An Approach Exploiting the Interplay between Elicited Emotions and Product Design to Improve Business Competitiveness

Conference Paper · November 2015

CITATIONS
0

READS
125

2 authors:

Lawrence Farrugia
University of Malta
9 PUBLICATIONS **7** CITATIONS
SEE PROFILE

Jonathan Borg
University of Malta
88 PUBLICATIONS **306** CITATIONS
SEE PROFILE

interplay2015
DESIGN ▶ SCIENCE ▶ TECHNOLOGY ▶ ARTS

IASDR 2015 Congress
2-5 November 2015
Brisbane, Australia
http://www.iasdr2015.com

iasdr QUT

An Approach Exploiting the Interplay between Elicited Emotions and Product Design to Improve Business Competitiveness

Lawrence Farrugia, University of Malta, lawrence.farrugia.07@um.edu.mt
Jonathan Borg, University of Malta, jonathan.borg@um.edu.mt

Abstract

The elicitation of a human emotion, may be regarded as a consequence of the interaction between the human individual and the properties of the designed system. In addition, elicited emotions have a capacity to influence the behavior of the individual experiencing them. Research into product design and emotions has so far exploited the interplay between the emotions elicited from customers and their purchase behavior, in order to improve business competitiveness. Yet this relatively new area of research, has been limited to the consideration of human-product interactions that take place during the use phase. The research work presented in this paper extends the notion of human-product interactions across the entire life-cycle of the product. In addition to customers, the research work considers the emotions elicited from human life-phase workers who interact with the artefact during phases which precede and follow the use phase. The paper contributes with an approach which is intended to support design teams in eliciting desirable emotions from both workers and customers. The motivation behind this approach is that the competitiveness of a business can be further improved, by exploiting the interplay between the elicited emotions and the change in human behavior across multiple life-cycle phases.

Interplay; Human emotions; Design support; Life-Phase system, Human behavior

Product development is a process in which a perceived market opportunity is exploited through the design and manufacture of a product, which is subsequently sold at a profit to the customer (Magrab, 1997; Ulrich & Eppinger, 2003). The degree of competitiveness of such a business model, is typically gauged in terms of metrics such as development cost,

time to market and product quality (Ulrich & Eppinger, 2003). Throughout the product development process, a multidisciplinary design team is required to *concurrently* make important decisions pertaining to the product and also the manufacturing system which supports the realization of the designed product. This is due to the interplay which exists between the properties of the product and the manufacturing system.

The commitments made, particularly during the early stages of design (Nevins, Whitney, & Fazio, 1989), have consequences which result from the meeting between the product and other life-phase systems. Fabrication equipment, the assembly system, the human customers and human life-phase workers are all examples of life-phase systems which the product interacts with throughout distinct phases of its life-cycle.

For many years, research into product design provided a variety of tools in order to put design teams in a better position to *foresee* (Borg, 1999) the consequences of the design decisions made. For instance, the Design for Assembly (DfA) guidelines (Boothroyd, Dewhurst, & Knight, 2010) help design teams to foresee, how the interaction between the designed product and the assembly system has consequences in terms of the total assembly time. In recent years, research into product design started to express a keen interest in the capacity of product design attributes to elicit specific emotions from customers during the use phase. The elicitation of a human emotion may also be regarded as a consequence (Borg & Farrugia, 2014) of the meeting between the human customer and the designed product. This research, has been motivated by the interplay which exists between elicited emotions and the behavior of customers. This interplay is denoted by the fact that product design attributes such as form, color and odor contribute to the elicitation of specific emotions from customers, which in turn influence their purchase behavior (Saucken, Schröer, Kain, & Lindemann, 2012), re-purchase intentions (Bitner, 1992) and judgment of a product (Agost & Vergara, 2014).

To this end, research in product design and human emotions has so far sought to elicit desirable emotions from customers, with the intent to exploit the interplay between customer emotions and their behavior in order to improve business competitiveness. Yet, research into product design and human emotions has focused *exclusively* on emotions elicited as a consequence of human-product interactions, which take place during the use phase.

The objective of this paper is to present an approach which is intended to support design teams in order to elicit desirable emotions from both human life-phase workers and customers. This is achieved by considering human-product interactions across the *entire* life-cycle of the product. The motivation behind this approach, is denoted by the interplay between the elicitation of desirable emotions through product design decisions and human behavior. To this end, the research work aims to address the following research question: *How can design teams exploit the interplay between human emotions and product design in order to improve business competitiveness?*.

The next section presents the research work which has been carried out within the field of product design and emotions. The section outlines current limitations of design for emotions support tools and provides evidence to justify why the consideration of emotions elicited from workers is important. Section 3 discloses in further detail the interplay between the emotions elicited from human individuals and their behavior. This section also rationalizes how business competitiveness, can benefit from exploiting this interplay which exists across multiple phases in the life-cycle of the product. Section 4 presents the main contribution of this paper, which is the provision of a design approach intended to support product designers in eliciting desirable emotions from both workers as well as customers. The last section of this paper presents the key conclusions and identifies further research work that needs to be carried out.

Research into Product Design and Human Emotions

The authors of this paper have identified two themes which are salient to the research field of product design and human emotions. These themes are related to:

i. the capture of emotion knowledge by defining and measuring emotion prototypes
ii. understanding how product design commitments such as the choice of form, texture and color, contribute to the elicitation of specific emotions from human customers.

With respect to the first theme, two authors (Beuzekom & Caicedo, 2006) reviewed a variety of emotion measurement methods. In their review, the authors conclude that the Product Emotion Measurement Instrument (Desmet, 2005) and the Geneva Emotion Wheel (Scherer, 2005) are two self-assessment methods which are particularly suitable for emotion measurement in the context of product design. This is due to the relative ease of use and the inherent ability to gauge a wide variety of emotions when compared with the other reviewed methods. Another important challenge which is related to the first theme, pertains to the definition and structuring of terms such as pleasure, joy and happiness which refer to specific emotion prototypes. To address this challenge, (Desmet, 2012) contributed with an emotion typology composed of 25 positive emotion prototypes. The motivation behind this research (Desmet, 2012) , was the lack of emotion typologies which were comprehensive yet practical to use in design practice. The provision of a concise yet practical emotion typology, also presents tangible benefits to the product development process by enhancing the communication among the different decision makers and stakeholders that are involved (Yoon, Pohlmeyer, & Desmet, 2014).

The second theme which is salient to research into product design and emotions concerns the development of design support tools, which enable product designers to exploit product attributes in order to elicit specific desirable emotions from customers. A case in point is the research work carried out by (Rahman, 2012) who investigated the influence of visual and tactile product attributes on the customers' perception of the product. The results from the

investigation indicate, that both visual and tactile attributes have a capacity to influence the customers' judgment of a product.

The study carried out by (Fenko, Schifferstein, & Hekkert, 2011) investigated the effect of product noise on the perceived pleasantness and annoyance of products by its users. It should be noted that according to the authors of this paper (Fenko et al., 2011), the meaning of the term noisiness is twofold. The first meaning of noisiness, refers to the auditory property of the product while the second meaning refers to cluttered visual patterns and bright colors. The experiments which were presented in the study investigated the influence of both types of noisiness on the subjects. The results indicate that emotions of pleasantness and annoyance were influenced mostly by the auditory property of the product. The study concludes that visual patterns, when compared to the auditory property, had little effect in eliciting strong emotions from subjects.

The olfactory sense was the focal point of the work carried out by (Ludden & Schifferstein, 2009) who investigated the extent to which the congruency of scents with the appearance of a product influences the emotions and judgments of subjects. The results presented by the authors, indicate that scents which are congruent to the appearance of products are considered more pleasurable when compared to incongruent scents. Based on these results the authors conclude that product designers should consider attributing scents to products, which are congruent to their appearance.

Product form is also an attribute which can be sensed by individual and hence contribute to the elicitation of emotions. A prototype design tool (P. J. Farrugia, Borg, Grima, & Fenech, 2008) which employs computer aided sketching, was developed in order to support designers in the conceptual synthesis of product form with the intent to elicit positive emotions from customers. This prototype tool was based on a framework intended at providing design for emotion support (Fenech & Borg, 2006).

The state-of-the-art indicates that current design for emotion support tools focus exclusively on the emotions elicited as a consequence of human-product interactions which take place during the use phase. Yet, these interactions are not limited to the use phase, but take place across the entire life-cycle of the product as shown in Figure 1.

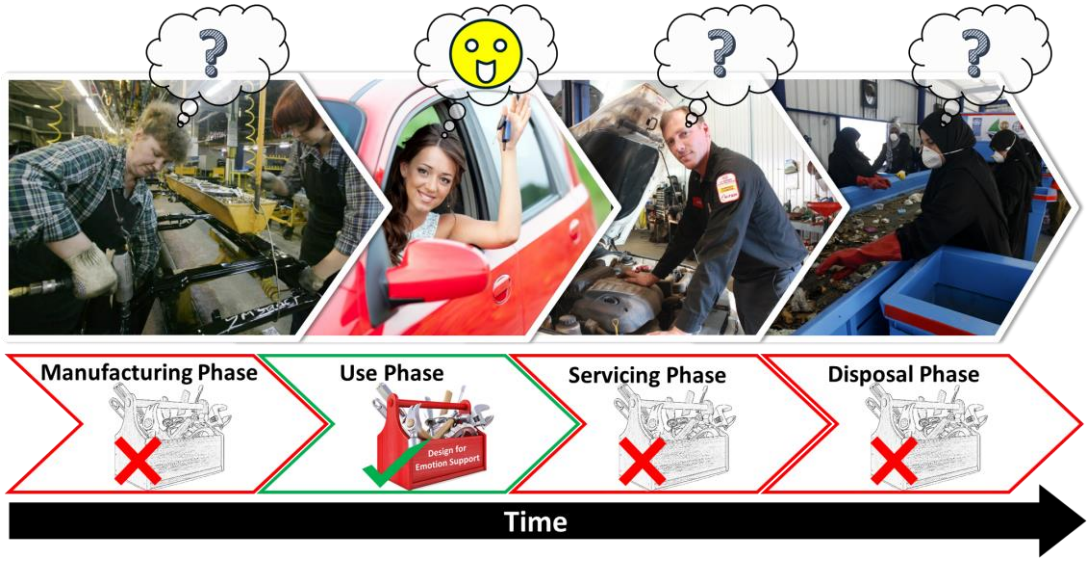

Figure 1: The State-of-the-Art of Design for Emotions Support Tools

Throughout life cycle phases such as manufacturing, servicing and disposal, human workers interact with the designed artefact and other systems while executing work related tasks. For example during the manufacturing phase, human life-phase workers interact with the evolving product and the manufacturing system in order to fabricate and assemble the designed product. Currently, design teams lack the necessary support means in order to foresee the emotions elicited as a consequence of human-product interactions which take place before and after the use phase.

In order to address this limitation, the authors presented a framework (Borg & Farrugia, 2014) that considers the elicitation of a human emotion as a *consequence of the meeting between the human individual* and *life-phase systems* such as the product and the manufacturing system. These life-phase meetings take place across the multiple phases in the life-cycle of the product. In their research work (Borg & Farrugia, 2014) the authors classify life-phase systems as being natural or artificial, as shown in Figure 2.

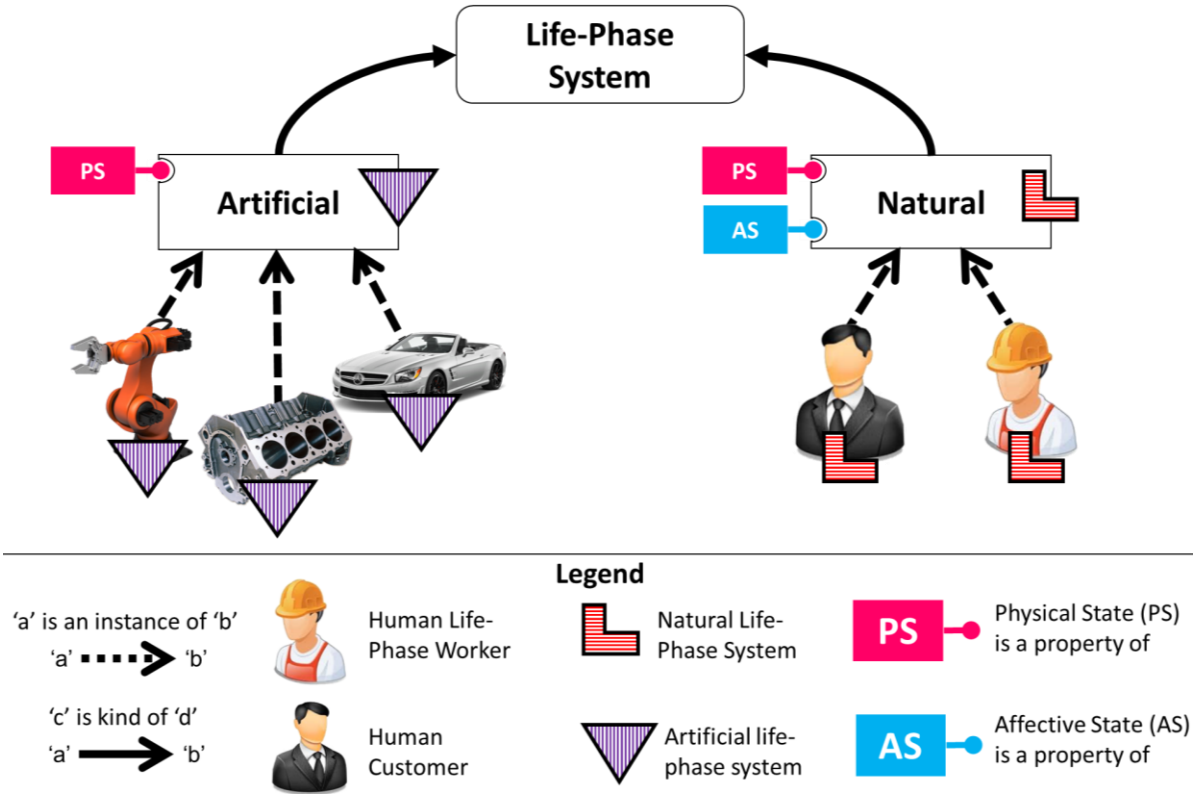

Figure 2. A Classification of Life-Phase Systems

The distinction between the two systems is that artificial systems can be described in terms of their physical state (e.g. color, structure, form etc.), while natural systems have a physical as well as an affective state. The product, the manufacturing system and the physical work environment are all examples of an artificial system. Both the human worker and customer are considered to be instances of the natural system due to their inherent capacity to experience the elicitation of emotions.

Why research into life-phase worker emotions?

The cognitive appraisal process (R. Lazarus, 2006; Scherer, Klaus, Schorr, & Johnstone, 2001) which is responsible for the elicitation of human emotions brings about a number of changes in the human individual. These include changes in the physiology (Dacher & Paul, 2010; Scherer, 2005) and behavior of the individual.

Multiple independent studies agree (Bashir, 2010; Chandhok & Monga, 2013; Dar, Akmal, Naseem, Ud, & Khan, 2011; Qureshi, Iftikhar, & Abbas, 2013) that the elicitation of negative emotions from workers has a negative impact on their performance. The study conducted by (Yang & Diefendorff, 2009) demonstrated that the elicitation of negative emotions does not only result in a decay in the performance of workers, but also renders workers more prone to engage in counterproductive work behavior. The investigation presented by (Zelenski, Murphy, & Jenkins, 2008) also confirmed the thesis that the elicitation of positive emotions from workers contributes to increase their productivity.

It should be noted that the studies presented in this section, did not involve workers who are responsible for the execution of tasks related to specific life-cycle phases such as manufacturing, servicing or disposal. This motivated the authors to conduct a case-study experiment (L. Farrugia & Borg, 2015). The objective of this experiment was to understand how emotions elicited from life-phase workers during manual assembly influence their performance. The results presented in this study (L. Farrugia & Borg, 2015) show that the elicitation of negative emotions from workers is an antecedent to a decay in their performance. In particular the study shows that negative emotions lead to a longer assembly time and an increase in the number of mistakes made by workers during the manual assembly task. On the contrary, the elicitation of positive emotions was correlated to a shorter assembly time and a decrease in the number of mistakes made by the subjects during the manual assembly task. This study therefore demonstrates that emotions elicited from workers, can indeed influence the competitiveness of a business in terms of the time to market and product development costs.

In view of these results, the research work presented in this paper contributes to exploit the interplay between product design and human emotions in order to further improve business competitiveness. The following section shall outline how emotions elicited from customers as well as human life-phase workers, may contribute to improve the competitiveness of a business.

The Interplay between Product Design and the Elicitation of Human Emotions

The literature presented in the preceding section outlined a variety of design for emotion tools. These tools are intended to support design teams in creating products that elicit desirable emotions from customers during the use phase. The process of developing products, typically requires the design team to concurrently design the product and the manufacturing system, which supports the realization of the product. The simultaneous consideration and execution of design tasks pertaining to the product and other systems is referred to as concurrent engineering (Aparicio, 2004; Winner, 1988).

The illustration in Figure 3 outlines how during product development, a multidisciplinary design team is required to concurrently make design commitments pertaining to the properties of the (1) product and other artificial systems such as the manufacturing system (3). While the design of the manufacturing system and the design of the product are two distinct activities, these cannot be considered as separate. This is due to the interplay (4) which exists between the manufacturing system and the product. This interplay (4) is denoted by the fact that design commitments pertaining to the properties of the product, influence and are influenced by, the design commitments concerning the manufacturing system.

For example, product properties such form and material type influence the type of manufacturing process which can be employed in order to realize the designed product. On

the other hand, the type of manufacturing process influences product attributes such as the reliability and selling price of the product.

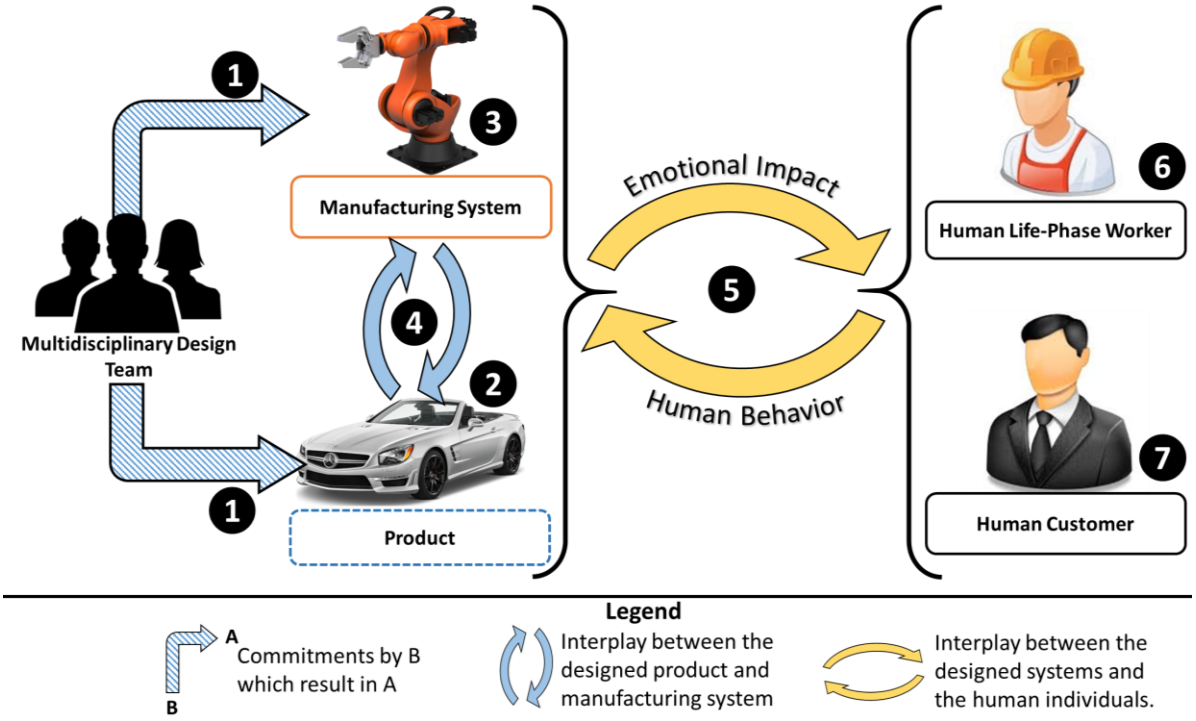

Figure 3: The interplay between artificial and natural system

The product (2) and the manufacturing system (3) are also in an interplay (5) with the human life-phase worker (6) and customer (7). The properties of the developed artificial systems (2, 3), have an emotional impact (5) on the human life-phase worker (6) and customer (7) who interact with these artificial systems during distinct life-cycle phases. The emotions elicited from the human worker and customer, in turn contribute to a change in their behavior (5) which has an effect on business competitiveness. The following sub-sections shall explain in further detail the interplay (5) between developed artificial systems and the human worker and customer respectively.

The Interplay between Human Worker and Artificial Systems during the Manufacturing Phase

The illustration in Figure 4, shows the interplay between the developed artificial systems and the human worker during the manufacturing phase. During this life-cycle phase, the human life-phase worker, interacts directly with the evolving product (3) and the manufacturing system (2) in order to execute the necessary work related tasks.

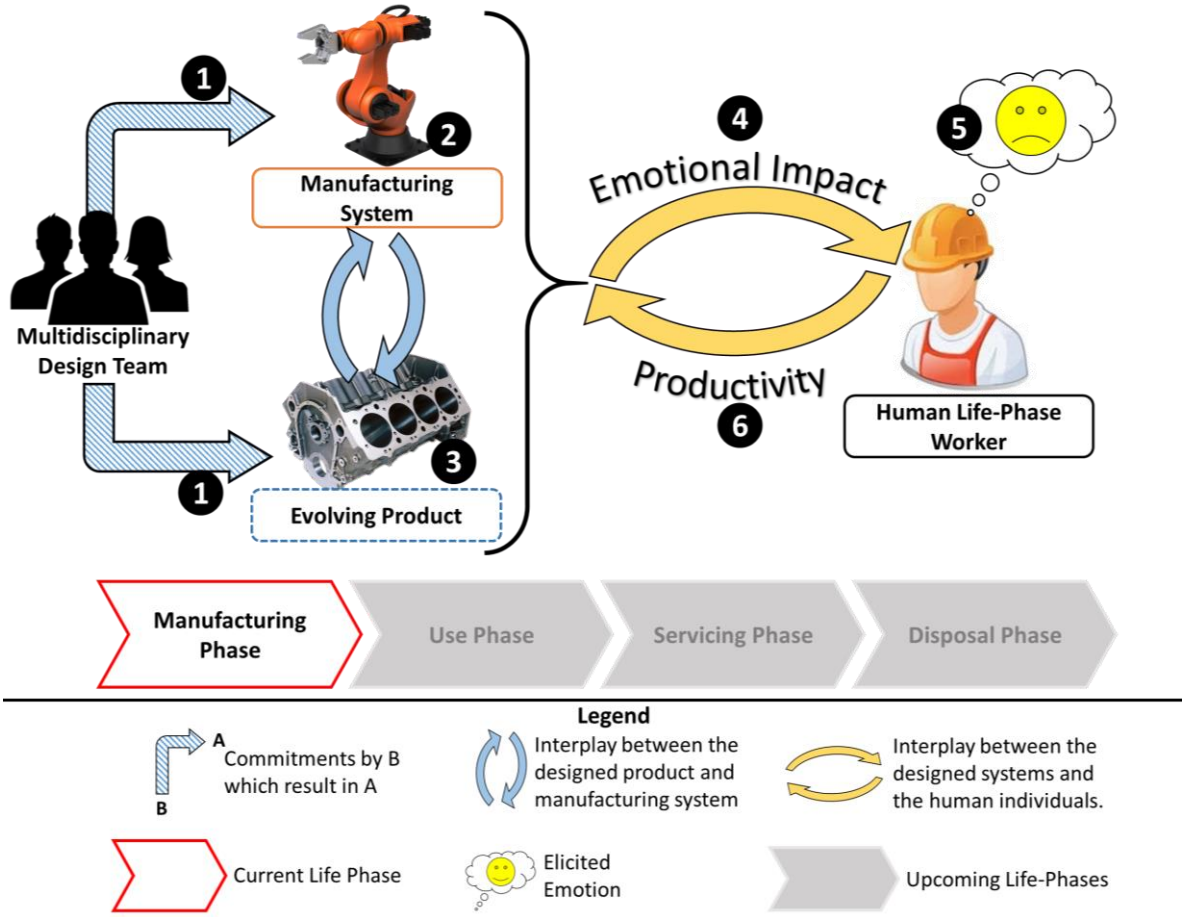

Figure 4: The Interplay between Human Worker and Artificial Systems

A study which saw the participation of 60 workers (L. Farrugia & Borg, 2014) showed that it is indeed the properties of these systems that have an emotional impact (4) on the human worker. In addition, the elicitation of negative emotions (5) has been demonstrated to contribute to a decay in the productivity (6) of the human worker. The decay in the performance of workers due to the elicitation of negative emotions, in turn has a negative impact on business competitiveness metrics such as time to market and product development costs.

The Interplay between Human Customer and Product during the Use Phase

The interplay between elicited emotions and human behavior is also present during the use phase, as shown in Figure 5.

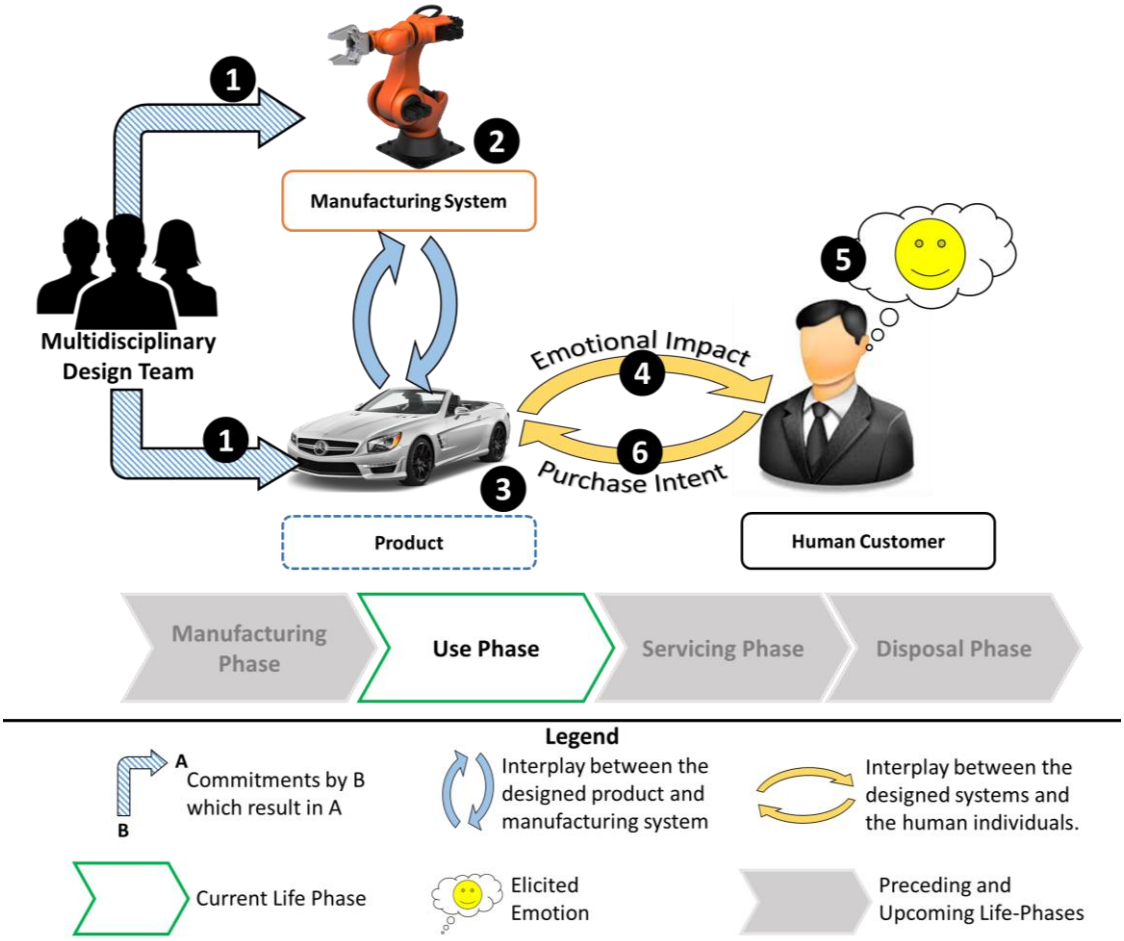

Figure 5 : The Interplay between Human Customer and the Product

Throughout this phase, the customer interacts directly with the end product (3) which is no longer in an evolving state. Although the customer does not interact directly with the manufacturing system (4) the latter still influences certain attributes of the product. The design for emotion support tools presented in the literature review, are intended to provide support to the design team in order to create products which have a desirable emotional impact (4) on the human customer. This is due to the fact that the elicitation of desirable emotions (5) from customers, influences their judgment, purchase intention and re-purchase intention (6), thus contributing to improve business competitiveness.

This section has demonstrated the interplay which exists between the emotional impact of artificial systems and the behavior human individuals. The scope of the next section is to present an approach which is intended to support design teams in exploiting this interplay to improve business competitiveness.

A Design Approach for Eliciting Desirable Emotions from both Human Workers and Customers

As outlined in the preceding section the interplay which exists between artificial systems and human individuals can be exploited for the purpose of improving business competitiveness.

The underlying principle behind this approach is to support design teams in choosing properties pertaining to the product and the manufacturing system, in order to elicit positive emotions from workers as well as customers. This approach is motivated by evidence which shows that the elicitation of desirable emotions from workers as well as customers influences their behavior which in turn contributes to improve business competitiveness in terms of metrics such as development cost, time to market and selling price. The five stage approach being presented is shown in Figure 6.

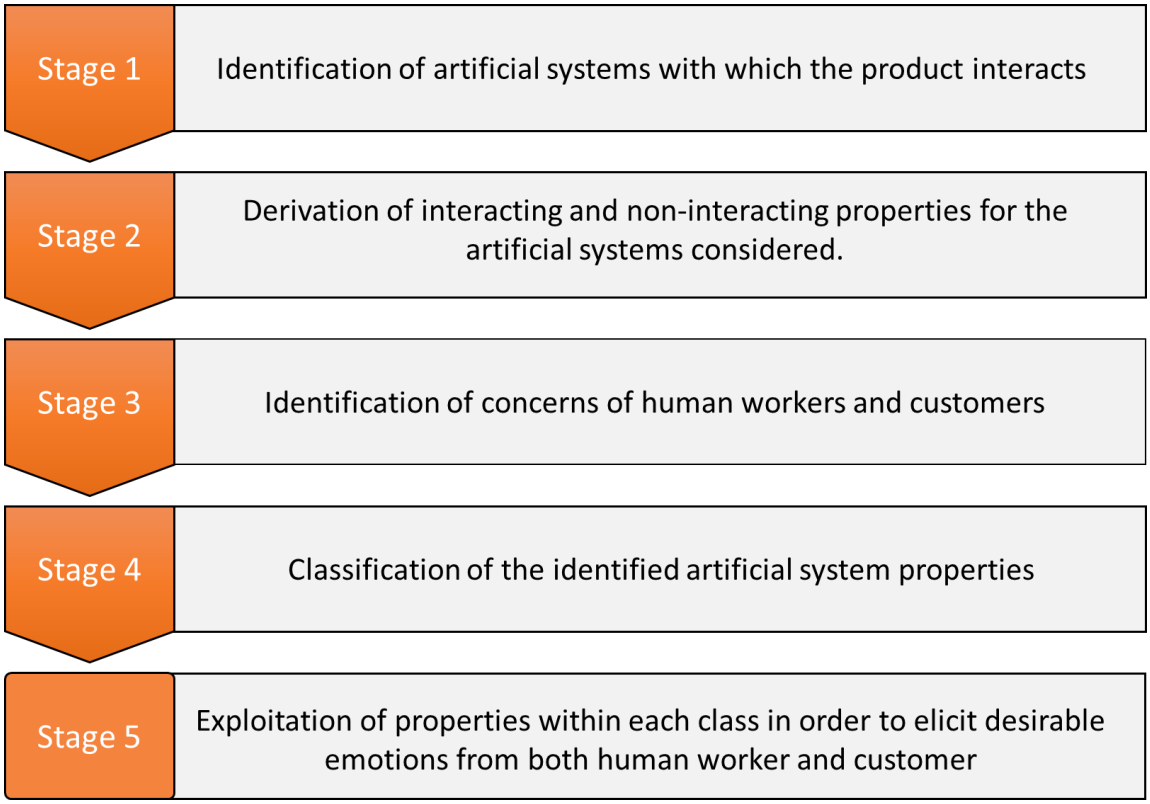

Figure 6: Proposed Approach

Stage 1: Identification of artificial systems with which the evolving artefact interacts

The objective of the first stage in the proposed approach, is to identify the artificial systems with which the evolving artefact interacts. In this paper, the manufacturing system was considered to be a type of artificial system with which the product interacts. Yet, other artificial systems may interact with the product being considered.

Stage 2: Derivation of interacting and non-interacting properties for the artificial systems considered.

During this stage the design team has to identify the properties of the product and the artificial systems identified earlier in stage 1. The diagram in Figure 7 shows two types of artificial systems that are being considered in this paper: the product and the manufacturing system. The diagram shows two sets of properties, set A which contains the properties of the manufacturing system (MS_Pr) and set B which contains the properties of the product

(P_Pr). The identified properties pertaining to each system may be interacting or non-interacting.

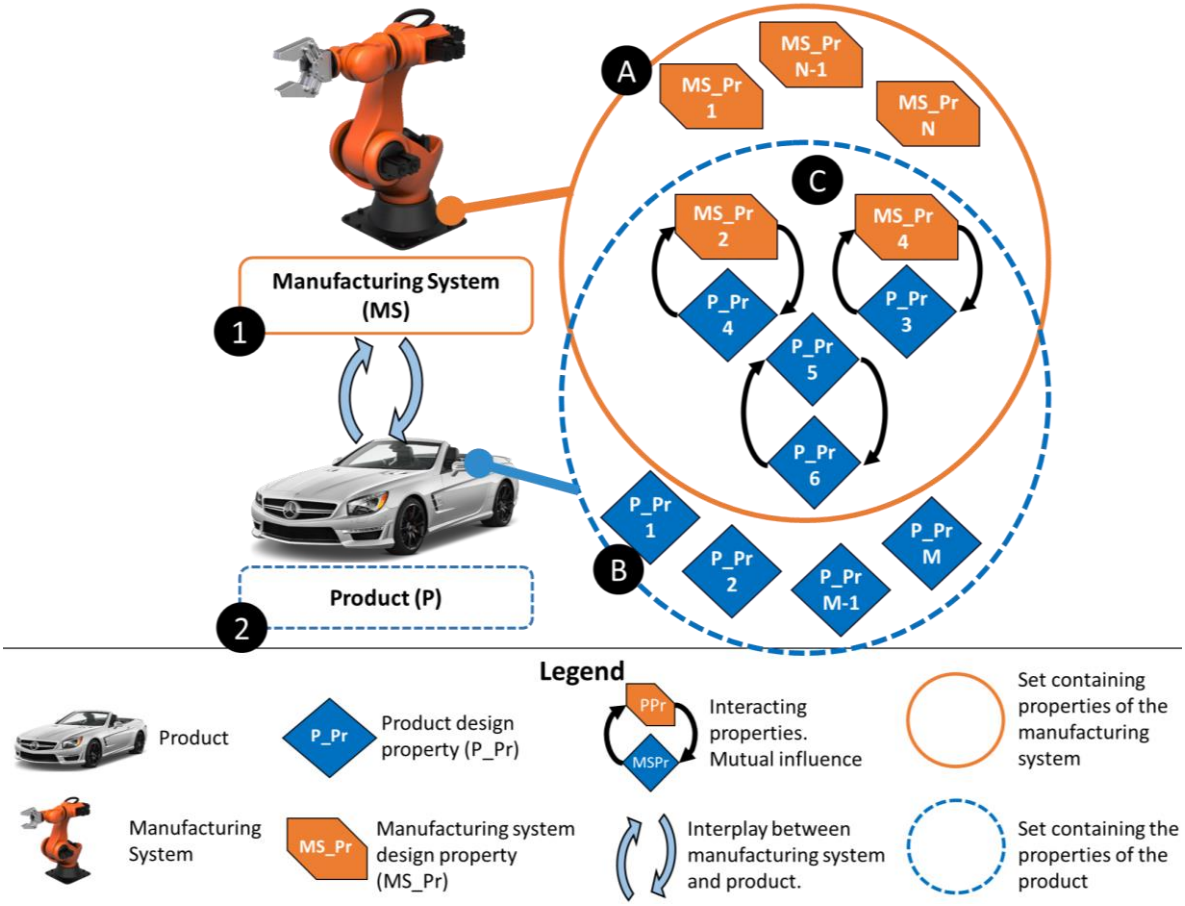

Figure 7: Property sets containing interacting and non-interacting properties

With reference to Figure 7, the interacting properties are contained within set C, which is the intersection of sets A and B (A∩B). Interacting properties are those properties which reflect the interplay between the manufacturing system and the product. For example, the type of manufacturing process and the product form are two properties which influence each other. Both of these properties are therefore in a mutual relationship with each other. It should be noted, that the interacting properties may belong to the same artificial system, as in the case of the product properties *P_Pr5* and *P_Pr6*. For instance the size and ease of assembly of a product are two interacting properties which belong to the product. The properties which are not in the intersect between set A and B (~(A∩B)) are termed as non-interacting properties. These are properties which do not influence and are not influenced by the other identified properties.

Stage 3: Identification of Worker and Customer Concerns

The focus of the approach at this stage is shifted on the human worker and customer. With reference to Figure 8, during this stage of the proposed approach, the design team is required

to conduct a study (1) in order to identify the concerns of the human worker (3) and customer (2).

The concerns of the human individual play a key role in the cognitive appraisal process (R. Lazarus, 2006; Scherer, Klaus et al., 2001) which is responsible for the elicitation of emotions. In fact, concerns are a key element in determining the type and intensity of emotions which are elicited from human individuals. Negative emotions are elicited whenever the human individual perceives a threat to his/her concerns, while positive emotions are elicited whenever the individual perceives a benefit to his/her concerns (R. S. Lazarus & Folkman, 1984).

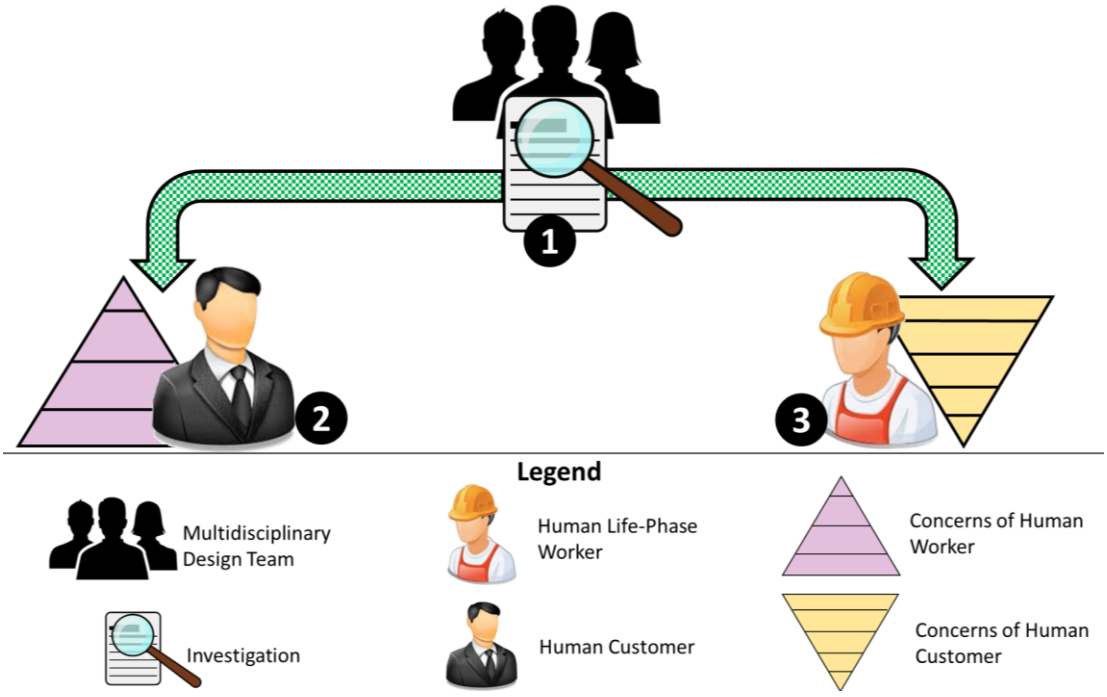

Figure 8: Identification of concerns of human worker and customer

It is to be expected that the concerns of workers and customers are different if not contrasting. This is due to the fact that beliefs, expectations and commitments of customers differ from those of workers. For instance a customer may be concerned about the aesthetic appeal of a product while the human life-phase worker may be more concerned about the ease of assembly during the manufacturing phase. The challenge of the design team is to exploit the properties of artificial systems into order to provide a benefit to the concerns of workers as well as customers.

Stage 4: Classification of the Identified Artificial System Properties

This stage requires for the design team to separate and classify the properties identified in stage two, into four distinct classes as shown in Figure 9.

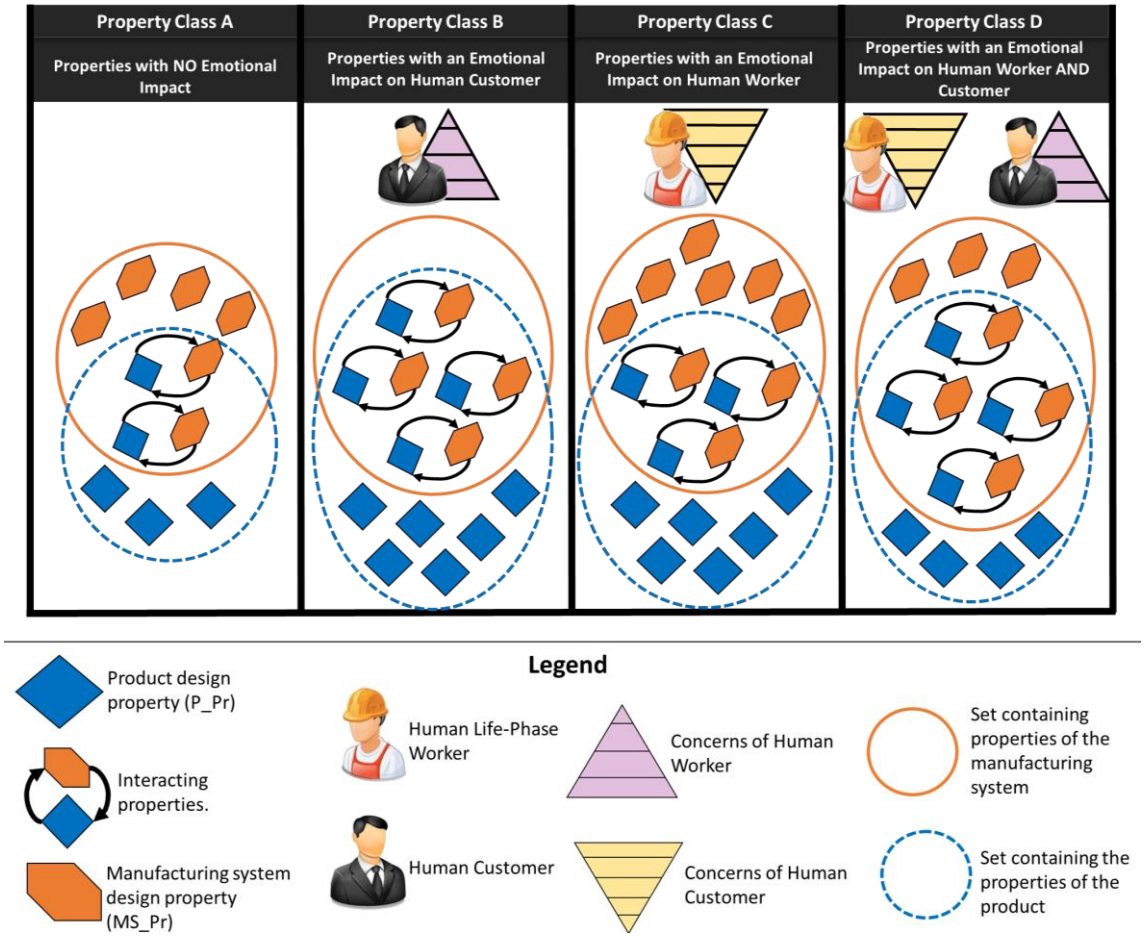

Figure 9: The four classes of properties

The four classes of properties are defined as follows:

Property Class A: This class contains properties which are of no relevance to the identified concerns of workers and customers. In essence the properties within this class do not pose a threat or a benefit to the concerns of workers as well as customers. This means that the properties within this class have no emotional impact on both worker and customer.

Property Class B: This class contains a mixture of interacting and non-interacting properties which are of relevance exclusively to the concerns of the customer. This implies that the selection of a particular property value within this class will result in the elicitation of emotions exclusively from customers. The properties within this class must therefore be exploited in order to maximize the elicitation of desirable emotions from the human customer.

Property Class C: The properties within this class are relevant exclusively to the concerns of the human worker. This means that the properties within this class will only have a emotional impact on the human worker.

Property Class D: The properties within this class are relevant to the concerns of both worker and customer. When exploiting properties within this class the design team has to be careful that the elicitation desirable emotions from customers does not result in the elicitation of unintended negative emotions from workers.

Stage 5: Exploitation of Properties to Benefit the Concerns of Human Individuals

During this last stage of the proposed approach, the design team is required to exploit the properties within each class by choosing an adequate property value (S Hosnedl, Vanek, & Stadler, 2004; Stanislav Hosnedl, Srp, & Dvorak, 2013; Hubka & Eder, 1996) or a range of property values. The property value(s) should be chosen so that these present a benefit to the concerns of the individual being considered, thus resulting in the elicitation of desirable emotions.

The outcome from this approach should be selection of property values which result in the elicitation of positive emotions from human workers as well as customers.

Conclusion

The research work presented in this paper contributed with the proposal of an approach which is intended at improving business competitiveness by eliciting desirable emotions from human individuals. The research question: *How can design teams exploit the interplay between human emotions and product design in order to improve business competitiveness?*, was addressed through the proposal of a 5 stage approach which was presented in section 4.

This objective of this approach is to guide design teams in selecting properties pertaining to the product and other artificial systems, which result in the elicitation of desirable emotions from human workers as well as customers. This is achieved by identifying properties and exploiting their values in order present a benefit to the concerns of the life-phase worker and/or customer.

The contribution of this approach is that it provides design for emotion support that unlike existing tools, *supports the elicitation of desirable emotions across multiple phases in the life-cycle of the product*. To this end this approach also contributes to further improve business competitiveness due to the interplay which has been demonstrated to exist between the elicitation of desirable emotions and the behavior of individuals. The research presented in this paper also provided evidence to show why research into product design and emotions should consider the emotional impact of design decisions on human life-phase workers. In particular this paper presents evidence which shows that like customers, the emotions elicited from workers also influences their performance during the execution of work related tasks.

The approach proposed in this paper contributes to improve the success of a business by considering the emotions elicited as a consequence of human-product interactions which occur across multiple phases in the life-cycle of the product. The approach presented in this paper sets the foundation for the development of a design support tool which is intended to:

i. Elicit desirable emotions from both workers and customers, thus also contribute to improve their psychological well-being.
ii. Improve the competitiveness of a business by exploiting the interplay between elicited emotions and human behavior, across multiple phases in the life-cycle of the product.

The short term goal of this research will be to identify the tools and methods which may be employed at each stage of the proposed approach. At this point the approach can be subjected to a validation process. The validated approach will subsequently be implemented into a computer aided design support tool.

References

Agost, M.-J. J., & Vergara, M. (2014). Relationship between meanings, emotions, product preferences and personal values. Application to ceramic tile floorings. *Applied Ergonomics*, *45*(4), 1076–1086. doi:10.1016/j.apergo.2014.01.008

Aparicio, J. M. (2004). CERG / SMIC Concurrent Engineering Information Center Definitions of Concurrent Engineering, 29–30.

Bashir, U. (2010). Impact of Stress on Employees Job Performance A Study on Banking Sector of Pakistan. *International Journal of Marketing Studies*, *2*(1), 122–126.

Beuzekom, M. Van, & Caicedo, D. G. (2006). *"How do you feel ?" An assessment of existing tools for the measurement of emotions and their applications in consumer product research*.

Bitner, M. J. (1992). Servicescapes : The Impact of Physical Surroundings on Customers and Employees. *Journal of Marketing*, *56*(2), 57–71.

Boothroyd, G., Dewhurst, P., & Knight, W. A. (2010). *Product Design for Manufacture and Assembly* (3rd ed.). CRC Press.

Borg, J. C. (1999). *Design Synthesis For Multi-X - A "Life-Cycle Consequence Knowledge" Approach*. University of Strathclyde.

Borg, J. C., & Farrugia, L. (2014). Life-Cycle Interactions for Modelling Human Emotions. In *Design and Emotion Conference, D&E 2014*.

Chandhok, A., & Monga, M. (2013). Impact of Job Stress on Employees's Performance of Sales Department : A Comparative Study of LIC and BAJAJ Allianz Life Insurance Company Ltd. *International Jounral of Management Research and Business Strategy*, *2*(1), 62–70.

Dacher, K., & Paul, E. (2010). Facial Expression of Emotion. In *Handbook of Emotions*.

Dar, L., Akmal, A., Naseem, M. A., Ud, K., & Khan, D. (2011). Impact of Stress on Employees Job. *Global Journal of Management and Business Research*, *11*(6), 0–4.

Desmet, P. (2005). Measuring emotion: Development and application of an instrument to measure emotional responses to products. In *Funology* (pp. 111–123). doi:10.1007/1-4020-2967-5

Desmet, P. (2012). Faces of Product Pleasure : 25 Positive Emotions in Human-Product Interactions. *International Journal of Design*, *6*(2), 1–29.

Farrugia, L., & Borg, J. C. (2014). Towards Handling Worker Emotions for Improved Product Development. In *10th International IDE Workshop* (pp. 49–59). Gommern, Germany.

Farrugia, L., & Borg, J. C. (2015). Why Product Design Support for Improved Worker Contendedness. In *20th International Conference on Engineering Design - ICED 15*. Milano, Italy.

Farrugia, P. J., Borg, J. C., Grima, C., & Fenech, O. C. (2008). " Form Design For Emotion " with a Cameraphone Based Tool. In *Desgin and Emotion Conference - D&E'08, Hong Kong*.

Fenech, O. C., & Borg, J. C. (2006). Towards A Sensory Approach for Designing Pleasurable User-Product Experiences. In *6th NordDesign 2006 Conference, Reykjavik, Iceland* (pp. 223–233).

Fenko, A., Schifferstein, H. N. J., & Hekkert, P. (2011). Noisy Products : Does Appearance Matter ? *International Journal of Design*, *5*(3), 77–87.

Hosnedl, S., Srp, Z., & Dvorak, J. (2013). Technical Product and Their Attributes - Theory and Practical Applications. In *Internation Conference of Engineering Design - ICED13* (pp. 1–10).

Hosnedl, S., Vanek, V., & Stadler, C. (2004). PROPERTIES AND QUALITY OF TECHNICAL SYSTEMS 3 . Strategies for the consideration of TS properties, 1–6.

Hubka, V., & Eder, W. E. (1996). *Design Science*. Springer-Verlag.

Lazarus, R. (2006). *Stress and emotion: A new synthesis*. University of Pittsburgh.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. *Vasa*. New York, USA: Springer Publishing Compan.

Ludden, G. D. S., & Schifferstein, H. N. J. (2009). Should Mary Smell Like Biscuit ? Investigating Scents in Product Design. *International Journal of Design*, *3*(3), 1–12.

Magrab, E. B. (1997). *Integrated Product and Process Design and Development*. CRC Press.

Nevins, J. L., Whitney, D. E., & Fazio, T. L. De. (1989). *Concurrent design of products and processes: a strategy for the next generation in manufacturing*. McGraw-Hill.

Qureshi, M. I., Iftikhar, M., & Abbas, S. G. (2013). Relationship Between Job Stress , Workload , Environment and Employees Turnover Intentions : What We Know , What Should We Know. *World Applied Sciences Journal*, *23*(6), 764–770.

Rahman, O. (2012). The Influence of Visual and Tactile Inputs on Denim Jeans Evaluation. *International Journal of Design*, *6*(1), 11–25.

Saucken, C. Von, Schröer, B., Kain, A., & Lindemann, U. (2012). Customer Experience Interaction Model. In *International Design Conference - DESIGN 2012* (pp. 1387–1396). Dubrovnik, Croatia.

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, *44*(4), 695–729. doi:10.1177/0539018405058216

Scherer, Klaus, R., Schorr, A., & Johnstone, T. (2001). *Appraisal Processes in Emotions*.

Ulrich, K. T., & Eppinger, S. D. (2003). Product Design and Development. In *Product Design and Development* (3rd ed., pp. 2–4,9, 12–15). McGraw Hill.

Winner, R. I. (1988). *The Role of Concurrent Engineering in Weapons Systems Acquisition*.

Yang, J., & Diefendorff, J. (2009). The relations of daily counterproductive workplace behavior with emotions, situational antecedents, and personality moderators: A diary study in Hong Kong. *Personnel Psychology*, *62*(2), 259–295. doi:10.1111/j.1744-6570.2009.01138.x

Yoon, J., Pohlmeyer, a E., & Desmet, P. (2014). Nuances of Emotions in Product Development : Seven Key Opportunities Identified By Design Professionals. In *Proceedings of the 13th International Design Conference DESIGN 2014* (pp. 643–652).

Zelenski, J. M., Murphy, S. a., & Jenkins, D. a. (2008). The Happy-Productive Worker Thesis Revisited. *Journal of Happiness Studies*, *9*(4), 521–537. doi:10.1007/s10902-008-9087-4