, Germany
Email: thorsten.herrmann@iktd.uni-stuttgart.de