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New design and manufacturing technologies for craft products

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Abstract

Considering the principles characterising the craftsman and industrial production systems as a starting point, this article explores mechanisms that promote the interdisciplinary relationship between industrial designers, industrial manufacturers and craftsmen. The main objective is to enhance knowledge contributing to the development and consolidation of the craft activity. The performed analysis demonstrated that some fundamental concepts and strategic plans can be applied to craft processes. These factors support a viable proximity between the three centres of industrial production, technological innovation and craftsmanship. This study allows the definition of a strategic plan for restructuring the craft activity, providing the craftsman with upgraded skills to new media and industrial technologies, allowing them to adapt its work to the current market demands. This proposal has been validated by a qualitative research work performed using collaborative tools, which was conducted in the field of wicker crafts in Madeira, Portugal.

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Keywords: Craftsman, Design, Industry 4.0, CAx Technologies, Enables technologies

1. Introduction

Throughout the twentieth century there has been a steady decline in the craft activity due to increasing market demands. Even the concept of need has changed, creating the society that we know today, which is characterised by a permanent dependence on objects that solve its problems. This situation led to a consumer-oriented society, given that man no longer felt the need to create and develop his own solutions and started consuming low-cost mass-produced objects by industries.

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This problem led craftsmen to lose their market competitive capacity. In this sense, and from the socio-economic point of view, we are facing a clash of values: on one hand, the cultural value associated with craftsman know-how often under extinction threat and, and on the other hand, the technological advances from the industrial sectors which have a high response capacity regarding the growing demands of society.

However, in order to find a solution to this problem, we have been witnessing renewed attention to the crafts sector during the last decades of the twentieth century and the first decades of the present century. Thus, with the emergence of new craftsmen with a background and culture very different from their predecessors, new motivations and ways of approaching the concept of craftsmanship are emerging today.

Recognising this complex paradigm in which the craftsman activity finds itself, and recognising that the new tendencies of the industrial system are set to implement methodologies that privilege the personalisation and singularisation of the products, in order to satisfy the needs of each consumer, it is fundamental and urgent to consider methodologies that can promote both productive sectors. Taking into account the evolution of the handicraft and industry, in the relationship between R & D & I activities since the industrial revolution, today deserves special attention, within the industrial sectors, the design and the manufacture as well as the proximity of the "Industry 4.0 "[1], which aims at excellence in production through technology, focusing its innovation potential on the introduction of technological facilitators such as the internet of things, additive manufacturing, augmented reality, cloud computing, big data, etc., allowing (among other things) product customisation.

It should be noted that although the focus of "Industry 4.0", regarding the development of productive activity, is centred on the industrial activity, it is transversal and projectable to other areas such as the crafts activity.

Analysing the opportunities provided within "Industry 4.0" [2], digital facilitators constitute an opportunity to streamline craftsman production processes without changing its identity traits; They offer great application flexibility and can enhance, not only the expressiveness of the activity, but also its value in global markets in an economically sustainable way. However, it is also possible to identify one of the greatest obstacles to the modernisation of the craft sector as the rejection of emerging technologies [3].

Generally, these technological incursions are still considered by craftsman as disturbing elements of their procedures and as a challenge to the sustainability of their activity [3, 4]. Nevertheless, due to the exponential development of means and technologies and to the constant evolution of society, craftsmanship will necessarily have to integrate innovation in order to survive. Given its amplitude and complexity, this type of study requires a holistic observation and analysis of the framework to which each process is associated. It is necessary to emphasise that the very foundations of industrial manufacturing derive and evolved from the concepts of craft production. Their conceptual approximation is evident, although both sides assume distinct trajectories in the way they focus on the development of the product life cycle [5, 6].

Considering the current situation regarding craftsmanship, and recognising that new trends in the industrial system are focused on automating, digitising and maximising the personalisation of product and service results [7], it is necessary to compare and evaluate new paradigms, techniques, models and procedures from Industry 4.0 that can be applied and add value to the crafts productive activity [8,9]. Within the industrial background, the comprehensive use of technological facilitators currently provides the creation of more elaborate and complex forms [10, 11].

Without loss of the characteristic identity of the handicraft, the factors previously discussed can establish a synergistic and viable proximity between the approaches of industrial and artisanal production systems. To this end, a methodology is developed that allows exploring the benefits of the methodological and technical resources of the production in Industry 4.0 that can contribute to the recovery and optimisation of the craftsman processes, from a professional and collaborative approach between craftsmen, design and product development engineers and production engineers.

2. Presentation

This section presents the development of a methodology based on case studies, combined with procedures allowing the comparison and evaluation of the data. The purpose of this methodology is to establish the guidelines to explore the potential value that results from the joint intervention of craftsmen, design engineering and production under the articulation of technology facilitators. With its application, the sustainability of the crafts activity is sought through the definition of a strategic plan. The characterisation of this interdisciplinary cooperation allows defining a proposal

of a collaborative project to explore and enhance the knowledge and domains of interaction. It is a simple way of introducing innovative strategies in crafts production that defends cultural and economic sustainability in small and specific geographic areas.

In order to enable this collaboration, it is necessary to establish a flexible and holistic methodology adapted to local and historical contexts, aiming at capturing the most varied aspects of craft production and the most innovative procedures in the industry [12, 13]. Therefore, the methodological proposal, in addition to the matrices and its associated tools, establishes the guidelines for new technology implementation.

The proposed methodology is composed of five phases:

- PHASE I: Identification of common factors and characterisation of industrial and crafts processes
- PHASE II: Identification of areas of opportunity
- PHASE III: Identification and evaluation of resources
- PHASE IV: Definition of an integrated proposal
- PHASE V: Development of the strategic plan

Contrary to the different agents' models of action, this methodology allows the craftsman and industrial processes to be in perfect harmony, leveraging solutions of interdisciplinarity, from the origin to the end of the product life cycle. From this interaction, it is aimed that craftsmen and designers have a joint "growth", generating knowledge exchange, in a process of "horizontal" development that allows the optimisation of the entire conceptual, operational and socio-cultural sustainability management system of the activity. The aim is to enhance the general cycles of craft production without the craftsman ceasing to be a craftsman or changing the identity that defines the craft product.

The methodology developed and understood in a constructivist and holistic knowledge dynamics, has been validated with the objective of verifying its applicability to several specific activities. For this purpose, it has been applied to the wickerwork sector in the autonomous region of Madeira, specifically in the design, development and manufacture of wicker furniture [3]. In the pilot project participated 3 craftsmen associations of, 4 craft companies and 37 craftsmen.

In this methodological context, Fig. 1 presents the problematics regarding the role of the new technologies as propellers of innovation and of exchanges between the different players. Technological resources are therefore the means to find a relationship dynamics between craft and industrial production.

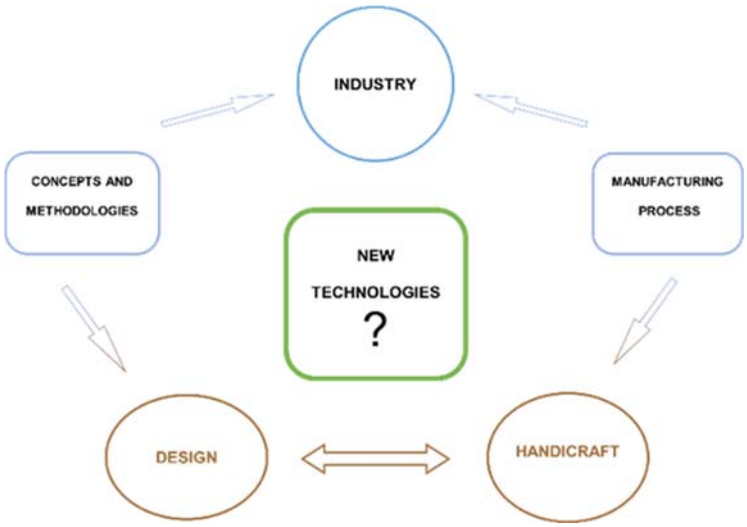

Fig. 1. Relationship diagram.

Phase I consists of a brief presentation of the current situation of crafts and industrial production methodologies, in order to later establish a correlation between them. For this purpose, the analysis of the properties, activities and

processes shared by b Phase I consists of a brief presentation of the current situation of crafts and industrial production methodologies, in order to later establish a correlation between them. For this purpose, the analysis of the properties, activities and processes shared by both domains is performed. Upon obtaining the results, the characterisation is carried out and the points of contact, relationships and convergences are identified, as well as possible exploitation and improvement strategies.

For the sustainability of this processes' fusion, as previously mentioned, it is necessary to integrate in this analysis new technologies, namely digital tools and rapid prototyping technologies, which will also be presented and analysed, as shown in Fig. 2.

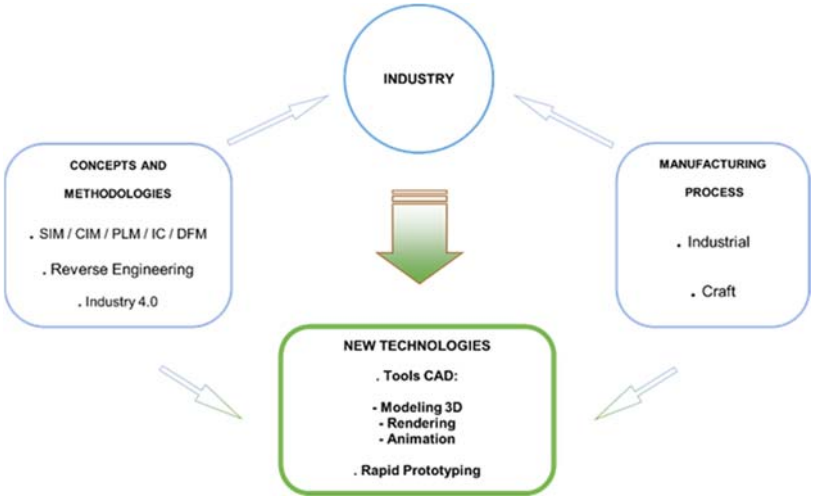

Fig. 2. Diagram representing the application of new technologies and manufacturing processes.

In phase II, an analytical summary of the main relationships between crafts and design is performed, as professions that develop products through different design and elaboration processes, but largely equivalent, justifying the need to understand how these two professionals can dialogue and cooperate. To achieve this aim, it is necessary to present and characterise design at the methodological level to establish contact points, frontiers and opportunity areas, with the objective of incorporating the innovation drivers derived from "Industry 4.0" technological and digital facilitators [14]. Thus, we arrive at the following diagram of relationships that completes phase II of the proposed methodological model (Fig. 3).

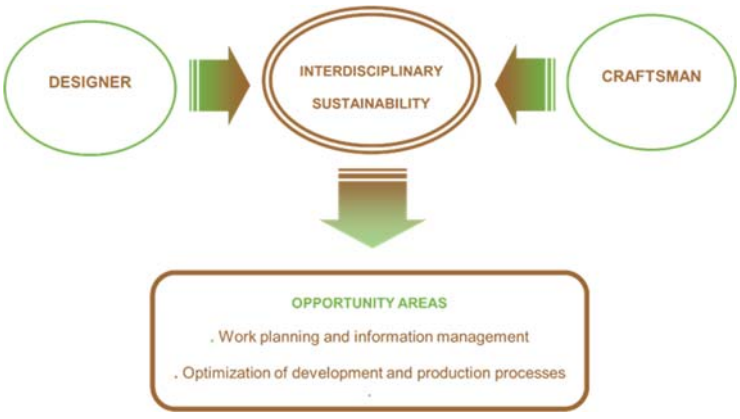

Fig. 3. Craftsman-designer relationship and determination of opportunity areas.

This situation allows structuring a common ideological matrix. It is possible to identify which methods, management techniques, design development tools, or even new technologies such as additive manufacturing or rapid prototyping can be applied to both domains even if approached through different methods.

In order to frame more precisely the areas of opportunity, namely in the application of methodologies, during phase III it is essential to characterise the needs and resources in a specific sector. This survey should take into account a production universe characterised by the absence of industry, often associated with small locations.

With the objective of selecting the most appropriate "Industry 4.0" facilitators to be efficiently integrated into craftsman activities, a detailed evaluation of the crafts sector is carried out to identify the possible impact of these measures. They will be obtained from an inductive methodology of several crafts sectors. At this stage we focus on techniques and tools that allow us to collect the most characteristic and identity aspects, namely interviews and surveys about the professional career of the craftsmen.

Taking into account the intersection between the areas of opportunity found for the concerned specific sector and the activity of the craftsman, in phase IV, through the performance of a pilot project, new facilitators are identified, as well as the specific moments of their integration in the design, development, manufacture and sale of the handcrafted product as well as the resulting impact. After obtaining phase IV results, a nesting of the integrable resources is performed. This plan is defined through processes of open innovation, based on the cooperation between craftsmen and designers, in order to foster the triple valuation between crafts, design, and production whose convergence will be possible as a result of the digital facilitators of "Industry 4.0", providing a concerted activity within the market and the current industry. This information will later allow the definition of a strategic plan (Fig. 4) for the re-design of the activity, incorporating facilitators that allow the flexibility, agility and optimisation of the crafts process without eliminating their identity values.

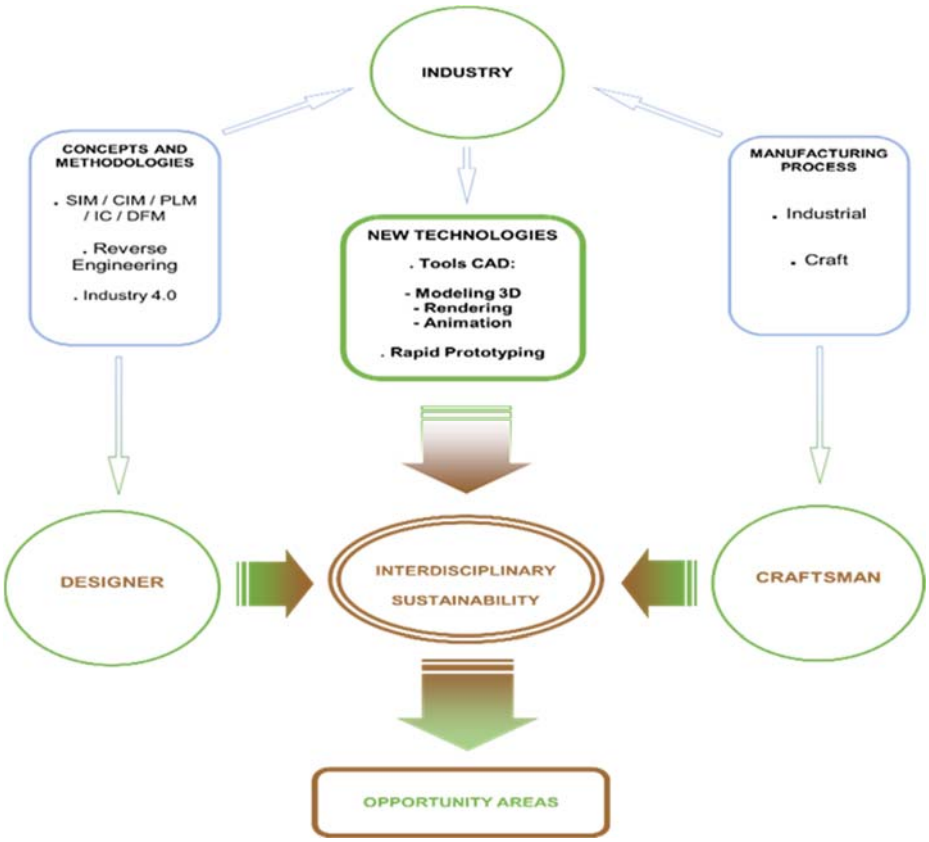

Fig. 4. Strategic plan diagram to be applied to specific sectors.

This strategic plan will answer to the identified needs taking into account the specificities of the concerned crafts sector and specific geographically and socially delimited cases [15, 16]. In this last phase, it is necessary to complement the methodological model with elements that foster the communication at the training, promotion and commercialisation levels or with more cohesive and supported approaches to the resources that belong the industrial background. In this sense, in order to provide a more comprehensive answer to this problem, an improvement to the current model is proposed, which can be applied to any sector of craft activity in general (Fig. 5).

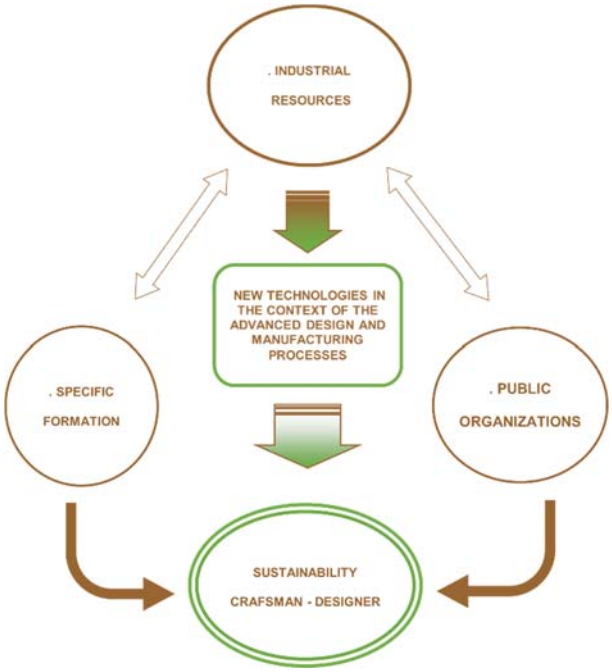

Fig. 5. Fundamental peripheral vectors to guarantee the sustainability of the Strategic Innovation Plan (SIP).

In this new plan academic institutions are included, prioritising specific and joint training that puts empirical and scientific-technological knowledge in contact, valuing horizontal communication between the involved players. On the other hand, it is necessary to establish closer relationships with the institutions that have the responsibility of fomenting and supporting the promotion and internationalisation of these activities.

It is a complementary model that aims to ensure the effective integration, in the medium and long terms, of digital technologies in the relation between craftsman and designer within the context of advanced design and manufacturing processes, thus making the triangulation of relations more sustainable.

3. Results and validation

We recall that the methodological model was validated with the objective of verifying the viability of its application to various specific handicraft activities. In that sense, and given its amplitude, it was applied as a case study to the wicker craft sector in the Autonomous Region of Madeira, specifically focusing on the design, development and manufacture of wicker furniture [17].

It was possible to verify the main relationships established between the different universes under study (crafts, industrial concepts, new technologies and design), through theoretical foundation and analysis of the labor places (phases I and II), allowing to present a characterisation of different production processes and, consequently, the identification of opportunity areas to be applied in the following phases. After this comparison, it was possible to validate the pertinence of concepts such as Computer Integrated Manufacturing (CIM), which can be applied to craft activities as a means of planning, structuring and organising the design and production process. We have also observed

that craftsman, even without realising it, apply Product Lifecycle Management (PLM) methodologies, albeit empirically. In summary, the main points of contact between the crafts production process and its equivalent in the industrial sector can be analysed, recognised and listed in order to build a basis for determining opportunity areas to be applied to a particular sector of the crafts activity.

This observation allowed the identification of the following opportunity areas: work planning and organisation; optimisation of development and production processes; introduction and implementation of new digital tools (CAX and Rapid Prototyping technologies) and exploration of new communication channels associated with the online market.

The results obtained during Phase III, corresponding to the case study, allowed the identification of the limitations inherent to craftsman's activity, which meet the opportunity areas foreseen in the previous phase. According to the performed survey among the craftsmen, it was possible to ascertain a set of limitations that, in general terms, correlate to the weak competitiveness of wickerwork in the Region, in the current markets. This reality follows the international tendency of small locations without industrial expression. In general, it was verified that there is no commitment on the updating of resources and knowledge, especially in technologies related to the management, design and production aid. In terms of promotion and marketing, a weak investment in this sector is also confirmed. However, the cultural and social identity that characterises craft production remains very present in the Region. Simultaneously, there is a timid renewal of the activity, mainly promoted by young craftsmen, devoid of vices and preconceived concepts, usually resulting from a long professional activity.

However, it was essentially during phase IV, corresponding to the pilot project that the methodological model of this investigation was tested and validated. After surveying and characterising the specific sector of Wicker Crafts in the Madeira Island, it was possible to explore the conditions of cooperation between craft activities and the current concepts and methods of industrial development, taking into account the different techniques of design development, within the scope of design and manufacturing.

The participation of craftsmen and designers in this project allowed testing the application of new technologies, namely, the digital CAD tools and rapid prototyping. During project design and prototype fabrication, these tools streamlined the process of analysis and decision making. Through 3D models and prototypes, a greater efficiency in clarifying and objectifying communication was evidenced. After completing the pilot project, it was possible to obtain a reduction of the time allocated to the development phases of about 10 to 15%, which resulted in a reduction of costs of the final product, through the implementation of the mentioned technologies. This experience has shown that the application of technological facilitators of the emerging "Industry 4.0" can be perfectly compatible with the crafts processes, without at any time endangering the craftsman's position, as a central and nuclear pillar of the artisanal manufacture. Upon completing the case study, it was possible to establish global and transversal parameters based on the triangular interaction of activities.

However, in order to successfully implement the proposed model, it is necessary to create conditions of proximity and convergence with sectors related to the different areas of intervention, namely through the joint articulation of governmental institutions, education and industry, as demonstrated in phase V of the Strategic Innovation Plan.

4. Conclusions

This research project, based on the initially defined objectives, allowed us to obtain evidence that know-how exchange can contribute to a more sustainable craft activity and manufacture. The performance of this research project was based on the development and experimental application of the methodological model with the objective of evaluating the use of facilitator technologies by the craftsmen in collaboration with designers in the context of the advanced design and manufacturing processes.

It was verified that, through the theoretical basis and analysis of the main relationships established between the different universes under study (crafts, industrial concepts, emerging technologies, design and manufacturing), a characterisation of the various production processes is presented and, consequently, the identification of opportunity areas. Global and transversal parameters were established, based on the triangular interaction of these research activities. It is also reinforced the crucial position that the designer occupies within the methodological structure, due to his conceptual proximity to the craft activities and to his connection with the industrialised processes as a discipline.

After identifying and characterising the craftsman processes, and based on the data obtained through the developed pilot project, it was possible to verify that both conventional industrial development tools and the new proposals of digital and technological facilitators emerging from "Industry 4.0", can be compatible with the craftsman processes, as long as there is a means of learning and supporting its introduction. Both have great potential to optimize the crafts system without compromising their identity values.

It has been demonstrated that it is necessary to create conditions of proximity and convergence with sectors linked to the different areas of intervention, mainly through collaborations with government institutions, higher education and industry, which together have provided greater support to the crafts activity through qualified training and through promotion and support actions regarding new projects development.

The proposed methodology is a valid option for the revitalisation of a crafts sector in a defined geographical area, for supporting the development of new solutions and applications, and as a means of registering and preserving knowledge.

The performed research allowed the identification of several moments where the craft activity needs better adaptation to the guidelines established by the market. In this sense, given the extensive and complex nature of this problem, some issues need to be studied in more detail, more specifically what concerns management and labor planning, joint training and ways to streamline and bring resources from the industrial area to crafts activity.

References

[1] R. Sauter, M. Bode D. Kittelberger. “How Industry 4.0 is changing how we manage value creation”. Available at: https://www.horvath-partners.com/en/publications/featured-articles-interviews/detail/how-industry-40-is-changing-how-we-manage-value-creation/ (2016).
[2] J.R. De la Torre. Neg. en Nav. 274 (2015) 24-33.
[3] C.B. Alexandre, E.A. Gomez, A.C. Valente. Proc. Eng. 132 (2015) 1089-1095.
[4] J.C. Pacheco, G.E. Barrero, G. Gómez Vásquez. Cuad. de Des. Rural 10 (2010) 115-129.
[5] L. Mumford, Technics & civilization. University of Chicago Press. (2010).
[6] M.G. De Molina, V.M. Toledo. The social metabolism: A socio-ecological theory of historical change (Vol. 3) Springer (2014).
[7] M. Hermann “Design Principles for Industrie 4.0 Scenarios: A Literature Review”. Technische universität Dortmund. (2015). 10.13140/RG.2.2.29269.22248.
[8] K. Herdzina, B. Nolte, S. Hegner, ERSA conference papers, European Regional Science Association. 98 (237) (1998).
[9] AP. Demarchi, C.B.E. Fornasier, RF. Martins. “A Gestão de Design humanizada pelo Design thinking a partir de relações conceituais.” Projética - Rev Científica Des da Univ Estadual Londrina.. 2 (2011) (1). Available at: http://dx.doi.org/10.5433/2236-2207.2011v2n1p19.
[10] S. Pugh, Total Design: Integrated Methods for Successful Product Engineering”. Pearson Education. Engineering Technology and Design, (2010).
[11] P. Santos, “Sustentabilidade e responsabilidade social no design de produto: rumo à definição de indicadores” PhD Thesis, Universidade de São Paulo, 2007.
[12] W. Bauer, S. Schlund, D. Marrenbach, O. Ganschar. “Industrie 4.0 – Volkswirtschaftliches Potenzial für Deutschland”. BitKom, Fraunhofer. (2014).
[13] I. Gibson, Computer-Aided Des & App. 2 (6) (2005) 785-793.
[14] G. Johansson, Environ. Manag. Health, 13 (1) (2002) 98–107.
[15] C.B. Alexandre, E.A. Gomez, A.C. Valente, “Artesanato em vime na Região Autónoma da Madeira. A sustentabilidade da relação artesão-designer”. Actas del 1º Encontro Ibérico de Doutoramentos em Design. ISBN 978-989-20-3421-8, U. Aveiro. (2014).
[16] L. Guedes, “Consumo e identidade cultural: o papel do designer na preservação da sua cultura e tradições perante um mundo globalizado”. En: V Encontro Nacional de Estudos do Consumo, I Encontro Luso-Brasileiro de Estudos de Consumo Rio de Janeiro (2010).
[17] M.D.S. Fernandes, Estratégias para o desenvolvimento do artesanato contemporâneo na Madeira (2010). (Doctoral dissertation, Universidade da Madeira).
[18] W. Eder, S. Hosnedl, “Design Engineering: A Manual for Enhanced Creativity”. Taylor and Fracis Group CRC press (2008).