Pendular Design
Connections Between Design and Mature Industries

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Abstract
Industries change and mature. The object of this study was to identify design in these circumstances. Mainly because featuring design in the maturity phase of the industry life cycle is part of a limited and diffuse knowledge. It is believed that Design may be affected and limited by the maturity of the industry; also, possible ways of breaking this limiting logic is also considered. To study the theme, an integrative approach was used, and a bibliographic review in design management, strategic design and business management was done. The Design Science Research methods and a case study of the textile industry were also adopted. Thus, a theoretical and conceptual framework about the relationship between design and mature industry was built; five paradigms on industry maturity were proposed; and, finally, Design was featured using an analogy with the displacement logic of a pendulum, highlighting restraining, and driving forces.

Keywords
Design Management
Industry Life Cycle model
Mature industry
Pendular design
Strategic Design

Even as a project activity, design will remain partially associated with products and industrial processes, however, it will also address corporate and strategic challenges, while moving towards an increasingly systemic vision.

In this context, industries are susceptible to maturation and to the implications that this process brings about; thus, they need to act strategically in a future-oriented way. Therefore, if industries transform themselves and mature, we seek to identify what design looks like under these circumstances.

The characterization of design in the maturity stage of the industry life cycle[1] is part of a limited and diffuse body of knowledge.

In design management and strategic design studies, one can recognize implied relationships with the maturity of industries using expressions and terms related to the theme. For example, product redesign and differentiation (Walsh, 2000; Mozota, 2011; Celaschi et al., 2011; Verganti, 2012); incremental innovation (Krippendorff, 2006; Holston, 2011); commoditization (Zurlo, 2014); operational efficiency (Best, 2010; Moraes, 2010); linear processes detached from strategic steps (Cooper, 2014).

And, in the field of business management, mature industry design is essentially confined to the drafting of the offers, whether products and/or services (Porter, 2005; Moon, 2005; Kotler & Keller, 2012; Bergek et. al, 2013; Lilja et al., 2015; Onufrey, 2017).

Initially, it is important to explain that:

A The industry life cycle model is considered a strategic diagnostic tool of the stages of introduction, growth, maturity and decline because each of them is susceptible to different challenges and opportunities (Moon, 2005; Kotler & Keller, 2012).

B Mature-stage industries consist of a set of goods manufacturers competing among themselves that exhibit stability in key economic performance indicators, but are subject to decline (Porter, 2005; Kotler & Keller, 2012).

Thus, mature industries, such as automobile, furniture, electronics, textile, among others, are not free from witnessing their offerings become outdated due to technological, cultural and marketing transformations. However, these industries do not know when this will happen and, when considering the most promising alternatives, they should learn how to deal with the risk of obsolescence.

In this regard, it is argued that design is limited by the characteristics of maturity, but, nevertheless, it is not able to contribute so that these industries make their choices based on a critical and ingenious view. Thus, this study presents a framework for the relationship between design and mature industry.

To research the "mature design-industry" combination, an integrative approach is chosen, in which a bibliographical review on design management, strategic design, and business management is conducted.

Also, the following were added: (a) the *Design Science Research* (Dresch et al., 2015) to develop a construct based on the relationship between design and mature industry; (b) a case study to validate the model. For this, we referred to the experience with the

1 This characterization was included in the Ph.D. dissertation *Design Management in Mature Industries: Proposition of a Creative Analytic Matrix for Strategic Design* (Bergmann, 2018), and is developed in the current article.

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mature and specialized Brazilian industry in textile coating for residential floorings by reviewing related material between 2000 and 2018, and for the analysis of proposed Pendular Design.

Mature Industry Paradigms and Design Restraining Forces

Industries in the maturity stage show a typical behavior that affects design performance and vice-versa. Therefore, in Fig. 1, we develop an interpretative synthesis of five paradigms that establish relationships between mature industry characteristics and the design profile, that is, stability, predictability, linearity, pattern reproduction and incremental innovation.

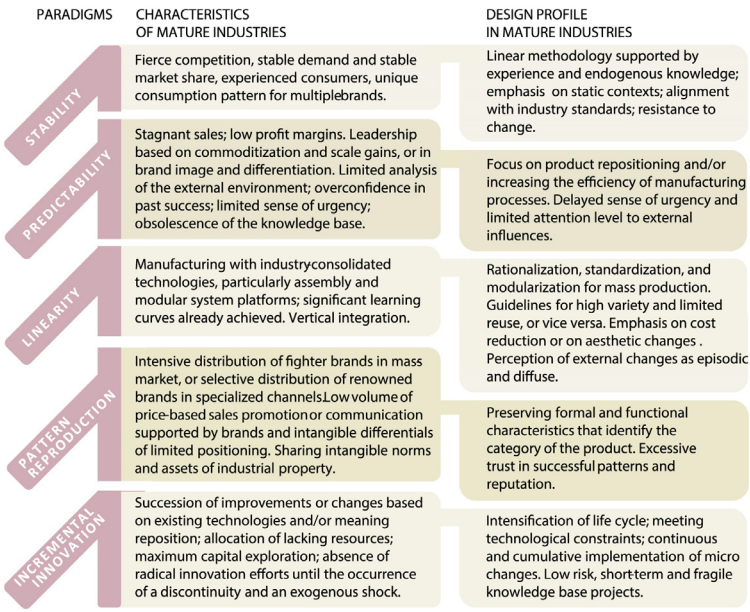

Fig. 1
The five paradigms of the mature industry and design. Adapted from Bergmann (2018).

These five paradigms influence and restrain the design action through effort prioritization to extend the product life cycle and, consequently, of the industry itself.

This occurs both at the operational level of design, where project management and offer development take place; and at the strategic level of design, where the design strategy management and the development of visions that contribute to the entire business take place (Cooper & Press, 2000; Best, 2010; Mozota, 2011).

At the operational level, the prevalence of the Dominant Design is identified. This is the standardization of design solutions supported by a kind of consensus between manufacturers and buyers, who undertake efforts to maintain the previously established technological and sociocultural aspects (Suarez & Utterback, 1995; Walsh, 2000; Krippendorff, 2006; Baldwin & Woodard, 2008; Verganti, 2012). Dominant Design is mainly associated with industries based on assembly systems, where products are the result of the combination

of modules, meeting essentially two principles: high variety and low reusability, or the opposite, supporting the strategy of differentiation or commoditization, respectively (Suarez & Utterback, 1995; Koen, 2007; Baldwin & Woodard, 2008).

Differentiation refers to developing alternative solutions from a basic architecture (Suarez & Utterback, 1995; Walsh, 2000; Koen, 2007; Baldwin & Woodard, 2008). It can cause the "dematurity" process, that is, industrial rejuvenation by implementing a series of small changes combined and executed in a relatively short interval to meet new market demands (Sviokla, 2014).

But differentiation — as it becomes more widespread — can turn design into a codified and predictable process (Verganti, 2012). Thus, when the mature industry uses differentiation unrestrictedly in a sequence of product generations, it may face the risk of seeing its offerings become commodities.

In a broad approach, commoditization includes industries with fierce competition and limited ability to differentiate their offers, where the brand is an attribute with reduced relevance, and low costs tend to promote competitive pricing (Bank, 2015). In this scenario, there is a convergence between commoditization and the characteristics of mature industries. Apparently, the risk of this strategy is the loss of their real purpose.

Both differentiation and commoditization are then perceived as components of the Dominant Design, manifesting itself as a restraining force at the design operational level in mature industries. It becomes evident that the design performance is aimed at maintaining the Dominant Design and reinforcing past successful choices, but that may no longer be in accordance with new contexts.

And, therefore, the difficulty for mature industries to identify, understand and take advantage of external aspects, such as changes in their surroundings, becomes evident (Onufrey, 2017). For this reason, a gap is noticed between design at the strategic level and mature industries.

For design, strategy is a process that incorporates ongoing actions and adaptations to changes in the environment (Meroni, 2008). It is up to design activities to identify changes, interpret them, and take advantage of them, manipulating information and building knowledge (Moraes, 2010).

However, by keeping the focus on the five paradigms of the industry maturity stage, design overlooks threats and opportunities in the external environment. And, thus, the crystallization of obsolescence monitoring is characterized as a restraining force at the strategic level of design in mature industries. This force neglects knowledge building for the development of future strategies and is based on two interdependent components.

The first one is inertial resistance, because it is associated with an excessive confidence in historically successful business models; a focus on existing knowledge; a sense of overdue urgency; therefore, a reluctance to change.

The second component is the lack of ability to read the external environment with its transformations, contingencies, and externalities. It is based on a limited level of attention to contextual influences; on the obsolescence of the knowledge platform; on the perception of technological and cultural transformations as episodic and diffuse.

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For all these reasons, design promotes resistance to obsolescence in the short term, but ignores future strategic possibilities by conforming to the existing conditions of the industry's maturity stage paradigms.

Context of Changing Mature Industries and Design Driving Forces

Design needs to constantly fine-tune its focus to adapt to new situations and reorient its thinking and practices. Thus, to design alternatives to the logic based on the Dominant Design and the crystallization of obsolescence monitoring, it is essential to shift the focus of mature industry paradigms to a less restrictive and more dynamic context.

First, it is necessary to understand that the context in which design operates is composed of the confluence of social, cultural, technological, and economic conditions, which are constantly subject to change. So, it is essential to strategically establish the outline of this action context by including relevant considerations for the field of design (Meroni, 2008; Mozota, 2011).

If the contemporary Zeitgeist is perceived as uncertain, changing, multiple, fluid, unlimited, tense, turbulent, volatile, ambiguous, and less predictable, among other dynamic characteristics (Moraes, 2010; Zurlo, 2010; Holston, 2011; Best, 2015), this is the context to be monitored by design at the strategic level of mature industries.

Supported by disruptive changes, by the orientation for long deadlines and by the acceptance of risk arising from these choices, design, at the maturity stage of the industry, needs to rely on the opposite of previous paradigms, acting in a dynamic context and characterized by the rejection and/or creation of patterns, radical innovation, complexity, instability, and unpredictability.

Thus, design is then able to face the risk of obsolescence in mature industries and this will probably take place through a driving force at the strategic level identified with leadership in innovation processes.

This capacity of design to lead innovation processes is often associated with three key factors: (a) knowledge generation; (b) organizational learning processes, as well as (c) a continuum of activities that converge to functions specific to strategic design.

Underlying this triadic relationship are the components of this enabling force, i.e., transdisciplinarity, multidimensionality and creativity. They act together against the effects of crystallization of obsolescence monitoring, and their articulation with the key factors is summarized in Fig. 2.

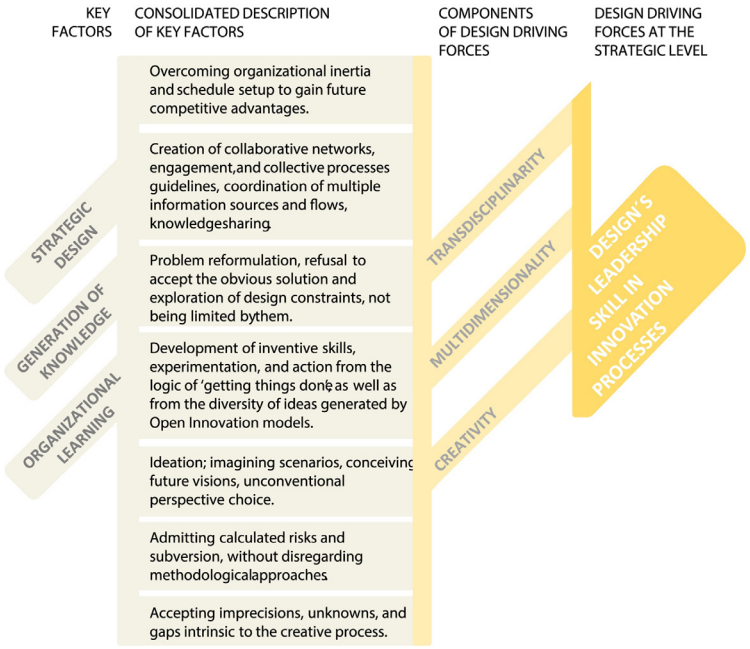

Fig. 2
Factors and components of design driving forces at the strategic level of mature industries. Adapted by the authors based on studies by Meroni (2008), Best (2010), Cooper et al. (2011), Press (2011), Holston (2011), Franzato (2011), Verganti (2012).

At the mature stage, traditional sources of knowledge may become obsolete and new sources may be neglected. To counteract this process, transdisciplinarity is considered a component of the driving force behind design as it involves managing relationships in collaborative networks consistent with the logic of Open Innovation. They provide a space for continuous discussions and learning that stimulate innovation processes by expanding the knowledge base (Best, 2010; Press, 2011; Mozota, 2011; Franzato, 2011; Verganti, 2012).

Transdisciplinarity favors the development of the second component of the driving force of design, that is, the multidimensionality. It refers to simultaneous action on multiple driving axes for innovation. They are based on changes linked to buyers' needs and expectations; materials and manufacturing processes; sociocultural movements and object meanings (Holston, 2011; Verganti, 2012). These axes are not necessarily conflicting, but organizations tend to devote themselves to only one of them (Verganti, 2012).

Therefore, at the maturity stage of the industry, the simultaneous approach of technological and socio-cultural transformations may drive innovation processes and make the best possible use of the potential derived from the contextualized and integrative analysis of the external environment.

Transversal to the first two components of the driving force of design, creativity, the third one, is also essential for innovation in mature industries. Creative processes are requirements for strategic alignment in disruptive hypotheses by addressing problems in unconventional ways; by generating non-standard alternatives; and by making innovative ideas tangible (Cooper & Press, 2000; Best 2010; Mozota, 2011; Zurlo, 2010). In this manner, creativity can minimize the effects of an organizational environment characterized by pattern repetition.

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Consequently, in an integrated way, leadership in innovation processes as a driving force for design at the strategic level is supported by creative approaches and performed by transdisciplinary groups, when designing with a simultaneous focus on multiple driving innovation axes.

Design in Mature Industries and the Pendular Design

Based on the previous sections of this article, the "Pendular Design" concept is defined. In other words, a characterization of design in the maturity stage of the industry life cycle is introduced using an analogy with the predictable logic of pendular movements. As it moves away from its equilibrium position, it oscillates between two poles before stopping.

This comparison between design and pendular movements is justified based on the existing restraining logic among design activities and the five paradigms of the maturity of the industry life cycle. Therefore, Pendular Design is expressed in two ways: Pendular Design 'Type I', when conforming to such paradigms; and Pendular Design 'Type II', while confronting them and admitting a dynamic context.

However, it is important to highlight that the commitment to present reasonable options enables the action scope of the second variant to remain limited to the space of pendular movements. This happens because of the relevance of the assets acquired by mature industries during their trajectories to success, being tangible, such as plants and machineries; and/or intangible, such as reputation and industrial property modes.

Both variants of the Pendular Design are shown below and summarized in Fig. 3 .

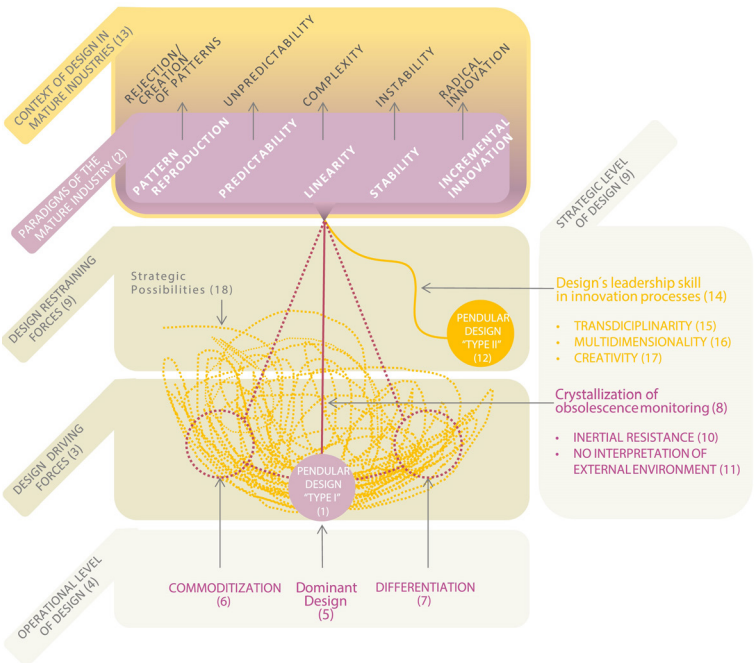

Fig. 3
Pendular Design and both variants. Adapted from Bergmann (2018).

Pendular Design 'Type I' (1) focusses on revitalizing the offer with the object of exhausting the market potential. It keeps the creative elaboration restricted to the paradigms of mature industries (2) including, linearity, stability, predictability, pattern reproduction and incremental innovation. And so, design alternatives become reliant on two restraining forces (3) and their respective components.

The first restraining force is the Dominant Design (5). It acts on the operational level of design (4), where a standard of technology and meaning prevails, linked to the possibilities of modular systems and assembly platforms. In a predictable way, the Dominant Design oscillates between two components: on one side, commoditization (6) and improvements in processes; on the other, differentiation (7) and incremental innovations in products.

The second restraining force of Pendular Design 'Type I' is the crystallization of obsolescence monitoring (8). It acts on the strategic level of design (9) and indicates the trend of the pendular logic to neglect technological and cultural changes affecting the external environment of the mature industry. This restraining force is expressed through two components. One of them is inertial resistance (10) to break through usual practices and design possibilities that exceed the surroundings of the Dominant Design. The other component is the lack of interpretation of the external environment (11) to support the change of the inertia state in dynamic contexts. None of them contribute to the knowledge creation for future designs; on the contrary, they hold back strategic design.

Therefore, Pendular Design 'Type I' shows conformity to maturity paradigms and enables the understanding of obsolescence because of multiple neglected strategic possibilities.

However, if the industry life cycle includes change as an intrinsic element and assumes that the determinism between its stages may be modified through strategic actions, design should not be conditioned to limits considered insurmountable.

Thus, at a strategic level, the second variant of Pendular Design is introduced as a way for design to respond to changing contemporary values and prepare mature industries for the future, which includes resisting obsolescence or proposing new options.

Pendular Design 'Type II' (12), however, questions the paradigms of mature industries and seeks knowledge in a dynamic context (13), considering notions such as instability, unpredictability, complexity, rejection and/or creation of patterns and radical innovation. It is important to emphasize that paradigms and contexts are not addressed as a restrictive approach. On the contrary, a relationship of continuity is established among them.

To work on this wider and more flexible scope, the second variant relies on a restraining force identified with design's leadership skill in innovation processes (14). It stimulates the generation of knowledge and learning to identify, explore, imagine, propose, and promote tangible new relationships between production and consumption in mature industries.

All of this based on three components: (a) transdisciplinarity and co-creation through collaborative networks (15); (b) multidimensionality and innovation enabled simultaneously through technological and cultural references (16); (c) creativity and idea

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generation based on collecting exogenous and endogenous knowledge, not by repeating known patterns (17).

The joint driving force of Pendular Design 'Type II' and its components intensify the innovation in mature industries when considering unexplored strategic possibilities (18) by Pendular Design 'Type I'.

In brief, the success of Pendular Design 'Type II' can influence the success of Pendular Design 'Type I'. This happens because if design seeks to efficiently design the offer in the present at the operational level of the mature industry, at the strategic level it seeks alternatives to change or replace this offer in the future. Therefore, both must happen simultaneously.

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Conclusions

This study contributes to the field of Design by expanding the theory on design performance in mature industries by introducing specific terminology to the discourse, and by adding concepts to the formal and organized knowledge related to design.

A reference framework about the relationship between design and mature industry was developed; five paradigms of a mature industry were proposed; and design was featured using an analogy with the logic of pendulum movements, highlighting restraining, and driving forces.

All of this supports systemic assessments about the industrial logic during a transitional moment, while trying to reflect on existing models and the need to expand or to change with them to achieve a sustainable development in all dimensions.

The study of the Brazilian textile coating industry for residential floorings using the Pendular Design concept enabled a strategic diagnosis by observing the alignment of the relationship between design and maturity, described in the model.

The compliance with Pendular Design "Type 1" logic and its restraining forces were verified. Rugs and carpets were noted as commodities or products oriented to aesthetic differentiation, setting up a Dominant Design standard.

This allowed the need to explore strategic possibilities based on Pendular Design "Type 2". However, it was possible to observe that this industry neglects dynamic relationships as the presence of the enabling force identified with the design leadership skills in innovation processes was not obvious.

For example, promising trajectories are ignored for future developments based on the creative potential of (a) technological hybridization, (2) resignification of residential spaces based on emerging cultural principles, and of (3) alternative business models that emerge in new competitive environments.

As a result, the proposed construct makes the research trajectory tangible by transforming it into the starting point for other case studies oriented to mature industries, such as electronics, furniture, and automobiles, in addition to the textile subsectors, for example.

Finally, understanding how Pendular Design promotes resistance against obsolescence at an operational level, while providing multiple perspectives to the industry at a strategic level. Ideally, there are no dilemmas, but only the simultaneous performance of design in two levels.

Nevertheless, if operational design triumphs over strategic design, the risk is that design might contribute to a deterministic view of the industry life cycle and, as a result, have its own value questioned.

It is important to emphasize that obsolescence, as a challenge faced in the maturity stage of the industries, is not a responsibility of design alone, but can count on its true contributions and principles.

References

Baldwin, C. Y. & Woodard, C. J. (2008). *The Architecture of Platforms*. Harvard Business School.

Bank, E. (2015). What Is a Commodity-Based Industry? *Chron Magazine*.

Bergek, A., Magnusson, T., & Berggren, C. (2013). Technological discontinuities and the challenge for incumbent firms. *Research Policy*, *42*(6-7), 1210-1224.

Bergmann, M. (2018). *Gestão do design em indústrias maduras: Proposição da matriz analítico-criativa de design estratégico.* (Publication No. 1412274/CA) [Doctoral dissertation, PUC-Rio]. Puc-Rio Campus Repository. https://www.maxwell.vrac.puc-rio.br/37405/37405.PDF

Best, K. (2010). *The Fundamentals of Design Management*. Ava.

Best, K. (2015). *Design Management.* Bloomsbury.

Celaschi, F., Celi, M., & García, L. M. (2011) The extended value of design: An advanced design perspective. *Design Management Journal*, *6*(1), 6-15.

Cooper, R. G. (2014). What's next? After Stage-Gate. *Research Technology Management*, *57*(1), 20-31.

Cooper, R. D., Evans, M., & Williams, A. (2011). New design business models: Implications for the future of design management. In R. Cooper, S. Junginger, & T. Lockwood (Eds.), *The handbook of design management.* Berg.

Cooper, R., & Press, M. (2000). *The Design Agenda: A Guide to Successful Design Management*. John Wiley.

Franzato, C. (2011). O processo de inovação dirigida pelo design. *REDIGE*, *2*(1), 50-62.

Holston, D. (2011). *The Strategic Designer: Tools and Techniques for Managing the Design Process.* How Books.

Koen, P. A. (2007). The fuzzy front end for incremental, platform and breakthrough products and services. In K. B. Kahn, *The PDMA Handbook of New Product Development.* John Wiley & Sons.

Kotler, P., & Keller, K. L. (2012). *Administração de marketing*. Pearson Prentice-Hall.

Krippendorff, K. (2006). *The Semantic Turn: A New Foundation for Design.* CRC Press.

Lilja, M., Sundberg, C., & Sundberg, G. (2015). *Growth Strategies in Declining Industries*. Jonkoping International Business School.

Meroni, A. (2008). Design estratégico: onde estamos agora? Reflexão em torno dos alicerces de uma disciplina recente. *Strategic Design Research Journal*, *1*(1), 31-38.

Moon, Y. (2005). Break Free from the Product Life Cycle. *Harvard Business Review*.

Moraes, D. (2010). *Metaprojeto: o design do design*. Blücher.

Mozota, B. B. (2011). Design strategic value revisited: A dynamic theory for design as organizational function. In R. Cooper, S. Junginger, & T. Lockwood (Eds.), *The handbook of design management.* Berg.

Onufrey, K. (2017). *Enabled by the Past: Understanding Endogenous Innovation in Mature Industries*. (ISBN: 978-91-7685-561-4) [Doctoral dissertation, Linköping University]. LiU-Tryck Repository. http://liu.diva-portal.org/smash/get/diva2:1084796/FULLTEXT01

Porter, M. E. (2005). *Estratégia competitiva.* Atlas.

Press, M. (2011). Working the crowd: Crowdsourcing as a strategy for codesign. In R. Cooper, S. Junginger, & T. Lockwood (Eds.), *The handbook of design management.* Berg.

Suarez, F. F., & Utterback, J. M. (1995). Dominant designs and the survival of firms. *Strategic Management Journal*, 16, 415-430.

Sviokla J. (2014). How old industries become young again. *Strategy+Business*, 76.

Verganti, R. (2012). *Design-driven Innovation.* Canal Certo.

Walsh. V. (2000). Design, innovation and the boundaries of the firm. *Design Management Journal*, *1*(1), 74-92.

Zurlo, F. (2010). *Design strategico*. Enciclopedia Treccani.