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DESIGN RESEARCH IN THE DIGITAL ERA

Opportunities and implications
Notes on Doctoral Research in Design 2020



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Digital Transformation

Creativity 4.0. A method to explore the influences of the digital transition on human creativity within the design process

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Abstract

A new digitally enhanced humanity is growing up totally immersed in a digital world, accepting digital enhancement as an opportunity and an integral part of their existence. Developing creative skills thus becomes a mission to adopt and guide the future technological development. The research aims at providing a method to deeply understand the main positive and negative influences the current scenario of digital transition is bringing to the cognitive, emotional, motivational and social factors of creativity involved in the design process for innovation.

The research contributes to structure a scientific approach to systematize the knowledge produced in the rapidly evolving emerging realm named “Digital Creativity” where multiple disciplines investigate the relationship between the factors of creativity and digital technology from several and fragmented perspectives. This resulted in the definition of a Creativity 4.0 Model and Framework that supports the development of digitally enhanced human-centred design methods and tools for creativity enhancement.

Co-evolution between human and digital technology

In the 21st century we are witnessing massive economic and technological changes, with the introduction of completely new devices, sensors, robots, and applications that are totally affecting the ways in which people live and work, and also how society is viewed and organized (Sahin, 2009).

The emerging digital technologies have the potential to revolutionize all sectors of our society (i.e., healthcare, transportation, manufacturing, enter-

tainment, and even art), playing a key role in the creation of new business models and transforming the industrial economy and the associated job market (National Research Council, 2008).

Ubiquitous, invisible and affective computing, artificial intelligence, machine learning, big data analytics, robotics, virtual/augmented reality and all the emerging technologies, are changing skills requirements and capacity building for 21st-century digital economy. This specific phase of technological progress seems to be very different from all the preceding ones: it involves a combination of transformative and cognitive digital technologies, tools and processes and most importantly people, in terms of culture, skills and mindset. Therefore, the interconnection between technology, human cognition and human life in general will become much more intrinsic, invisible, and impactful.

This digital transition is profoundly changing the human condition, especially for the digital native (Prensky, 2009) generation that is growing up with information and communication technology (ICT) as an integral part of everyday lives.

As we move further into the 21st century, the generational gap is narrowing, and the concept of digital natives is evolving since we all are growing up and adapting, each at our own speed, to this era of digital technology. A new distinction can be made in terms of digital wisdom, “the ability to find practical, creative, contextually appropriate, and emotionally satisfying solutions to complicated human problems through the support of computer enhancement” (Prensky, 2009, p. 2).

We can define these new individuals as **digitally enhanced people**¹.

Digital enhancement is already available for just about everything we do, and digital tools already extend and enhance our cognitive capabilities in a number of ways.²

The human being is indeed co-evolving with digital technology (Corazza, 2017) as it modifies our “relationships to ourselves (who we are), the interaction with others (how we socialize), our conception and interaction to the real world” (Floridi, 2015, p. 7). Neuroscientists are beginning to see significant changes, which correlate with the diffusion of digital technologies and their

¹ “he or she accepts digital enhancement as an integral fact of human existence, and he or she is digitally wise, both in the considered way he or she accesses the power of digital enhancements to complement innate abilities and in the way in which he or she uses enhancements to facilitate wiser decision making” (Prensky, 2009, p. 4).

² For example, electronic storage enhances memory. Digital data-gathering and decision-making tools enhance judgment by allowing us to gather more data than we could on our own, helping us perform more complex analyses than we could unaided.

widespread use (Loh and Kanai, 2016). Some researchers are questioning the impact of ICTs on human cognition, especially in terms of brain modification and changes in cognitive processes. Others are studying the social behavioural changes and the shift in mindset that led to the creation of new social phenomenon, initiatives and communities (e.g., open source, peer-to-peer, etc.) emerging with the aim of contributing to a more community-oriented society (Florida, 2014).

In this digital transition, **creativity** has been recognized as one of the most distinctive human skills to nurture and develop in order to manage at best the powerful collaboration between human and machine. Indeed, creativity helps people conceive novel and useful ideas (Amabile, 1988), and get the benefit of the opportunities offered by digital technologies in any field. It also represents the intangible substrate for innovation (Kozbelt *et al.*, 2010) and is, therefore, a key to economic growth and social transformation (Florida, 2014).

Human existence will be related one-to-one with our ability to generate ideas to successfully exploit the opportunities that technology is offering us. Hence the responsibility of studying, understanding and developing creativity skills, and defining how digital technology and human evolution influence those abilities and how to exploit the new opportunities to digitally enhance them, becomes a sort of multidisciplinary mission.

Focus of the research

Starting from the observation of this scenario, research questions have been formulated from general aspects to specific ones, highlighting rationale:

- How to empower the human creativity of the digitally enhanced people to generate new and original ideas?
- How to enhance human creativity exploiting the potential and opportunities provided by the digital transition?
- And more specifically:
- What are the factors underlying human creativity?
- What are the changes of the current scenario of transition that could have positive and negative influences on human creativity?
- How is the creative design process influenced?

Given the complexity and the multitude of approaches that can be adopted to study creativity, it is essential to frame a clear definition and above all to choose which aspects to investigate.

Drawing on the 7 C's creativity framework (Lubart, 2017), the research aims at investigating creativity by studying the integration and interconnection of three of its different facets (fig. 1), which are:

- **creator**, referring to the digitally enhanced, the research adopts an individual perspective, considering the cognitive, personality, motivational and emotional characteristics of the actors that engage in creative activities;
- **creating**, referring to *Stage and Componential Process* theories (Kozbelt, Beghetto and Runco, 2010) that study the creative process from the macro perspective as a form of activity or action (Dewey, 1934);
- **context**, referring to the actual scenario of digital transition that influences several aspects of the human being.

The general aim is, therefore, to study how the aspects of the context of digital transition positively and negatively influence the creator and the creative process, which is a first attempt of this kind and contributes to the originality of the present investigation.

Therefore, I adopted a more extended and elaborated definition of creativity offered by Plucker, Beghetto and Dow (2004), which claim: "Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (p. 90, orig. emphasis).

The research aims at structuring a scientific approach to draw on the knowledge produced in the emerging domain named "Digital Creativity"³, which is a wide and rapidly evolving realm that is being constantly redefined, where multiple disciplines – psychology, sociology, computer science, HCI, etc... – already investigate the influence of and relationship between creativity and digital technology from several and fragmented perspectives.

This exploration results in a method designed to deeply understand the main positive and negative influences that the current scenario of digital transition is bringing to multiple levels of human creativity to inform and empower the creative design process for innovation.

³ "As digital innovation has permeated our daily lives, creativity has started to take a new shape: **digital creativity**" (Lee and Chen, 2015). A first analysis of the state of the art brought me to discover this recent emerging domain of study which collect different Lee (2015) provided one of the first definition of digital creativity as "all forms of creativity driven by digital technologies". In other words, digital creativity occurs when any kind of digital devices or digital technologies are used for various creative activities.

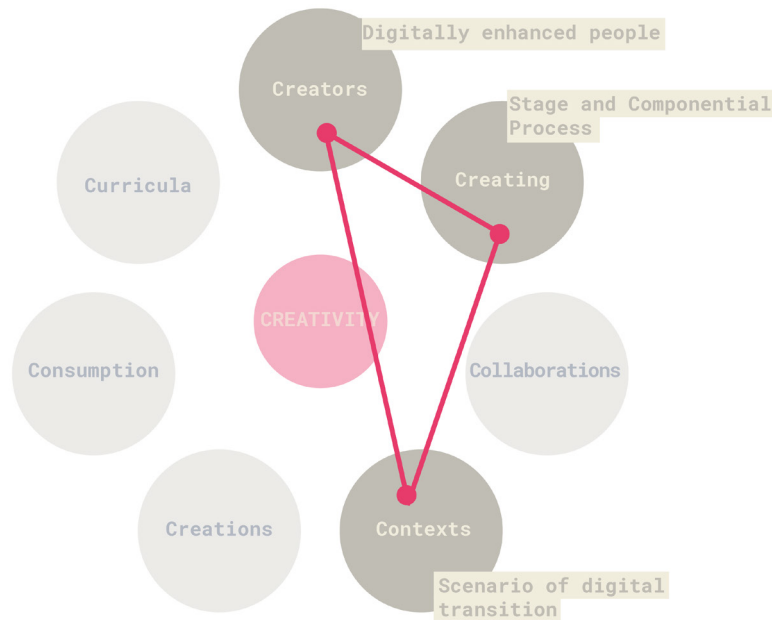


Fig 1 – The diagram shows the intersection of the three aspects of the 7 C's creativity framework on which the research is settled, thus drawing on their related theories and sources.

What is needed to be creative? Components and factors of creativity

Two major beliefs underly this research: the first one is that everyone can be creative, all persons of normal intelligence possess some ability to think creatively and to engage themselves in imaginative and innovative efforts (Roth, 1973). The second one is that creativity can be trained and learnt and that it relies on personal attitudes, cognitive skills, motivations and environmental factors. Psychology literature reports a category of theories called componential approaches (Amabile, 1983; Sternberg and Lubart, 1995; Bottella *et al.*, 2013) that explains creativity taking into account the interaction between the individual inner level and the surrounding social and cultural environment. They focus on the ingredients, in terms of attributes, abilities, and circumstances, necessary for creativity to emerge.

One of the leading theories is the Componential Model of Creativity (Amabile, 1983; Amabile and Pratt, 2016) that identifies the major components necessary for individual or small group creativity in any particular do-

main, considering also how each component might enter into the creative process. According to the model, creativity is influenced by three main individual components (i.e., constituents or building blocks necessary for an individual to produce a creative outcome) each one including different factors (i.e. various elements that define the component and allow to put it into practice). These are: *knowledge&skills* that include factors such as domain knowledge, technical skills, special talents; *creativity-relevant processes*, including factors related to both personal attitudes and cognitive processes; *motivation* that includes the inner motivation and the external factors that influence it. The fourth component of the model is the surrounding *environment*, which can extremely influence the individual components and includes social and material factors, such as access to knowledge resources, space set up, technical and social support from others.

The Amabile model has been taken as a scientific reference for this research since it supports a holistic view of creativity merging both the individualistic and the socio-cultural perspectives (Sawyer, 2012) and factors, which are crucial to explain and study creativity in this era. Amabile (1983) also argued that “Although it is proposed that the three main components constitute a complete set of the general factors necessary for creativity, the listing of elements within each component can only be completed gradually, as progress is made in creativity research” (p. 362). Therefore, each component has been integrated with the factors identified by reviewing the main waves of creativity studies (Sawyer, 2012) adopted by psychologists to study creativity scientifically – only if explicitly demonstrate its relationship with the component. This allowed to add a fifth component, which is *emotion*, and to collect a wider and more precise overview of factors. Fig. 2 shows the overall components and factors that could influence human creative potential.

In recent decades, with the advent of ICTs, people and society have started a process of transformation, changing their behavior and becoming increasingly interconnected. Fischer, Rohde and Wulf (2007) defined the term social creativity as working together to solve a problem with the help of computer media and technologies. Digital technologies are indeed bringing new opportunities to empower the creative potential. Therefore, the need emerges to define a new model of creativity that could explain the multiple shades of creativity in this era and which could include the interaction between the three main aspects defined in the previous section (e.g., creator, creating and context).

This new model should also allow to effectively understand how the digital transition is positively or negatively influencing or transforming the ingredients that contribute to make a person more creative and their effect on the creative process.

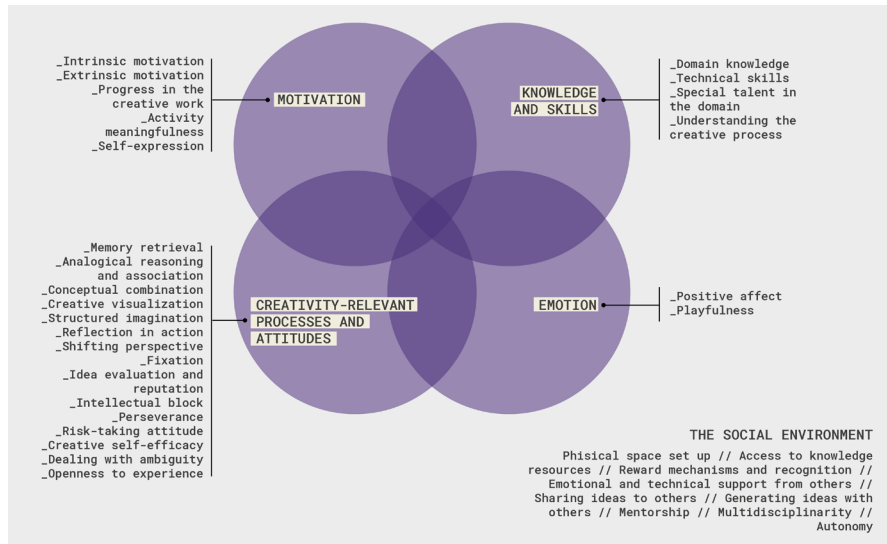


Fig 2 – Integrated componential theory of creativity.

The Creativity 4.0 model. Representing creativity in the digital age

An in-depth study of the literature reveals that the digital transition is radically impacting the human being in profound ways. A Human-centred approach has been adopted as a basic principle of the research placing the human being at the centre of the analysis and understanding how the changes wrought by the digital transition can somehow influence the human creative potential.

The human-being has, therefore, been broken into the three levels that belong to each individual (Huitt, 2012) and that influence the way in which a creative activity is performed, precisely:

- the **cognitive level** that includes mental functions that deal with logic and the way in which we process information;
- the **individual level** that includes the physical and the emotional dimensions of the human-being involved in his ability to carry out actions;
- the **social level intended** as the dimension of the human being involved in communicating and collaborating with other individuals in creating an outcome.

The analysis of the current scenario of transition enabled to build a model to understand the multiple dimensions and the crucial factors that affect creativity in this era.

The Creativity 4.0 Model (fig. 3) is structured through three main elements: the *digital transition*, that is the ground on which the model is growing and feeding; the *human being* analysed according to the three levels on which the digital transition has an impact (cognitive, individual, social) and, finally, the *creative process*, namely human ability, which is transversal to all levels of the human-being.

These three elements also correspond to the three aspects of the 7 C's creativity framework on which the research is settled – context, creators and creating.

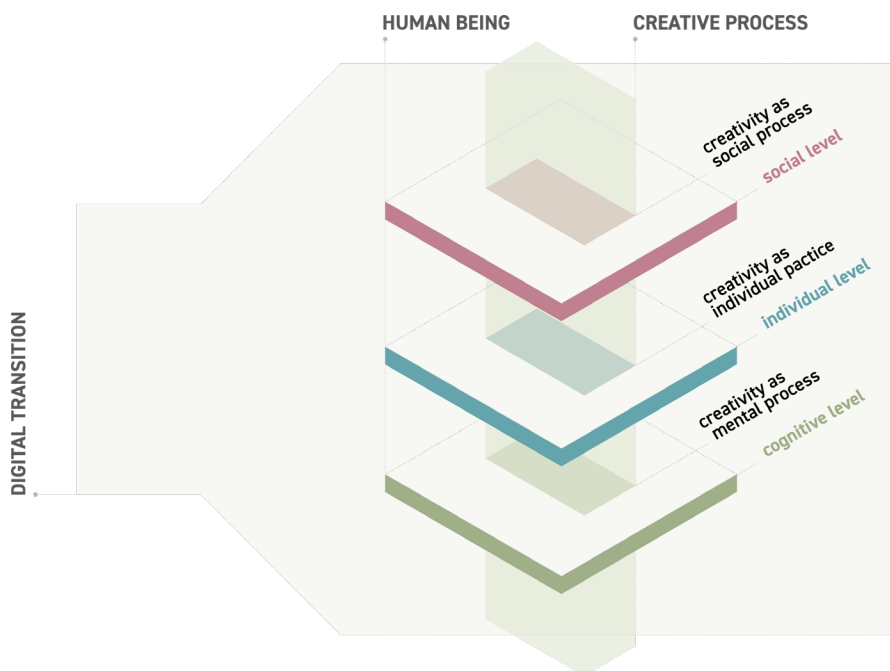


Fig. 3 – Creativity 4.0 model.

The Creativity 4.0 model built enables to include the many dimensions and factors of creativity identified that intervene within the human-being on the three different levels, which include:

- **creativity as a mental process** from problem definition to evaluation and implementation, supported by specific cognitive processes (Finke *et al.*, 1995, Ward, 2001);
- **creativity as an individual practice** requiring activity, things and tools, states of emotion and motivational knowledge as well as creative attitude (Amabile, 2012; Sanders, 2008);

- **creativity as a social process** that unfolds with others (Csikszentmihalyi, 1996; Fischer, 2004; Literat and Glăveanu, 2016).

The intersection of those three levels provides a comprehensive understanding of the complexity and multifarious aspects of the creative process comprising several steps, activities as well as the motivational, cognitive, attitudinal, technical constituents and the social and environmental components influencing these constituents during the process. The three levels also influence each other as they are part of the same person.

The Creativity 4.0 model is not static, but it represents a tool that allows to observe the impacts of the digital transition on the three levels of the human-being understanding how they influence the creativity factors. This paragraph presented the overview of the main elements composing the model in order to help readers go through it easily and gain a better understanding of the overall structure. The following section focuses on explaining how the model can support the analysis of the factors of creativity identified.

Factor analysis. Objectives and methodologies

The model guided three main investigations and several steps of iteration and refinement on how the digital transition is impacting on the cognitive process unfolding during a creative activity, the competences, motivation and tools needed, besides the interaction with other stakeholders for the enhancement of its creative potential.

In the first investigation, based on an extensive literature review in the digital creativity domain, the factors were related to the positive and negative impact the digital transition has brought on the human-being on each level, to understand how they can be influenced. The second investigation, based on case studies analysis, aimed at identifying researches that explored the potential of specific digital technologies in the enhancement and stimulation of certain factors, verifying their influence on the creative process. The third investigation, based on expert interviews, focused on confirming the crucial factors highlighted from the previous investigations and on understanding where and how the digital transition is shaping human capacity to generate original and effective ideas. The analysis results in the definition of a set of positive and negative influences brought by the digital transition to the factors of creativity and in the identification of trends in the use of digital technology adopted to support the creative potential within the creative process.

Example

Observing the impact on the cognitive level. Managing the abundance of information. The Internet and Web browsing technologies have made a huge amount of information easily accessible. The extensive digital stimulation on developing minds has taught a digitally enhanced generation to respond faster, encoding information differently (Small and Vorgan, 2008). Altering our neural networks and synaptic connections through activities, such as emails, video games, search engines, or other technological experiences sharpens some cognitive abilities. Therefore, in the digital era it has become increasingly important to develop the ability to manage the abundance of information and learn where to find the most useful and reliable knowledge.

Understanding the influences on the factors of creativity. Neuroscience studies report that the increased presence of hypertext environment reduces the cognitive resources required for deep processing, and the ease of online information retrieval reduces the need for deep processing to commit information to memory. This combination can augment the cognitive overload of information that exponentially decreases the human decision-making ability. The resulting information overload blows up the divergent phase of the creative process, weakening the *conceptual combination* process in the convergent phase, thus creating **difficulties in combining and integrating the information** when attempting to form new ideas (Huber, 1990) **as well as in isolating the problem.** Creativity does not require a big amount of information to generate breakthrough ideas (Corazza and Agnoli, 2015). Too much information can lead to the availability of too many ideas and perspectives to effectively screen, process and integrate, increasing the **inability to select the most interesting and appropriate information.**

Tab. 1 shows the impacts observed, the factors involved and the relative influences.

Tab. 1 – Relationship between the impact observed and relevant influenced factors.

IMPACT	FACTORS INVOLVED	NEGATIVE INFLUENCE
Managing the abundance of information	Intellectual block	Inability to select the most interesting and appropriate information
	Conceptual combination	Difficulties in integrating the information when forming new ideas

Creativity 4.0 Framework. Mapping the impacts on the design process.

For design research and practice, this analysis becomes strategic if it is structured within a theoretical framework that associates the impact identified and the influenced factors with the design process. The framework thus becomes a tool to analyze the influence of the digital transition on the multiple aspects of the design process as well as to define design actions and tools to empower it. On the one hand, the framework integrates the factors of creativity which are mostly shaped by the digital transition and that consequently influence the components responsible for generating new and innovative ideas throughout a design process. On the other hand, it can be considered an analytical framework that maps the state of the art of the positive and negative influences of the digital transition, also identifying how digital technologies can facilitate the creative design process.

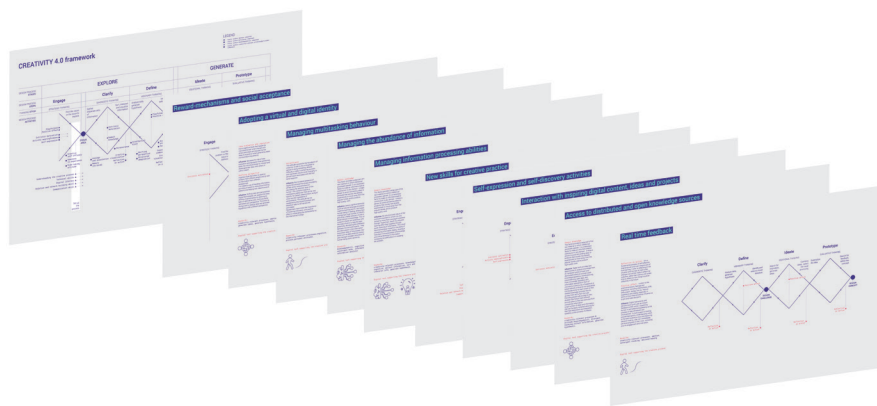


Fig 4 – Overview of the framework layers corresponding to the impacts identified.

A total of 13 impacts (fig. 4) and their positive and negative influences on some factors of creativity have been mapped on the creative design process, highlighting opportunities and threats brought by the digital transition.

The Creativity 4.0 framework has indeed been developed to properly understand how the digital transition is influencing the cognitive, emotional and social factors of the digitally enhanced generation that intervene in the production of new, original and useful ideas.

The framework strength lies in having systematized the knowledge on creativity from different disciplines, e.g., design, psychology, sociology and computer science, providing an overview of the main creativity factors on

CREATIVITY 4.0 framework

LEGEND
 ■ Factor with activation component
 ■ Factor with deactivation component
 ◆ Factor with creativity-relevant process/activities
 ◆ Element

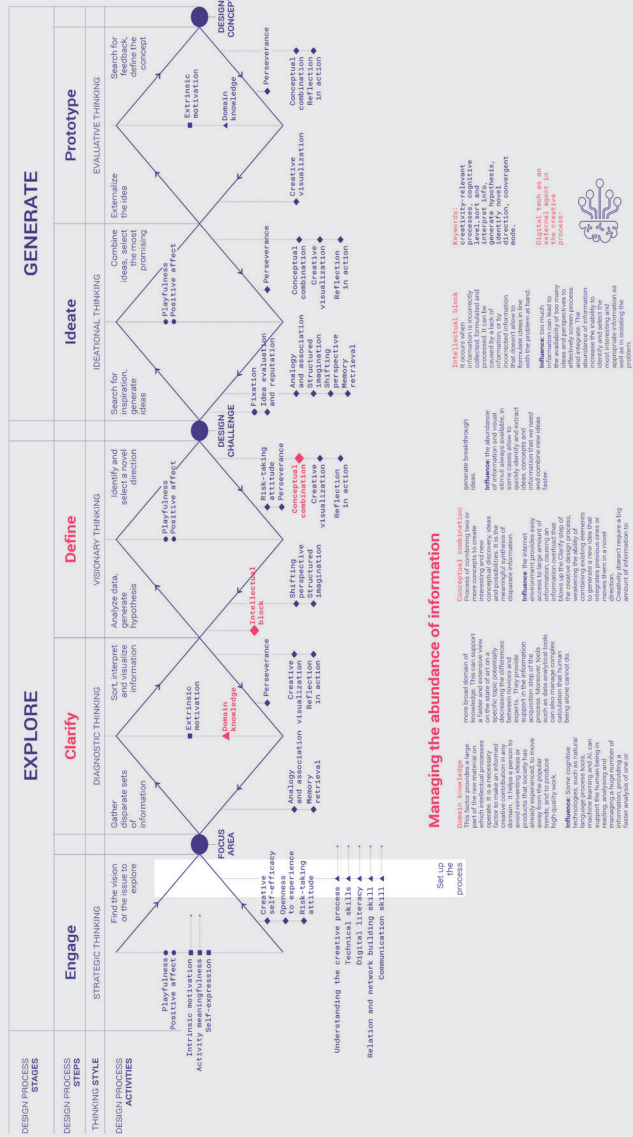


Fig. 5 – Mapping the impacts on the creative design process structure.

which the digital transition has an influence. That is not all of it. The framework informs how the numerous factors intervene in the creative design process, also highlighting how the changes brought by the digital transition can influence them. Fig. 5 shows the impact previously mentioned mapped on the framework highlighting the step of the process influenced, highlighting relations in order to define actions to enhance it.

Conclusions

The results of this research are crucial for the development of a Human-Centred method aimed at generating innovation by exploiting the emerging digital technologies. The method allows to study the human changes brought by this scenario of transition, in order to augment creativity both by empowering the factors on a specific step of the process and by transferring a design process to learn a strategic approach to technological development.

The method, through the application of the Model and the Framework, aims to facilitate and support the emotional, motivational, cognitive and social components of the human-being at the basement of the creative design process. These components are the levers to be activated and enhanced through technology. They allow the human being to express his maximum creative potential. Moreover, one of the aims of this research is also to contribute in updating and implementing the design vision about creativity in order to better understand and adopt digital technology to train and increase the development of the human creative potential.

The research and the framework allow to organize the fragmented data collected within the literature from different fields and disciplines and give them a new interpretation and a new meaning, providing members of different research disciplines with a common language and a frame of reference to define the boundaries of a complex phenomenon, such as creativity in the digital age.

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