Creative Mind: Hyperconnected or Disconnected ?

On digital motor of creativity.

[1]Christophe Krzeminski (Eng., Ph.D), Researcher , Department of Physics

IEMN-UMR CNRS 8520, Institute of electronics of microelectronics and nanotechnology, Villeneuve d'Ascq, France.

Abstract: Creativity is the subject of many views. In liberal viewpoint, creativity is considered as the core of the ``economical competitivity'', being a key driver in terms of change rate and economical growth. On the other side, the intellectual vision often seen creativity as a reflection, a mirror of our civilisation. It seems hazardous to consider a single creative method ? An interesting highlight is the comparison between the outcomes of two different creativity processes, the introspective one and the collaborative approach. Striking differences in terms of timescale, relationship, emotion and final products can be identified unfortunately at the end of the creative process. A particular care should be taken to prevent imitation or conformity effects resulting from the misuse of modern technologies. The human nature of reflexion process based on agregating informations, coordinating imagination, associating ideas, has been disrupted by the introduction of hyperconnected digital space. Creativity is probably more fragile, more human and cultural related that it was previously thought. Environmental factors play a major role in the way, creativity is organized.

Index Terms - Creativity, Introspective mechanism, Psychomechanic and creativity ,Cooperative approach, Interactive method, Imitation effects, Perceived creativity, Outcomes, Organisational feature, Transactional process and research ecosystem.

INTRODUCTION

Worldwide intense economic competition has trigger the development of innovation and new method such as design thinking in order to create and renew objects and services [1]. However, an interesting question sometimes put in the place [2]: while with an increasing budget spend to increase the speed of innovation [3], the perceived creativity seems to slowdown [1] or even worse regress. A open question could also be : why some culture are or were more inventive than the others [4]? Many hypothesis have been proposed in order to explain this paradigm : the difficulty to satisfy the need of high-skills profile, the knowledge trap [5] or the increasing division of labor. Among these various hypothesis, this article suggests a another one: the impact of the digital space and modern technology on individual or small team creativity. The hypothesis developed here is that a a natural creative attitude could be inhibited by the use of modern digital technologies that maximizes the interaction space like spontaneity, connectivity but also imitation and conformism effects. A another idea proposed is that the shift from natural to digital environment tends to modify the way how original ideas emerge. This article also simply remembers and synthetize the key role of environmental factors in creativity such as human or architectural constraints [6].

CONTEXTUAL CREATIVITY

Having a look of the literature reveals that the notion of creativity is quiet complex. Creativity is often see as the ability to create and a mirror, reflect of our civilisation [7]. Creative works often triggers a large diverse and spontaneous human reactions like fascination [8] or rejection and negative feedback [2,3]. An ambiguous character of creativity is emphasized by the fact that whereas the left hand tends to maximise creativity, the other part fear or rejects the consequence of creative ideas [9-11]. Thus, creativity is probably more dynamic and evolutive [12] also a reflect of cultural differences. The modern one tends to reduce it to novelty and utility. A pragmatic way is often see as :"*a novel idea or concept that can be easily transformed into a commercial product to the market*"". In the digital space, creativity is often qualify as computational creativity [13] and do not seems to meet adhesion [14]. Thus, the concept and the word creativity is being shared by many domains from the cultural up to the digital world. It seems also that a continuous stimulation by novelty is limited in regards of our psychological and stability needs [15]. Finally, creativity seems to be driven by pratice and seems to be more complex, human and social process [16].

II ON THE OUTCOMES OF CREATIVITY

The difficulty to define creativity is probably due to the fact that this notion is shared and used by many actors in the society. As a challenge to be creative, I would suggest a another one [9] : ``C*reativity is a long mental activity of an individual (or a small group) that could benefit of reasonable interaction and lead to a final outcome judged as pertinent, interesting and original by external parties. However, creative process are extremely fragile, highly dependent on the environment. Depending on the expected products related to a domain, a significant level of knowledge, information could be necessary*". Qualifying its outcome is probably even more difficult in the domain of innovation and research since often confused. Four main outcomes like discovery,

invention, innovation and communication could be distinguished as possible results of a creative work process. The next figure (Fig. 1) sketches, in a symbolic way, the relation between creativity and the different level of results. It should be emphasized that despite the confusion between these different notions, the processus are strongly different:

- *Discovery*: is defined as a breakthrough based on a long term creative process in a field which provide a new original understanding, knowledge, abstraction of a phenomena or the nature itself.

- *Invention:* is the result of a creative activity which leads to the creation of an original product or services.

- *Innovation*: is more negotiation, a transaction process by many players that lead to the adoption of an original but existing idea, process, product, service.

- *Communication*: is a large concept...Primarily, it corresponds to the creation and the transmission of emotion, message, information.

In the era of linear process, a hierarchical classification could be drawn between these different outcomes as shown in the figure (Fig. 1). For example, considering as an example, a research ecosystem, an ideal linear research process should consist in the discovery of new knowledge or understanding by a senior researcher which could trigger an invention implemented by an engineer that could be integrated in an innovation process by support services and could lead to communications, to a specific community. The main issue, at the digital era, is that the natural frontiers mould by informations in terms of organization and skills tends to disappear. Secondly, this long process barely coexists with timeconstraint, short economic cycles or policymakers expectation. The interconnection level tends to imply a non-linear or probably a correlated process of research. A global competitive creative process could be drawn in which creativity take a central place, each outcome being in competition which each other. This competition takes place on limited shared resources (human, time matter, effort, emotion) and visibility, return on investment. The fact that digital communication and innovation takes a major part in creativity is a sideback effect of contemporary environment.

Figure 1: It is often claimed that "the linear global innovation process is dead" [41]. However, have we foreseen all the consequences ? The different products from a relatively mechanical creative process expected are: discovery, invention,innovation and finaly communication. Each product is often confused since very difficult to apprehend without experienced it. They are different on many criterion such as difficulty, cost, resources, timelines and exploitation .

III INTROSPECTION OR INTERACTION ?

Various creative methods have been introduced with the evolution of the discipline. Two main models of creativity have been put forward and are discussed in this section. The first one corresponds to the individual introspective process of creativity based on reflexion and the basis of many vocation like scientist, engineer, architect, programmer, writer. This representation of personal creativity over a long period can sometimes be magnified and leads to the notion of genius often viewed "as the most intelligent and creative person" [1]. A different model is the modern cooperative approach often based on re-configurable and highly connected team as described just above. These two different way of doing creative activity differs not only in terms of method, timescale but even in terms of final expected results.

Introspective process

Description

The creativity and introspective innovation process was mostly based on the activity of an individual that investigate a field or a problematic. The classical creative process [17] in research has been reminded, in an elegant way, by Shapero [18] . Many researchers will probably identify somehow the way their ideas emerged. This complex process described by Wallas [17] could be summarized in this figure 2 based on five steps. It is a psychomechanic *linear* process with a succession of conscious and inscoucious phases:

Figure 2: individual creative introspective mechanism inspired from Wallas [17] and Shapero [18].

- An optional phase in creativity process is an orientation step. An open question linked to thematic field stimulates human curiosity can be put forward in order to initiate a creative process. Creativity can also be trigged by the emergence of an issue gaining the attention.

- The first stage of a creative process [17] is a relative long preparation phase in order to explore a domain, a field, a problematic. Simply, an overview of the state of the art could be interesting in order to clarify the understanding's degree, the progress and the remaining challenges in the field investigated.

- The next phase of a creativity process is related to the incubation step. It is a relatively long period of several months, not really understood, where the humain brain performed an associative activity. During this phase, a different activity is often experienced as beneficial for the maturation of ideas.

- The breakthrough or the discovery is often claimed to an ``illumination'' or revelation phase [19]. To be more precise, during a free conscient state or randomly, a new idea or concept suddenly emerge. However, it is often observed that this associative process between different ideas is maximised during a free conscious period or a by temporarily postponing the problem. Maturation is a clear beneficial factor during this phase. This is a key moment in a creative process and probably the most intriguing stage as being fragile and barely stimulated.

- The last stage is a formalisation step where the original ideas are being transcript in diverse forms and the result evaluated by the pairs. This formalisation stage leads to many forms of outcomes as described in the next table (Table 1).

Outcomes	Nature	Timescale	Abstraction level
Experiments	Physical	Up to many years	Low to high
Software	Digital	From days to years	High
Data	Physical, digital	Up to many years	Low to high
Patent	Information	Months	High
Communications	Information	Weeks	Medium

Table 1: Examples of outcomes expected from a introspective activity and timescale. The idea or concept issue from the discovery or invention can be valorized by a patent or by various form of communications. Experiments or software simulation that support creative research process can also provided to complementary information.

Complementary viewpoint is the emotion state linked with an introspective process. More precisely, each phase summarized by Wallas [17] can, in my opinion, reasonably linked to an emotional state that underline the human nature. The beginning of a personal creative process is often a problem or an open question that has gained attention. Curiosity probably characterizes, at the best, the early stage of the process during orientation and discovery phase. Next, interrogation comes often with the imagination of some primitive, rough solutions which evolves to a point of frustration [20]. Probably, this second phase can be described by a journey between frustration and interrogation that trigger unconscious thinking and could lead to a conceptualisation phase. The satisfaction feeling comes after the revelation phase and the breakthrough which remove the frustration feeling and can be perceived as a reward. Finally, with an examination positive or negative by the pairs comes the completion phase where the main feeling is that this personal process creative is finished and related to an another feeling that it seems not possible to a more satisful creation. The communication of results and the generation of new open questions is often the beginning of a new different introspective creative process but for another one. A distinctive feature of this introspective method is the relative isolation taking place that effectively reduce social comparison and interaction. One main drawback of such isolation is the reduction of environmental stimulation and the flux of new knowledge. On the other side, isolation can be beneficial in term of implication as the anxiety relative to pairs evaluation is reduced and sometimes discutable confidence that enhance in artificial way individual competition. Social interaction in similar field or involved activity can break this isolation effect, enhance competitive effects and support imagination, reflexion by exposure to new ideas or concept but unfortunately also boost imitation effects.

Activity, attitude and modern working environment

Surprisingly, the use of modern technologies claiming ``creativity'' based on highly connected devices (things-mean) can be on the detriment on the real creativity (meaning) by analyzing the influence on human emotion or behavior:

- Mental *concentration* is clearly limited by modern technologies which probably require a huge part of the user's attention. Dispersion seems also be a counterpart of the misuse of digital technologies related to barely structured information systems. The access provided by many different applications to a large flux of information non only captures but also often defocuse the attention and interrupt reflexion. Even, one secular ago, in the reflexion of Wallas [17], the necessity that ``*nothing should interfere with the free unconscious or partially conscious processes of the mind'' was seen as a prerequise in creation.*''

- Digital *connectivity* by the use of digital social network can be amplified but in the same times reduced. A another fact that has probably been underestimated is the difference between a relation and a connexion to the digital space. Socal network flattern the connexion barrier to others person through the use of digital communication that would probably never existed in a natural environment. On the other side, the predominance of short time digital communication increases the difficulty and the distance for real human communications often required in the first stage of a creativity process.

- Human *curiosity* on a specific topic can be reduced by the intrinsic dispersion introduced by the digital space as the access to structured information of quality is monetize or highly constrained. On the other side, curiosity is also amplified by digital device but unfortunately on low levels of information.

- Intellectual *frustration* which is the core of the human creative process is an important emotional state increasing the introspective imagination and reflexion period that, in my opinion, barely coexists with a digital space.

An opinion is that the paradigm shift from natural, to digital (or computational) creativity is confronted to the harmony need [17]. In a bygone era, the filtering of undesired sollications in the incubation or reflexion step was relatively easy. Such purpose is more difficult as most of the flow of external sollications are driven by spontaneity, opportunity or synchronise to the digital environment. These sollicitations are often mostly short-time based, fragmented and unrelated to the present activity.

Creative interplay

In contrast, many results could also be expected from real creative process ! Experiments and software simulations can often used or developed in order to support reflexion in a incubation phase. Simulations may be favorably used in order to clarify, support hypothesis. In this way, digital creativity that support human creativity is used, in its most interesting way by providing complex images, analysis or results that stimulate or confirm the human intuition. Different final outcomes are expected like scientific data that take a physical or digital form. There is probably an internal conflict between normative and creative activity in a sense that the product is often the results of a tension between various human attitude like divergent critical thinking and, in the same times, the respect to a school of thought or a field. Thus, a position on creativity is located somewhere between an independent, anticonformism view and the tolerance for another form of people's work [21].

On questioning the anthropocentric model

The introspective model often related to the occidental culture is clearly questioned [10]. One major criticism is that the cult of the creative ``genius'' or artists which tends to reduce the individuality as the only creative unit. However, environment as a source of new ideas plays a major role in personal creativity [22] and performance. Some limits have been clearly identified. Probably, whatever the vocation, the main one is related to a long career linked to one or few field's study. Copying with the change rate, in the modern area, is probably the main limit, at the individual level, with both the increasing specialization and division of work or science [1]. The second one is the global cost since its requires to block a long timeperiod for an activity whereas on the other side, most of the economy relies dangerously more and more on only very short term loop.

Some circumvention schemes can be introduced in order to cope with the limits of the anthropocentric model. The next section tackles the problematic of team creativity which clearly set a cultural and organisation challenge. On the other side, in the specific case of high abstraction and reflexion level, no real alternative to the introspective model seems to emerge up to now..

II The cooperative approach

In the hope to keep with the change rate and innovation, in the contemporaneous area, the collaborative or the co-design approach has been proposed which revisited simply the classical brainstorming method [7]. This creative approach seems to simply be derivated from thinking space environment [23] method. The main idea is to enhance personal creativity by stimulation and interaction quiet different from highly structured mechanical system :

Description

Environment : the use of vast open space with large tables for maximising group interaction and verbal exchange. The disposal of large set of small materials (pen, post-it, plastic board) and easy fabrication set (printing) and plugable hardware electronic cards that facilitate the development of prototype on a limited time period.

- Project : the definition of various number of projects based on a period of a dozen weeks maximises the number of creative experiences and meeting.

- Team : the use of highly re-configurable teams with various different players also maximises the combinatorial technique. This is the main principle of the co-design approach, as many different players, should be placed at the begining of this interaction process in different positions: marketing, design, engineering, business in order to increase the probability that a creative result emerge. In the present case, the originality comes from the presence of students in pre-professional working with professionals, animators, professors. Despite, the time limited period, the cost related to the team size is a intrinsic limit of the method.

- Management: a co-design meeting has a duration of few hours and by a strict protocol defined by the animator. As described by the next figure (Fig.2), a three steps process is being considered. The first step aims at relaxing the atmosphere and welcoming the participant by informal presentation. Simple creativity games are often done to start the cooperative work and to ``grasp the problem''. Secondly, the creative techniques helps the participant to exchange in smaller groups about the problematic and by noting the ideas on post-it or paperboard. The term "reactive expansion" has been proposed in order to describe this interaction phase where ideas are exchanged in a fluid way by the participants (Fig. 3). Thirdly, a restitution phase is often made that often leads to categorize the different ideas. Probably, one main surprising result of the method is that every participants finally go back with his own positive feeling [24] or result with a barely global evaluated results.

Identifying emotional state group and the co-design approach

Looking back, at the personal creativity process, the co-design approach is strongly different. It differs in terms of nature as being mostly based on interaction and then completely from a reflexion. The key principle it to maximize the interaction and the probability that an agreement emerge among the different participants during a meeting.

- Human *curiosity* related to the approach and observation between the different participants caracterised probably the first step of the collaborative approach.

- Team *spontaneity i*s the main feature of the ``reactive expansion'' phase and the ideas exchange between the participants [25]. In terms of method, a clear interest is the shift to an interactive period of verbal exchange and the connexion to the digital environment or routine activity is interrupted. The attention of the participants is focused on the present creative work and the written transcription on a paperboard or post-it.

- Group *transaction* and (low-level) transcription and formalisation among the different players summarizes at the best this stage. Informal discussion takes place at the individual level whereas the animator seems to smell the global feeling in the last stage of a co-design meeting.

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[1] The last universal mathematician and physicist scientist is often considered to be Henri Poincaré in the XIX Century.

Outcomes	Nature	Timescale	Abstraction level
Post-it	Written	Minutes	Low
Debate, spontaneous knowledge exchange	Oral	Minutes, hours	Low
Scale model	Physical (easy processing)	1-2 hours	Low
Concept, decision (storyboard)	Written	1-2 hours	Low
Fun period, mind opening	Psychological	Hours	Low
Brand, patenting	Written	Weeks	Low, moderate to high

Table 2: Example of products expected after a co-desing meeting. It can be observed that a completely different and interesting outcomes of the classical research process can be obtained. Moreover, the timescale and the material process illustrates the democratisation of creativity using the cooperative approach and also the diversity in terms of possible outcomes. Scale model or proof of concept are often made with simple materials anf design tool mostly for illustration. On the other side, at the exception of concept patenting, it does not really replace the classical research process in terms of foreseen outcomes.

It could also be observed that interaction based creativity strongly differs from introspective one. The spontaneity of the method gives some avantages. The participants often appreciate this creative period ``*out of the box*'' different from their routinal work activity. In this way, the approach clearly fullfith his objective of disseminate creativity. The second positive point is that each actors takes his own benefit, feedback which also contribute to increase the positive impact. On the other side, the limitation of collaborative and interactive approach are clearly seen. A main limit is that knowledge acquisition does not exist as in classical introspective process based on reflexion which imply that the exchange of ideas are not near at the knowledge frontier and the participant mostly not necessary aware of the current state of the art. The second one is that frustration, saturation is mostly transfered in another players in the creative process since the animator aggregates a large number of co-design meeting with an animation charge and being more concern on the originality of the final results. Constrained times of the creative work. A co-design meeting is a constrain creative process (a few hours) often integrated in a project of a few weeks that could leads potentially and reasonable to the deliverables summarized in the next table 2.

Inherent limits of interactive approach

Some limitation could probably be identified. The most striking one is relative to knowledge. The method is clearly not able to cope with the transmission and analysis of moderate or complex knowledge which required both an assimilation period dedicated to understanding, reflexion and also also probably a writing pathway. The second one is relative to the group interaction. A criticism often made to the model of the isolated inventor [26] [2]. That will not benefit from different viewpoints and that team activity generated by the collaborative approach could be ``*a more rigorous selection process*'' by implementing a natural filter that decreases the probability of useless invention. A complementary external observation is that is difficult to introspective personality to share idea's in a spontaneous way since time-period for introspection or reflexion process is probably much larger [3]. On the other side, there is a social need to personalize a creative process even at the hyper-connectivity age, fact that has probably been underestimated [27]. Clearly, one of the main limiting factor is simply here the spontaneous knowledge available during interaction to reach the point where invention, discovery could be possible. Interaction is sometimes scarce, fragile and precious on information exchange and the coupling of activity. However, in the specific point of view of creativity, interaction alone would probably be also a kind of illusion ?

Methodology and synthesis

Firstly, it should be underlined that despite quiet different these two methods based rather on personal introspection or team interaction belongs to linear methods. An another way of extending and viewing creativity could also be a journey by using short frames and exploration which has been elegantly summarized in the next reference [28]. This dynamic vision of creativity should probably received more care as being probably the commonly approach used in digital space but on the other side cinematograph-method seems far from to be applied on the conceptual domains explicited in this paper. As far as I know, no mathematical thought which highly depends on the entanglement of rigourous thinking, knowledge or abstraction emerge from highly dynamic framing technic.

The questioning of the individual creative process by modern innovation or group brainstorming gives an opportunity to draw a phenomenological return. The first one is that personal creativity seems to be strongly related to emotional intelligence. The emotion and behavior is strongly different between an individual and a group. The nature of creative process is clearly an important factor in terms of product expected. Group creativity, mostly characterised by spontaneity and interaction seems to be the most suitable for oral or image outcome like transaction, debate, informal communication. Mental and personal creativity based process on preparation, reflexion seems more to be more adapted for formalised written outcomes like scientific communications, intellectual property or knowledge transmission. The influence of the digital space, even a phenomenological

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[2] T*he fact that a patent or an article has only one author do not necessary reflects the fact that the complete creative process was completely isolated, even in the orientation, preparation or examination phase. For the main part of the creative process, reflexion, maturation are different step. Moreover, symbolic communication relative to an article or a patent also made that all the contributors do not necessary appears suggesting a different viewpoint relative the myth of the alone inventor.*

[3] I*nversely, it seems difficult to shift from interactivity to introspection.*

return is complex. It is relatively clear that both individual or group brainstorming are also strongly influenced by the modern digital environment. The mental creative process seems probably the most disrupted and even the most critical article on the anthropocentric model recognize the necessity of isolation during a creative activity [22]. The orientation and final examination phase is effectively strongly environmental and contextual dependent. Protecting curiosity is a real challenge as contextualy dependent and also fragile against digital saturation effects. Isolation is precious after the curiosity stage since most of the central part of the creative process : understanding, reflexion, introspection remains a individual based process. Frustration should in someway protected and guided to expect a revelation phase. A clear inherent contradiction and a novel illustration of human ambivalence, is that in creative process, social and collaborative interaction and comparison are promoted and in the same time there is a need to personalised the creative process and to attribute the final outcome and the benefit often in a symbolic way to an individual. This tension between individual and group creativity is probably a form of inherent conflict between crystallized and fluid intelligence since fluid intelligence based on interaction, factual knowledge is on the other side being maximised by contemporarous technologies [29].

V Evolution of creativity and open questions

Transactional activity ?

The main idea developed is that the classical and in-fact psychomechanic creative process has been fundamentally disrupted by the use of modern environment and the permanent connexion to a digital space. The questioning of the introspective model and the shift from mental to interactive process is the unexpected shift of contemporaneous digital environment ? Other shifts in terms of behavior could also be identified. The first one is the interaction between a device and the emotional shift in the creative process. The creative method has been displaced from a self-centered introspective human through a human-device process which seems caracterized by various emotional states. The second one is the use of proactive digital environment in creative meeting which do not really enhance originality but seems to inhibit lateral thinking or limit divergent thinking. A futurist approach self-centered on the individual creative unit could be foreseen where creativity could be totally inhibited. The third one is the amplification of imitation effects through the use of digital tools which seems to be linked to modern communications systems. It is really amazing that the semantic used by the digital actors himself to qualify modern innovation seems to be more an expression of internal conflict between the level of dependence in terms of connectivity and a digital servitude. In my opinon, an hypothesis that could be formulated is that team creativity like co-design meeting seems interesting finally not in terms of final creative outcomes but as a process able to regulate emotional conflict and dependence of modern digital environment and would be also a particular interesting form of transactional process.

Creativity and mechanism shift

Whatever the nature personal or team creativity, it remains strongly related to an emotional and mental state. Modern working technology and the relation to the digital space probably change fundamentally the mental creative process in terms of emotion and behavior. If we analyze the way, that human reacts to a crative problem or a question, a paradigm shift could be observed with the use of digital space and access to information. This behavioral shift could be explained easily by the fact that human creative long term mechanism (assimilation, reflexion, conceptualisation) disappear and is replaced by short term human activity and communication in symbiosis with a digital space (Fig. 4). Human curiosity has been replaced by connectivity and consist mostly to find the person who can solve a problem. Personal reflexion has been displaced by two phenomena :
i) the capture of the human attention by the device
ii) by the amount of uncategorized information available.

A another striking difference in the creative process is that concentration necessary for introspection and interrogation has been displaced to activity and spontaneity through displacement, environmental captivating and interactivity via a digital framework. The transfer of reflexion is probably a measure of the level of dependance to the digital space in incapacity to respond. Moreover, contemporaneous way of information transmission is being mostly based on one to many and plays a key role in amplification and imitation effects. This is a another striking difference between human and digital space since most of the human communications are based on an individual feature.
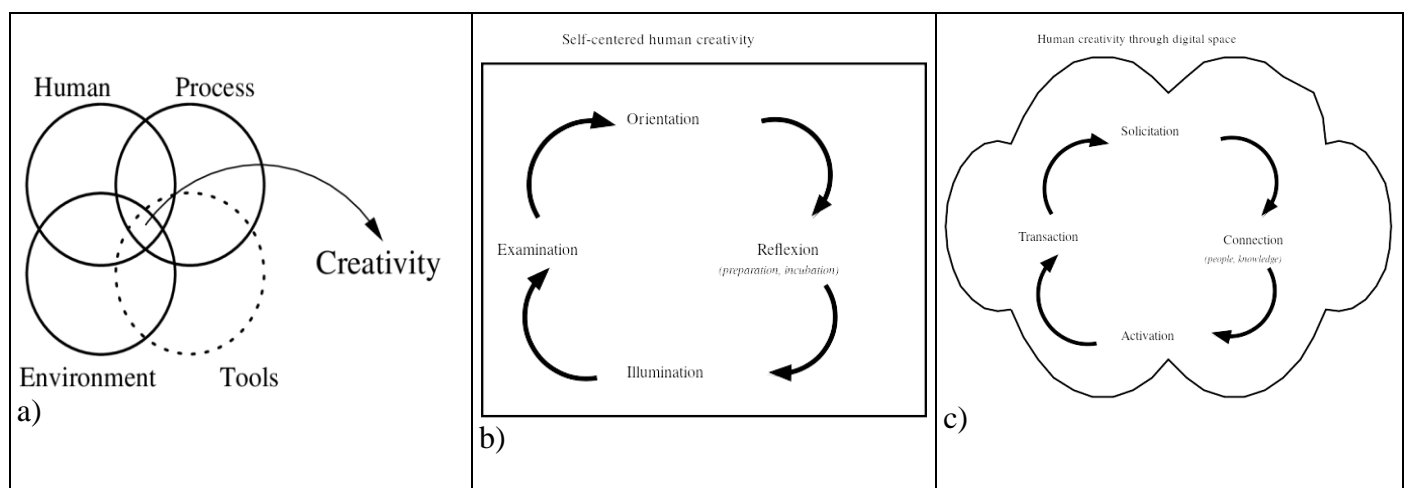

Figure 4: a) Creativity is both influenced and the result of human, process and environment. Probably, the tools used in human thought has been underestimated. b) Illustration of the paradigm shift from a self-centered human creativity to a human device related creativity through the digital space. c) The internal personal reflection, concentration process seems to have been replaced by emotion state close to "activation" corresponding to the act of captivating the environment or interacting with the device.

Yesterday, Human (self-centered)	Today (Human connected to a device)	Attitude related to a problem
Curiosity	Connectivity	Who can solve my problem ?
Reflexion	Spontaneity	Is the answer on Internet ?
Concentration	Activity	Displacement (facilited by hand device)
Observation	Captivating	Collecting photos (interpretation is let to the cloud)
Flexibility	Interactivity	Application based, flexibility can be limited by the environment
Self-frustation	Frustation	Device response not satisfaying
Contradiction	Rejection	Semantic

Table 3: Attempt to qualify the shift from human emotional state with a relation in the creative process to human and the digital space through a connexion. These changes in terms of human emotion and related to a problem. Digital would be probably mostly an emotional engine compare to other thinking process. This could probably be explained by the nature and the amount of the information flux. And at the same times, the limits in terms of human dependence to this digital space, frustration and rejection is often expressed in a semantic way.

Digital space, lateral and divergent thinking

Lateral, divergent thinking is often claimed to be a prerequisite to creativity. Such way of thinking is also mandatory also for niche activity. In term of information flux, digital transmission of information seems more a complex expression of verticality and uniformity than lateral thinking.

Beyond, the behavior shift in terms of relation but connexion between human and digital space, social influence is known to affect creativity. An another aspect is the proactive nature of the digital environment. A tendency is the number or the size of digital screens. It could of interest to imagine an extrapolation of this tendency since the next step would not be an human in interaction with a device but a futurist digital proactive environment. The connectivity to a complete digital space would be immediate with technology based on emotion recognition and the answer or retroaction by the cloud and knowledge providing quasi-instantaneous. Probably, a spontaneous phase of displacement observed today, is that the induction phase where thought is suggested could disappear to reach a immobilization. The perception, the comparison with the environment could be permanent by the use of symbolic resources provided by the digital space. Human frustation emotion or attitude outside a norm could be regulated through normative compliance. Creativity would probably be inhibited and divergent thinking necessary [30] in various activity simply not possible in a digital proactive environment. This futuristic vision would leave the place to a digital space probably more in phase with the redefinition of creativity as simply novelty [31].

Digital space, lateral and divergent thinking

Another fondamental shift with digital communication seems the increase of imitation effects detrimental to the diversity or originality. As shown by the figure (Fig.5), various mechanisms could be proposed to explain this amplification. First, the use of technology or applications based on broadcasting like e-mail, social networks generate similar orientations to an emergent problematic. Orientation has also a key influence, at the beginning of the creative process, which could explain, the increased number of similar activities. The use of professional social network and the permanent social comparison probably trigger imitation effects and reinforce the ``small world effects''. Secondly, the technical mechanism of duplicating or replicating information explain the demultiplication of the same information. Digital telecommunication are mostly based on numbers that amplified the mental projection to numerical space and less on writing systems, alphabet. For example, some limits in terms of identical thematic orientation, imitation effects induced by information could easily observed. Another observation is the dominance of communication as the only product of creativity not only from the participant but more surprisingly also by external parties like examinator or regulator. Finally, the disappearing of products requiring a high coordination level is probably a sideback effect of the tight synchronisation of activity.
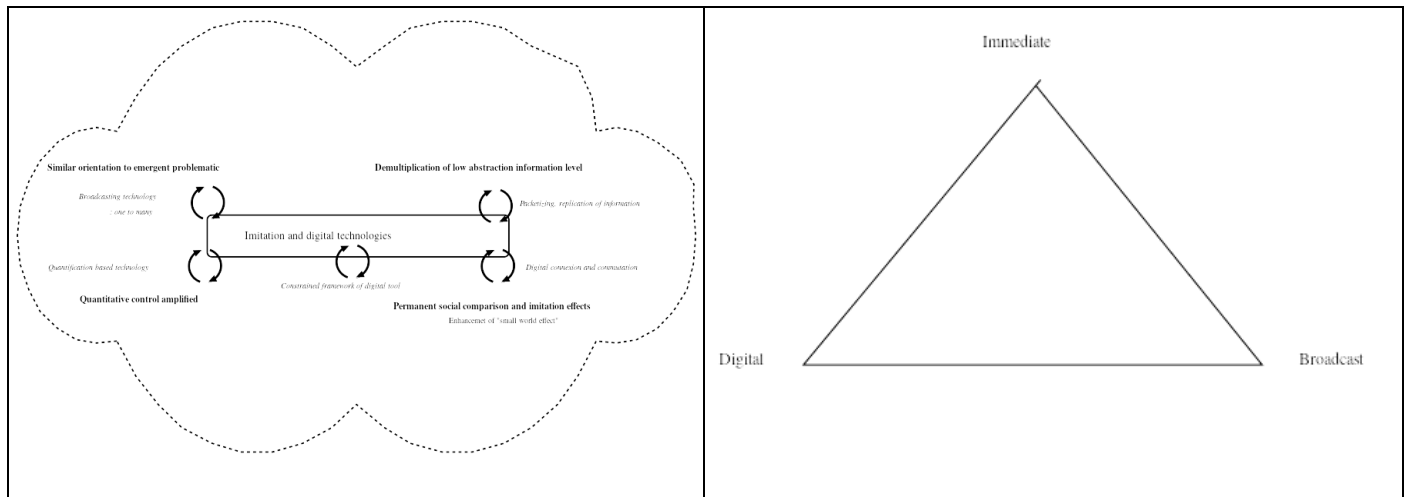
Figure 5: a) A key question is that imitation effects are detrimental to creativity which seems amplified by the use of modern technologies and the constrained framework of the digital tools. Some hypothesis related to technology and application modern technologies can be drawn to explain these phenomena. Probably, the digital connexion provided by devices characterised by immediately and also broadcasting could explained the amplification of imitation effects.

V ON THE MODERN ORGANISATION OF CREATIVITY ?

Creativity and society

Creativity takes probably a hidden but central part in the organisation of society [32]. The figure 6 is a non-exhaustive illustration of creativity and the different products taking a central part both in the economical sector (production, services, teaching) but also in cultural or occidental civilisation features. It could also be noticed that each product is probably tightly binded to a specific conceptual domain. Discovery, breakthrough is intimately linked with research, knowledge and finally intelligence. The invention of new products and management can be related to the production sector or services. Innovation is more tightly bind to business and networking and the original aim was probably to fluidify economical market by a transactional process between the different actors. In some part, his primary sense when very few products, services are in competition on the global market. Finally, communication plays a major role in the influence in cultural, civilisation aspects. The main risk is a lost of a major influence due to simply saturation effects and sometimes even a communication without message. The digitalisation has disrupted in some part the linear innovation process with some signs of a detrimental influence on different domain (services, production) due to the confusion between i) the nature of the outcome a creative process, ii) the economical resources allocated and iii) finally the function itself. It could also be noticed that each field (business, innovation, communication, creativity) tends to focus or even worse fold-up on his creativity pratice [4].

> *Figure 6: The products of creativity and some interrelated process. An illustration of the interdependance between various   societal domains. It could be observed that a discovery improve the global knowledge and understanding.   The notion   of invention and innovation is also strongly related to services, networking and business approach.*

Evolution: from interactionist to reactive/digitally-mediated model ?

Many work consider creativity at the individual level without any consideration of a systemic view. Before the digital revolution, creativity at the organisational level, was nicely described in this reference [33] as reported in the next figure (Fig. 7). In this model, the global creative outcomes of an organisation is function of the environment but also of team process. Ability is a team characteristic making his richness and fertility by different personality, motivation, knowledge, creative behavior and cognitive style. This interactionist model summarizes elegently the way, in a bygone era, how creativity between individuals could be finely aggregate to form a final creative product characteristics of an organisation.

Figure 7: Interactionist model of creativity taking into account the individual, the team, his organisation and environmental creativity.

Team creativity has probably been disrupted more than expected via group communication, exchange and by addressing directly the individual unit. As shown by the next figure (Fig. 8) and table 4, the environmental influence is no more outside the organisation but takes now a central part in the creative process with both positive and negative influences. In his connexion with the digital space, the user is always in demand through e-mail, social networks access to information which explain the shift from mental introspective process to ``reactive'' creativity.

The next figure 8 sketches a potential description of a ``reactive'' model of creativity through the digital space. The notion of individual is replaced by a user in a digital ecosystem. Motivation has been replaced by solicitation and personality factors blurred by human-device interaction. In a digital environment, the notion of community would probably more qualified to describe the group interaction since the agglomeration process takes place with the sharing of common values or upon incitation. The building mechanism is made by attraction or rejection with a self-organization (Fig. 7). The function in a group has been replaced by digital-mediated activities. The digital environment triggers a large range of different activities which remains however architecturaly constrained to the ecosystem. This ecosystem can be in conflict at the frontiers of the real world or ``earth''. An another issue is that individual crystallised knowledge often acquired, during a long mental activity, has been replaced by human-device interaction. The knowledge transmission path between the user and the community taking place via only a digital space. Compare to the standard interactive model of organisation, digital motor of creativity based on communities and activities could have a sideback effect with highly-connected and disconnected state and with poor concern on functionality, the main thesis of this article.

Figure 8: Sketch of an interactionist model of creativity through a digital space.

Looking back, at the original feeling of Jones [5], that the innovation space or more generally that creativity is slowing despite huge investment. The main hypothesis developped is that a particular care should be taken on the architectural and systemic definition of the working environnement in terms of information transmission, attitude and also in terms of final expectations both at the individual or group organisation taking account the side-back effects of contemporaneous technologies and hyper-connectivity. A striking issue is the conflict and a suitable ratio between ambient and crystalline intelligence since a too large part of ambient intelligence is detrimental to the acquisition of knowledge or how-to and leads to superficial and factual communication. Whereas, on the other side, it should be recognized that a crystalline state inhibits human interaction and creativity.

Creativity	Evolution	Attitude in a proactive environment
Connectivity	Immediately	Related to a problem
Spontaneity	Rarely	Verbal individual interaction
Energy	Virtual	Ponctual
Captivating	Virtual	Digital environment
Transaction	Permanent	Symbolic representation
Frustation	Regulated ?	
Rejection	?	?

Table 4: Extrapolation of the previous table to creative activity in a hyper-connected proactive digital centered environment using symbolic ressources. Novelty would not be trigger anymore by cultural, religious, economical or national concerns but digitally defined. It is not easy to understand that in such environment human or small group creativity would be strongly inhibited. Imitation effects would probably be maximised by a similar connection and stimulation or response given by the digital space. A curious transform with large similarity to the Fourier relationship between the environment and their characteristics and the impact on individual attitude transducted in the dimension of energy, time, space.

 Synthesis

With the synthesis of various point of view, it seems possible to sketch a explanation of the feeling expressed in the figure 1. In terms of creative process, discovery is mainly dependent the incubation stage with the way to think, to organize and to integrate scientific examination and on a fragile introspective unconscious integrative mental process. Invention is more a psychomechanical based on associative process resulting for the combinaison of different but existing ideas [34]. The entanglement of thoughts seems to be fragile at the hyperconnection age and not so compatible with framing technic [28]. Innovation differs being an interactive process between different actors and also a transaction via a emotional state of the group. Finally, in our hyperconnected society, spontaneous and interactive communications has been amplified by the intrinsic human need to show his activity. As we have gone to far in fluiding and forgetting the rigidity of thinking [7] ? The predominance of certain outcomes would simply be a consequence of hyperconnexion and the fluidity of the interaction space and on the other side a disordered flux of granular information. A dynamic view of creativity based on framing and exploring ``journey'' [28] could be an hypothesis. This only a feeling, but by losing the human character and the linear way of thinking [35], learning and working, probably many features could also disappear like the energy or the capacity of doing and a level dependence to a digital space. In this form of autoregressive process, a cycle would have been implemented as finally creativity would not so far from the latin origin ``creare'' sense (doing) [36] (and the capacity of doing).

VI CONCLUSION

Creativity is a central need in the build-up of our civilization. The environment and individual freedom as well as the ability to invent, to discover has probably be the central key of economical success of some countries in the last century. However, at the same time, the emerging creativity crisis seems to be a backside effect. The permanent need of social interaction trigger spontaneous and active creative methods, the use of digital device reducing even more the individual mental process let for creativity and reflexion. Hyperconnection leads to a fundamental shift from an individual centered creative process to a digital mediated environmental creative process, the creative freedom and knowledge being regulated by the digital space. An open question is the influence on the nature and the form of creativity products. Imitation effects by permanent social comparison and broadcast communication seems to be amplified. A further step in terms of digital technology and connectivity would consist in a digital proactive environment that would not only inhibits creativity and lateral thinking [37] but let the place to a consumerist creativity [38,39] where low communication level is exacerbated and on the other side an adhesion or an emotional state both at the individual or group granularity difficult to estimate [40].

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