International Journal of
**Design Sciences
& Technology**

Prabir Sarkar and Amaresh Chakrabarti (2015) Creativity: generic definition, tests, factors and methods, *International Journal of Design Sciences and Technology*, 21:1 7-37

europia

International Journal of **Design Sciences and Technology**

Creativity: generic definition, tests, factors and methods

Prabir Sarkar* and **Amaresh Chakrabarti** **

* Indian Institute of Technology, Ropar. Email: prabir@iitrpr.ac.in
** Indian Institute of Science, Bangalore. Email: ac123@cpdm.iisc.ernet.in

Creativity is crucial for most organizations. However, availability of a multitude of factors, tests, and methods of creativity makes it difficult for companies to select an appropriate test, factor, and method for enhancing the creative outcomes within their organization. In this work, we first synthesize a generic or 'common' definition of creativity from the variety of definitions of creativity available, using two methods. Using this definition, we then identify, creativity measures that assess creativity of people, factors affecting creativity, and creativity enhancing methods. This research shows that depending on the focus on the major factors of creativity, derived from the common definition, a company can select a specific set of tests and methods.

Key words: Creativity definition, creativity tests, creativity factors, creativity methods, idea generation

1 Introduction

Research suggests that some level of creativity is required in almost all jobs [87]. Creativity, both individual and group creativity, is vital for organizational creativity and innovation to occur [3, 62], as it affects firm performance and survival [57]. There are many reasons that make creativity crucial for most organizations. First, Creativity is regarded by many as a core business skill [10, 34, 41, 49]. Second, creativity is important for product development, is considered as the core ingredient of innovation, and it enhances the possibility of generating superior products [38]. "Without creativity there is no innovation [67]." Third, creative products have an advantage over other competing products, as creative products can command the market price and can have a larger market share [59]. Additionally, a major part of the future income of a company would come from new products; therefore, companies should introduce new and better products faster to make profit [31, 71]. Creativity is also important in architecture. Potur and Barkul state that, "While the encouragement and rewarding of creativity is very important in all fields, it is especially important in the field of architectural education [66]." Creativity is often considered as a catalyst for innovation of products and services with improved energy efficiency, and as a foundation for sustainable policies and practices [61, 77].

As stated above, innovation is the key for any company to introduce new products [3, 5], and creative individuals are responsible for this innovation to occur in new product development [81]. To enable such a level of innovation, innovative companies require to either recruit creative individuals, or to preselect them [81], or enhance the creative ability of the current staff. Thus, creativity measures are needed to be used for assessing individual's creativity.

Creativity of individuals is often measured by creativity tests [25] which either measures the intensity of creativity traits within an individual, or the creativeness of the outcome of an individual. There exist many creativity tests, and it is often difficult to select an appropriate test for measuring individual creativity [19]. One way to identify which test is appropriate is to compare 'what the test is measuring' with 'what need to be measured.' 'What need to be measured' could be found out from a common definition of creativity.

Similar to the creativity measures, issues exist for creativity factors and methods too. Creativity methods or techniques are often used to enhance creativity of individuals, and creativity factors are influences that affect creativity. Literature reports more than 140 factors (Section 9 discusses these in detail) that influence creativity and more than 90 creativity enhancement methods (Section 10 discusses these in detail). However, it is difficult for a company to focus on all these factors and methods simultaneously. Thus, we need a way to identify the most appropriate factor, test, and method for creativity. For this, as stated above, we first need to define creativity. A generic or common definition of creativity can be used to identify appropriate creativity tests and methods for testing or enhancing creativity. This is also echoed by Gotz [35] who expresses: "An enormous body of research has accumulated that purports to elucidate aspects of creativity, factors that enhance or hinder it, and test its presence and the degree to which it occurs. Yet all this body of research starts from either ambiguous definitions or, in some cases, no definition at all -the assumption being, I guess, that everyone knows what creativity means, or that any definition will do." To understand creativity in depth, Unsworth [87] proposed a matrix of creativity types, including responsive creativity (responding to presented problems because of external drivers), expected creativity (discovering problems because of external drivers), contributory creativity (responding to presented problems because of internal drivers), and proactive creativity (discovering problems because of internal drivers). However, Unsworth suggests, "future research must now explore these creativity types and their many implications." The main objectives of this paper, therefore, are to:

1 Examine a comprehensive set of definitions of creativity, proposed by various researchers and practitioners, and synthesize their features into a generic definition of creativity that can be used by organizations. The work then extends this definition to design creativity

2 Review a comprehensive collection of creativity measures or tests, categorize them and relate them with the definition of creativity

3 Review factors influencing creativity, cluster them and relate them with the definition of creativity;

4 Review a comprehensive collection of creativity enhancing methods available in literature and relate then with the definition of creativity

5 Develop a comprehensive understanding of creativity by establishing links among the definition, measures, factors, and methods of creativity

In this work, first we develop two methods to analyse the many definitions of creativity and summarize them into a generic or common definition of creativity. Next, we group creativity assessment tests, influencing factors, and enhancing methods in terms of their similarity, and relate these to the common definition of creativity. This, we argue, will help identify the most appropriate tests, factors, and methods of creativity that are consistently linked with one another.

2 Common definition of creativity

In literature there are many definitions and measures of creativity; however, there does not seem to have a shared common definition of creativity, and the measures proposed rarely relate to any particular definition

of creativity [35, 80]. As a result, while many measures of creativity are identified, it is unclear how well these findings relate to creativity [35]. Though creativity has been used in education for over fifty years, we struggle to define and identify it [35, 33, 50]. Klausen [45] states that "standard definition of creativity is problematic and maybe in an even worse state than is generally acknowledged by creativity researchers themselves." However, defining and measuring creativity will help the research community [80, 33]. The need for a generic definition of creativity has also been echoed by many other researchers [86, 87]. Plucker, Beghetto, and Dow [65] mention, "Without an agreed-on definition of the construct, creativity's potential contributions to psychology and education will remain limited." This statement might also be true for many other areas of research.

3 Methods to develop a generic or common definition of creativity

Development of a 'common' definition depends on the common characteristics of the word 'creativity' as held among researchers. Therefore, research started with an effort to collect a comprehensive list of creativity definitions from literature.

'Creativity' is applicable for a wide range of subjects- from literature to psychology to engineering to management. Practically, there is hardly any area that does not require creativity. This is the main reason, why this very term is been used by researchers in all areas of research. A review of creativity literature revealed many definitions of creativity. Search was carried out in Google/ Google Scholar [96] and individual journal publishers' sites Elsevier, SpringerLink and Taylor & Francis Online [95, 98, 100]. During search, no restriction was imparted in the year of publication or on the area of publication; however, organizational creativity was the focus. Definitions were collected from published works in journals, conferences, book chapters, and certain dedicated websites on creativity. Through this extensive, non-restrictive search, one hundred and sixty four definitions of creativity was identified and analysed from a variety of sources. During this search, we observed that creativity is also defined by various authors, some having several publications and have several years of experience in design research, while others having no publication, no experience, and often it was difficult to find their research background through Google's search. It is important that a proposed common definition of creativity should reflect its shared understanding of creativity within the research community. This led us to focus only on those definitions whose authors have contributed in the areas of creativity, design, or innovation through publications. We used Google again, to search each author's research background, and finally, selected fifty definitions, which satisfied the above criteria. Only these fifty definitions are selected for our analysis (see Appendix 1 for some these definitions). The range of the year for the selected definitions is 1926 until 2011; however, date was not taken as a criterion for search.

We see two possible meanings for a 'common' definition of creativity. The first is, since the 'common' definition should reflect the views held by the majority of researchers in the domain, we should develop an approach that uses, in the 'common' definition, those concepts that are most frequently used across current definitions. We call this method "majority analysis." The second, alternative meaning is based on the argument that the above (majority based) definition may not capture the rich, underlying relationships among the concepts used in the various definitions, and hence may not provide a combined representation of all the definitions. Thus, we develop and use another, alternative method that identifies the relationships

among the terms used in these definitions, and uses these to develop a definition of creativity. We call this method "relationship analysis." The outcome from the first method would give an insight into the collective concept of creativity definition, while the second aims to analyse each definition to find commonality across them through the links among the terms used in the definitions. The results from these two analyses are then compared and integrated to develop a generic or common definition of creativity.

Initial review of these fifty selected definitions showed three clear attributes among all these definitions:

− First, each definition uses a phrase (either a noun phrase or a verb phrase) to express the essence of the definition, and its corresponding qualifiers, consisting of adjectives or adverbs, to express something specific about the phrase such as 'new,' 'valuable,' or 'many'
− Second, in all these definitions certain important qualifiers of creativity have been highlighted, such as 'process,' 'new,' 'novel,' and 'ability'
− Third, in all these definitions, creativity has been defined using one or more of the following ways: (i) a product or outcome with a set of characteristics (most of the definitions use this), (ii) a special process or activity that makes someone creative, and (iii) a set of measurable and non-measurable ability or personal traits: e.g. fluency, originality, flexibility, and elaboration

In the next sections, we discuss how these findings could be used in the two methods to construct the common definition of creativity.

4 Majority analysis

Majority analysis aims to identify the underlying commonality across the definitions. To achieve this, first, each definition was divided into its primary noun or verb phrases. Next, frequencies of these noun and verb phrases with their qualifiers across all the definitions were noted. Next, these phrases and their corresponding qualifiers were analysed and clustered according to their similarity in meaning. Commonality between all noun and verb phrases were tabulated separately (Table 1 and 2 provide some examples). Next, statistical frequencies of occurrence were determined for each cluster, the core phrases and core qualifiers were identified, and these were used to construct the 'common' definition.

4.1 Analysing noun and verb

Four major clusters of noun phrases were identified. Each of these phrases was further subdivided into Part A and Part B (where Part A would be followed by Part B, Table 1), to have more in-depth understanding, as most often, the original phrases were long. Phrases with higher number of occurrences (shown in brackets in Table 1) were made part of the common definition of creativity.

Unlike noun phrases, out of the fifty selected definitions, only five definitions expressed creativity using verb phrases. Only one verb phrase (occur) was found more than once (Table 2).

If we try to construct a definition of creativity using the selected phrases/words, then the first part of the definition could stand as follows: Creativity occurs through a process by which a person uses his/her ability to generate ideas, products or solutions.

To avoid terms such as 'his' or 'her,' we replace the word' person' with 'an agent' - 'one that acts or has the power or authority to act,' or 'something that produces an effect or a change or is used for a particular purpose' [15]. Another way of considering 'an agent' is to consider a person-plus view of Perkins [63] that

is a person with the surrounding instead of a person solo. This substitution should enable inclusion of creativity-enhancing computer based agents. Literature shows that computer software (agents) can enhance creativity of engineering designers, e.g., by generating new design solutions [16].

Table 1 Clustering of definitions showing the highest occurrences (shown in bracket) of the noun phrases

Cluster number	Example from the list of definitions	Noun/ Noun	Phrase (occurrences)	What is selected	
		Part A	Part B	From part A	From part B
1	Definition 22: Creativity is perceived as three dimensional, consisting of the person, the environment, and the cosmos – this last component to include the supernatural forces that illumine creativity at the highest or genius levels [44]	persons(2)	-	person	
2	Definition 4: The process by which something judged (to be creative) is produced [2]	process(8)	something judged is produced (2)	process	-
3	Definition 15: The ability to bring something new into existence [7]	ability to (5)	bring something into existence (2)	ability	occur (already considered)
4	Definition 26: Generation of imaginative new ideas, involving a radical newness, innovation or solution to a problem, and a radical reformulation of problems[73]	generation of (11)	ideas (6), products (5)	generate	products and ideas
-	Definition 27: A special class of problem solving characterized by novelty [55]	problem solving (5)	-	(same as generation of solution)	-
-	Definition 28: Production of something new and valuable [51]	production of (6)	something (2), ideas and solutions (2), work (2)	-	solution and ideas (work can be taken as a solution)

Table 2 Clustering of definitions showing the highest occurrences of the verb phrases

Cluster number	Example from the list of definitions	Verb phrase (occurrences)	What is selected
1	Definition 31: Creativity occurs when someone creates an original and useful product [24].	occur(2)	occur

Therefore, we reframe the first part of the definition as: Creativity occurs through a process by which an agent (or agents) uses its ability to generate ideas, products or solutions.

4.2 Finding noun and verb qualifiers

Qualifiers are used after the verb or noun phrases to express something about those phrases. As stated above, the researchers have used different qualifiers for the noun and verb phrases that they used to construct their definition of creativity. These qualifiers are analysed and common qualifiers are identified, which are then added to complete the definition of creativity. Table 3, shows the highest occurring noun.

Table 3 Clustering of definitions- the noun qualifiers

	Qualifier of Noun/ Noun phrase (occurrences)	What selected
Cluster 1	new(11), original(2), novel(13)	novel (see discussion below)
Cluster 2	valuable (9), useful (5), appropriate (4)	valuable or useful (see discussion below)

Similar to the verb phrases, the verb qualifiers are also small in number. The cluster with the maximum number of entries is shown in Table 4; other clusters have negligible (one) entry.

Table 4 Clustering of definitions- the verb qualifiers

	Qualifier of Verb/ Verb Phrase	What selected
Cluster 1	new, with many ideas, original	new (novel -see discussion below)

In cluster 1 in Table 3, similar meaning terms 'new,' 'original,' and 'novel' appear. Several researchers such as Lubart, Sternberg, and Oche [80] defined 'novel' as 'original and unexpected.' Boden [11] stated that 'novelty may be defined with reference, either to the previous ideas of the individual concerned or to the whole of human history.' The former definition concerns P-creativity (P for Psychological), and the latter H-creativity (H for historical). H-creativity presupposes P-creativity, for if someone has a historically novel idea, it must be new to the person as well as to others. Cambridge Dictionary [15] provides the meaning of 'new' as 'recently created,' 'different,' or 'not familiar.' The above discussion shows that 'novelty' could be used to encompass both 'new' and 'original.' Importance of novelty on creativity has been also propagated by other authors, such as Cropley [18] who states that creative thinking seems to involve two components: generation of novelty (via divergent thinking) and evaluation of the novelty (via convergent thinking). Thus from cluster 1, the qualifier 'novelty' is selected.

From cluster 2, in Table 3, the term 'valuable' can be selected, as this has the maximum frequency of occurrence. So, the end portion of the definition of 'creativity' can be stated as 'that are novel and valuable.' Thus, using the 'Majority Analysis' method, the common definition of creativity is constructed as follows: Creativity occurs through a process by which an agent uses its ability to generate ideas, products or solutions that are novel and valuable (Definition 1).

5 Relationship analysis

In Majority analysis, we analysed the fifty definitions of creativity by identifying the attributes or features that are used by the majority of these definitions, and integrated these into a 'common definition.' However, this does not take into account the relationships between the attributes used, and in that process one may miss any potential, underlying unity among the attributes. In relationship analysis, we analysed as to how the essential features of these definitions related to one another, link them together into a hierarchy, and used this hierarchy to identify the overarching, high-level features that could be used to represent all the features in the hierarchy. A common definition of creativity that integrates these high-level features would also represent the definitions that use the related, lower level features, thus creating a more representative or 'common' definition of creativity than possible by using the criterion of a simple majority.

5.1 Identifying commonality

First, each of the fifty definitions of creativity were analysed to identify the underlying structure of the definition and its constituent features. We found that (as also found in the Majority analysis), in each definition, creativity was referred with respect to:

- a process/ability (definitions of Type A, i.e. A-1 and A-2)
- an outcome (Type B, i.e. B), or
- a person (Type C, i.e. C-1, C-2, and C-3, Table 5)

Table 5 Commonality among the structure of the definitions

Creativity is related to	Type (occurrences)	Examples from definitions (Appendix 1)	Type	Process/ ability	Properties	Outcome	Properties
Process or ability	A-1 (27)	1,2	Of process/ ability is	Process/ability Y		With Outcomes X	With properties Px.
Process or ability	A-2 (9)	41	Of process/ ability is	Process/ability Y	With properties Py.		
Outcome	B (10)	26,27	Of outcome is			Outcomes X	with Properties Px.
Person	C-1 (1)	24	Of a person is	Process/ability Y	With properties Py.		
Person	C-2 (1)	31	Of a person is	Process/ability Y		With Outcomes X	With properties Px
Person	C-3 (3)	25	Of a person is	Process/ability Y	With properties Py.	With Outcomes X	With properties Px

Additionally, in most of the definitions, outcome related properties or/and process or ability related properties have been used to describe creativity. Six generic structures either belonging to Type A, B, or C were identified (Table 5) in which all other definitions could be categorized. We used the term Px to categorize the outcomes(X) related properties and Py to categorize the process (Y) or the ability related properties.

However, most definitions were of Type A-1. This meant that a substantial number of researchers (27 of them) defined creativity with reference to a set of processes or abilities (Y) with a certain outcome (X) with certain properties (Px). For instance, Adams (1986) defined creativity as: Creativity has sometimes been called the (process) combination of seemingly disparate parts into a functioning and useful (Px) whole (Y). Let us take another example: 'Creativity is the ability to produce new ideas and solutions' (Definition number 17, Appendix 1). In this definition, creativity is seen as the ability 'to produce,' 'ideas' or 'solutions' as outcomes having the property of being 'new.' This definition can also be categorized under A-1.

Table 5 shows that except for A-2 type definitions, all other definitions refer directly to the outcomes with properties as the means of establishing creativity. Even for the A-2 type definitions, the process properties could be translated into outcome properties. We concluded that a definition of creativity should thus include the types of outcomes and their properties as essential features of the definition, for instance 'ideas' (outcome) that are 'new' (property of the ideas).

Next, the meanings of the various feature terms used (e.g., X, Px, Y, Py in Table 5) were identified, either from the explanations of the authors who proposed that definition, or from meanings of these terms across four major dictionaries: Cambridge [15], Oxford [28], Merriam-Webster [52], and Encarta [30]. Based on the relationship between their meanings, the features were placed in hierarchies of features having similar or related meanings. This, in essence, allowed each definition to be interpreted as a combination of features spread across the hierarchies, thereby making their relationships explicit. Several hierarchies were found; however, we found that three major hierarchies could be constructed from them. The outcomes formed a single large hierarchy, and the properties formed two large hierarchies, one for 'novelty' and the other for 'value.' We discuss these in the next subsections.

5.2 Linking outcome features

The first among the three hierarchies is formed by linking various creative outcomes. Figure 1 shows that the outcome of a creative act could be categorized into four broad types of outcome: (i) ideas (i.e., thoughts, concepts, and perceptions), (ii) problems, (iii) products (or artefacts), solutions, inventions, discoveries, and (iv) evaluative statements or evaluations (e.g., points of view and judgements).

Figure 1 shows that in the outcome hierarchy, all these outcomes could be described as 'something,' and thus, 'something' (i.e. different creative outcomes) was taken as the most abstract form of an outcome, and placed at the highest node of this hierarchy.

5.3 Linking novelty and value features

The feature hierarchy (Figure 1) was formed by linking all the features relating to novelty, while in the value hierarchy, all features that related to the value of the outcomes were linked.

Note that there are features that relate to surprise, interest or stimulation created by an outcome. What kind of surprise could an outcome create? Luden et al. [48] stated that "surprise reaction to a product can be beneficial to both a designer and a user and then expressed that "If you feel something unexpected, you will be surprised." They studied 101 products and observed that surprise arose due to the presence of different levels of novelty in the product [48]. The second kind of surprise could now be explained with respect to

the 'value' feature. We argue that surprise of this kind is due to the high degree of value that was possible to achieve by altering the existing ideas. Here the contribution to surprise comes not so much from its novelty, as from its apparent familiarity and yet fulfilment of the purpose! Hence surprise can be linked to both novelty and value (shown with dotted lines in Figure 1).
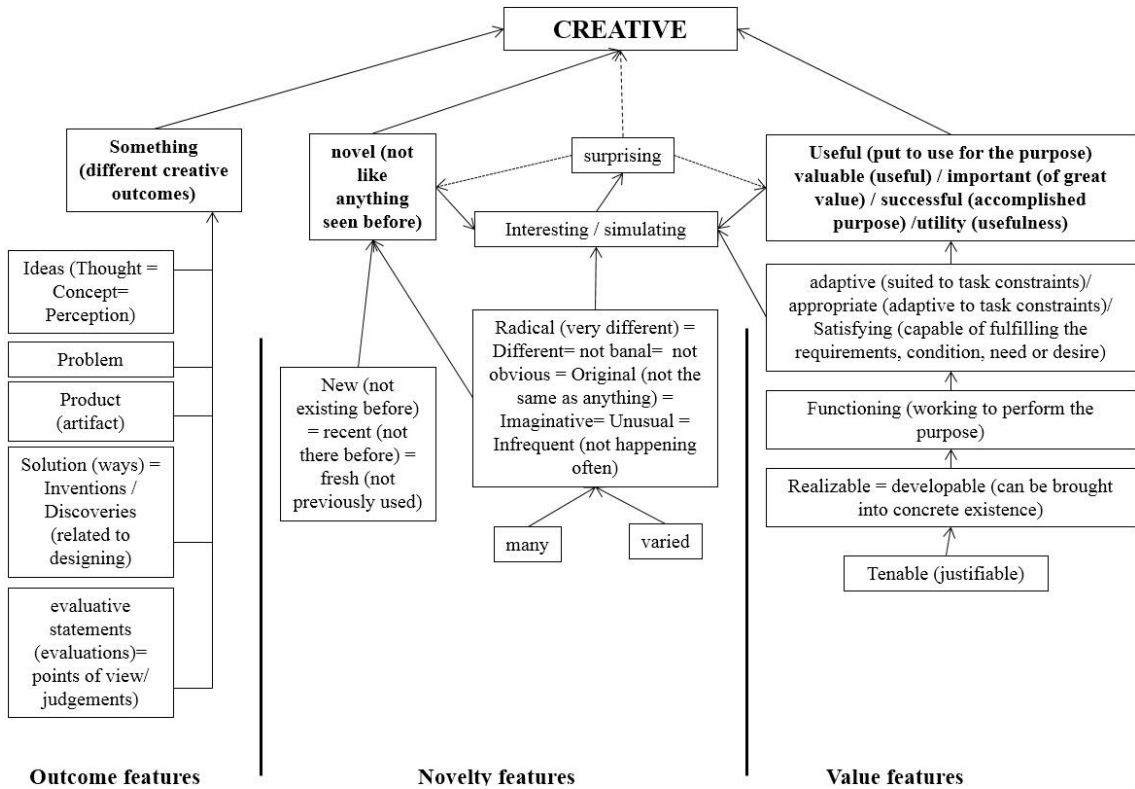
Figure 1 Three hierarchies of creativity[1]

In his theory of creative design, Schön [72] expressed that 'surprise' is useful for framing and reframing. Dorst and Cross [29] mentioned that "surprise is what keeps a designer from routine behaviour" and "surprising parts of a problem or solution drive the originality streak in a design project." Bruner [14] spoke of 'effective surprise' as an element of creativity. An effective surprise is created, not merely by an idea being novel, but being effective in solving the problem or meeting the need while being novel. In other words, both 'novelty' and 'value' play a role in creating the surprise. Surprise seems to be a matter of the degree of impact that the outcomes make – to the degree of creativity, and not as an essential feature distinguishing creative from the non-creative. Hence, while we included both novelty and value, we did not

---

[1] Features are shown in boxes; influence is shown by an arrow, and equality sign is used between the terms with similar meaning. The meanings of the features are shown in a bracket. For instance, inventions could be viewed as artefacts or solutions with a high degree of novelty. Since properties of the outcomes are considered within other hierarchies, we can take 'invention' as equivalent to 'solutions' or 'products.'

include surprise as an essential feature in the combined hierarchy or in the definitions. Thus, we linked only novelty and value (usefulness) directly with creativity.

6 Developing common definition of creativity

Finally, we selected the highest features of the hierarchies, to be included into a 'common' definition of creativity, by integrating them into a definition. If the two outcome-property hierarchies (novelty and value) are merged with the hierarchy of outcome-types, three distinct kinds of definition emerge: a few in which features from only 'novelty' hierarchy are used (such as Definition 1); another few that includes features only from the 'value' hierarchy (such as Definition 4), and the third kind, within which most definitions fall, that use a combination of features from both these hierarchies. In order to be inclusive, we need a definition of creativity that includes terms from both 'novelty' and 'value' hierarchies, and put them as essential features for the most generic outcome-types. Based on this analysis, the following has been proposed as a 'common' definition of creativity: Creativity is the generation of something that is both novel and valuable. On other terms, Creativity is an ability or process using which a person (or agent) generates 'something' that is 'novel' and 'valuable.' (Definition 2). This 'something' can be a 'problem,' 'solution,' 'work,' 'artefact,' 'statement,' 'discovery,' 'thought,' 'idea,' or 'judgement' depending on the context. In the context of design, 'something' could be taken as 'problem,' 'solution,' 'product,' 'idea,' or 'evaluation.'

7 Comparison of the definitions, and a definition for design creativity

The definitions created by the two analyses are different in the meaning of 'something.' While in Majority analysis, 'something' encompasses ideas, solutions and products, in Relationship analysis it encompasses a greater variety - in particular, problems and evaluations. Since identifying problems and carrying out evaluations are essential tasks during any creative activity, it can be argued that both problems finding and finding evaluation criteria are subtasks to the goal of generating creative ideas, solutions or products. Thus, focusing on generation of ideas, solutions, or products should provide a more direct measure of creativity. The general organizational definition of creativity from Relational analysis was hence simplified as: 'Creativity occurs through a process by which an agent uses its ability to generate ideas, solutions, or products that are novel and valuable' (Definition 3). This definition is the same as the definition proposed in Majority analysis (i.e. Definition 1).

The general attribute of social 'value' could be further specified in the context of product design and development in organizations, where it becomes utility value – or 'usefulness' (also see definition 49 in Appendix 1). It should be noted that the phrase 'useful' was the second most frequent phrase as found in the Majority analysis. Similarly, Mayer [50] expressed that creative products have 'novelty' and 'usefulness' as their characteristics. Thus, for product development, the definition could be further specified as: 'Creativity in design occurs through a process by which an agent uses its ability to generate ideas, solutions, or products that are novel and useful (Definition 4).'

This definition, for a design-specific definition of creativity (Definition 4), together with the more generic definition for creativity in Definition 3, provides an inclusive framework for creativity. This is because the features used in the definition now represent, and not eliminate the features that are not directly represented in the definition. It also provides a justification for the various measures proposed by earlier authors for

measuring creativity, and how directly these measures relate to creativity. For instance, Torrance [83, 82] uses fluency and flexibility as two measures for creativity, which in the novelty hierarchy are represented by 'many' and 'varied.' Shah and Vargas-Hernandez [74], and Lopez-Mesa and Vidal [47] use 'infrequent' as a measure of novelty. On the other hand, 'non-obviousness' has been used as a measure in assessing patent documents [8, 36]. Also, Amabile [5] uses experts to identify what is 'creative.' Except for the measure used by Amabile, who leaves the onus of defining creativity as felt appropriate by 'experts,' and therefore provides not a definition but a way of assessing creativity, all existing definitions are subsumed and represented by the above two definitions.

Interestingly, in a recent work to understand the trend in the definitions of creativity, Batey [9], states that the conception of creativity as 'new' and 'useful' and the 4Ps (person, process, product, press) approach already influences how researchers define and measure the construct. Kampylis and Valtanen [42] studied 42 creativity definitions spanning from 1950-2009 and found that substantial ambiguity exists among these definitions of creativity. They express that the majority of the definitions can be categorized into 4Ps [69]: Person (Creativity is a key ability of individual(s), process (Creativity presumes an intentional activity), press or environment (The creative process occurs in a specific context, and products (products must be novel (original, unconventional) and appropriate (valuable, useful) to some extent, at least for the creative individuals. The above two pieces of research further support our findings. While analysing several definitions of creativity, Sousa [27] views creativity as the process of communication between the creator (or the product) and the audience or between the creator and the product.

The generic organizational definition of creativity claims that the outcomes (ideas, solutions, and products) of creativity should be 'novel' and 'valuable.' Thus, 'novelty' and 'value' ('usefulness' for design creativity, see Definition 4) are the two direct measures of creativity. Consequently, the factors affecting creativity should be those that affect novelty or value of an outcome. Creativity tests should preferably directly focus on measuring the novelty and the value of the outcome. Creativity enhancing methods should ideally help designers to generate outcomes (ideas, solutions, and products) that are both novel and valuable.

8 Development of a common set of measures for creativity

As outlined in the introduction, creativity tests are used to assess creativity of an individual or an outcome. Typically, a creativity test consists of a procedure, a list of variables to be measured, and a way to compare these variables.

8.1 Literature review

There exist many creativity tests. Plucker and Joseph [64] expressed that while reviewing these tests one finds it difficult to describe the efforts as a collective entity. Creativity researchers such as, Torrance, Guilford, Kirton and Amabile (Appendix 2) proposed many tests for measuring creativity. These researchers had diverse perspectives and foci, which resulted in these diverse tests and measures. Some of these tests are highly detailed while some are not, or are not evaluated for their effectiveness. This led us to consider only those creativity tests whose test validation results have been published by their authors, or the tests have been used by other researchers. We found about 100 creativity tests (Appendix 2) existing in

the literature satisfied these criteria. Next, we categorized these tests as follows:

- Complete creativity tests: the entire test is for assessing creativity (such as, Torrence tests and Guilford tests)
- Partial creativity tests: only part of the test is for assessing creativity (such as, biological inventories)
- Indirect tests: these measure certain factors that are believed to be influencing creativity, for instance, IQ, giftedness, psychology, and character traits

Indirect tests are not actually tests for creativity. Indirect tests measure certain individual abilities that are presumed to influence creativity, often without support by extensive validation. Thus, we considered only complete and partial creativity tests and excluded the indirect tests. 74 tests belong to the first two categories. Next, we grouped similar tests into clusters.

In the past, researchers have attempted to cluster creativity tests. For instance, Torrance [60] grouped tests (which were mostly psychometric at that time) into: (i) tests involving cognitive affective skills such as the Torrance test of Creative Thinking (TTCT) and (ii) tests attempting to tap personality syndromes such as the Alpha Biological Inventory.

Kerr and Gagliardi [43] categorized tests into: (i) divergent thinking tests (2 tests), (ii) distinguishing traits (2 tests), (iii) personal inventories (3 tests), (iv) projective tests (2 tests), and the remaining tests into 'unsorted' category.

The classification developed by Bonk [58] includes: (i) divergent thinking (3 tests): the ability to consciously generate new ideas that branch out to many possible solutions for a given problem, (ii) convergent thinking (2 tests): the ability to correctly hone in the single correct solution to a problem, (iii) artistic assessments (1 test): the evaluations of an artistic product such as painting, story, poem, musical composition, collage, and drawing, (iv) self-assessments (8 tests): a person's response to the amount of creativity that he or she exhibits, and (v) other assessment (3 tests).

As the above classification schemes consider only a limited number of creativity tests, and have different application focus than ours, we classified the 74 creativity tests according to what the tests claimed to measure. Later, we compared them with the generic definition of creativity to find what the tests actually reflected: creativity of an individual or an outcome. We found that these tests measured one of the: 'abilities,' 'characters,' past creative activities of individuals,' 'outcomes of a creative act' (leading generally to a product) or 'characteristics of the environment' to foster creativity. Thus, the creativity tests have been categorized into five types:

1 Ability-based tests (42 tests out of 74 - 57 % of the total number of tests considered): These tests aim at measuring the quality or the (strength of the) abilities that an individual should possess in order to be able to generate creative outcomes. These tests are based on the assumption that if one has certain creative qualities, one will be creative. Guilford's battery of tests, Torrance Tests of Creative Thinking (TTCT), and Kirton Adaptor Innovator Inventory (KAI - creativity style) belong to this category. Appendix 2 shows the entire list.

2 Character-based tests (20 tests - 27 %): It is believed that attributes of one's character or attitude have effect on the performance of that individual in any field. These tests aim to identify the breadth of the attributes in one's character that are believed to be essential for being creative. The Myers-Briggs Type Indicator, the NEO Five Factor Personality Inventory, the Rorschach Inkblot Test, and the Thematic Apperception Test (TAT) belong to this category.

3 Determination of past creative activities (6 tests - 8 %): These tests assess individuals based on the number of creative activities completed by them in the past. These tests argue that if an individual was often creative in the past, the individual would be creative also in the future. Biological inventories are the major tests that fall in this category. These tests mostly employ self-evaluation and sometimes cross evaluation.

4 Outcome-characteristics based tests (3 tests - 4 %): Creative individuals produce creative outcomes. Rather than testing the characteristics of the subjects, these tests assess creativity of individuals by assessing the creativity of their outcomes. Based on the characteristics of the outcomes created by the individuals, these tests decide on the occurrence of creativity. The Creative Product Semantic Scale (CPSS), the Student Product Assessment Form, and the Consensual Assessment Technique (CAT) are in this category.

5 Environment suitability tests (3 tests - 4 %): It is assumed that environment is an important factor in developing creative talent and enhancing creativity. These tests aim at identifying and developing creative environments. The Breakthrough Creativity Profile, the Creativity Audit, and the Group Creativity Index (GCI) tests are in this category.

8.2 Measures of creativity and their relationship with the 'common definition'

As discussed in Section 7," the key measures of creativity are novelty and value (i.e. usefulness in the context of design.)

'The ability based tests' aim to ascertain the presence of certain abilities of a creative individual. Majority of these tests measures personal ability, by either measuring thinking ability or by identifying subject characters (i.e. personality traits). While some creativity tests such as the 'fluency tests,' focuses on the number of ideas generated, none of these tests aim to assess the novelty or the value of the outcome. For example, Torrance [83, 85] proposed fluency, flexibility, originality and elaboration as the four main factors influencing creativity, and used the ability to answer open-ended, multiple-answer-type questions as a means to assess the mental ability of the individuals to be creative; however, these too should be considered indirect measures of creativity. Thus, ability-based tests can only partially measure creativity of individuals.

'Character-based tests' and the 'environment suitability tests,' have similar issues as those of the ability-based tests. These tests also do not aim to measure the outcome of the individual and assess the outcome for novelty and value. For instance, Thematic Apperception Test (TAT), in which subjects are asked to make up stories in response to a series of pictures to reveal something, about their drives and emotions, is based on the theory that stories reflect a subject's personality needs and environmental pressures, which, in turn, reflect how that subject tends to cope with different kinds of perceived situations. It aims to measure the creative ability of individuals by testing their emotional reactions. Amabile et al [6] describe the development of KEYS, an instrument for assessment of climate for creativity, designed to assess perceived stimulants and obstacles to creativity in organization work environment. However, Amabile et al mention that apart from individual creativity, work environment perceptions are also crucial for organizational creativity.

The tests that, in some sense, consider the quality of the outcomes of acts of an individual are 'product characteristics based tests' and 'determination of past creative activities based tests.' These tests assess an individual's ability through assessing the outcomes of the individual. If we were to judge the creative quality of a given outcome, then assessing the outcome in terms of its novelty and usefulness with the present available products should be adequate; however, if the creativity of an agent has to be ascertained, it may probably be also important to check whether the agent was consistently creative over a period of time (that is, the agent developed a series of outcomes that were both novel and useful). So, the measure for creativity of agents should probably be based on their past creative activities, in which consistency of the agent in being creative should be checked to ascertain that the agent was able to generate creative outcomes in a number of occasions. These outcomes should be judged for their 'novelty' and 'usefulness,' socially rather

than personally. Thus, a combination of these kinds of tests would probably be an ideal solution to measure the creativity of outcomes or individuals.

9 Factors affecting creativity

Many factors affecting creativity have been identified in literature. However, it is still unclear which of these essential ones are [76]. The factors may be personality characteristics associated with creative individuals [3], or contextual factors that may enhance or discourage an agent's creativity [76]. While some of these factors (such as fluency and flexibility) have been proposed after empirical studies, others (such as the ability to predict outcomes, or bureaucratic procedures) are based on logical arguments only. Through literature review, we have identified over 140 influencing factors (Appendix 3).

Some researchers classified a limited number of influencing factors of creativity. For instance, Shalley [75] identified two broad categories into which the social and contextual factors affecting creativity can be grouped: (i) individual, job, group level factors, or team and (ii) organizational level factors. Amabile [3, 5] and Woodman et al. [90] focused only on personal factors influencing creativity. Woodman et al. [90] identified that individual creativity is influenced by personality factors, cognitive style and ability, relevant task domain expertise, motivation, social, and contextual influences. Similarly, Davis [24] identified several personality traits and abilities of creative people. Not all factors would influence creativity in the same way. The work reported in this paper aims to help identify the core factors of creativity, linking these factors with the common definition.

9.1 Categorization of factors

As stated before, 140 factors influencing creativity have been identified from literature (Appendix 3) and classified according to the type of influence that researchers claim these influences exert on creativity. The factors are grouped into two broad categories and other sub categories (Appendix 3):

1 Intrinsic factors – factors that are intrinsic to an agent, such as its character, attitude, or abilities. Many of these intrinsic factors are influenced by extrinsic factors. Intrinsic factors are further categorized into feeling, attitude, abilities, motivation, and other factors.
2 Extrinsic factors – these are environment-related factors (such as work environment and job types) or problem-related factors. Extrinsic factors can further be categorized into experience and education, information processing, problem and solution, job type and group, organizational, and human resource handling factors.

9.2 Factors of creativity and the common definition

The generic definitions of creativity (Definitions 3 and 4) show that there could be several kinds of factors that would influence creativity, such as process-related factors, agent-related factors, factors influencing only the generation of ideas, solutions, and products, and factors that influence novelty and value of ideas, solutions, and products. However, as discussed, the outcome of a creative act must be novel and valuable; thus, factors that influence novelty and value of ideas, solutions, and products are regarded here as the major factors of creativity. With this understanding, we searched for those factors that affect novelty and value. Direct association was not found; however, few factors could be found that indirectly influence novelty and value (or usefulness) of the outcome, as given in Table 6.

Table 6 Mapping list of factors that affects creativity[2]

From the common definition	From the list of factors analysed (Appendix 3)
Ability to generate ideas, products or solutions	Abilities: Divergent thinking: idea fluency, flexibility and synthesis ability. The cognitive ability to modify and create new concepts from existing knowledge
Ability to judge the novelty of ideas products or solutions	Abilities: Original in doing things. Can independently judge: Can recognize patterns, can make connections, can use both sides of the brain effectively, can use heuristics effectively, have analogical or morphological thinking, are able to predict outcomes and consequences. Ability for analysis, evaluation, logical thinking. Able to guess, have intuition and insight
Ability to judge the Value/usefulness of ideas products or solutions	Probable Abilities: Have skills such as problem finding, problem construction and definition, combination, and idea evaluation. Can independently judge: evaluation, logical thinking, able to guess, have intuition and insight.

10 Creativity methods

Creativity techniques or creativity methods are used to enhance creativity of individuals, such as designers working for business organizations. Many methods for enhancing creativity have been proposed in the literature. Some methods, such as Brainstorming and TRIZ are popular among product development companies, while others such as 'relational words' and 'ask questions' are not. Efficacy of some of these methods has been evaluated extensively and the results published widely, while for others it has not been evaluated. It is unlikely that all methods are equally effective in enhancing creativity [76]. In this work, we identified only those methods that affect creativity directly, and we did this by associating the methods with the proposed, common definition of creativity.

10.1 Literature review

Ninety-three creativity enhancing methods and techniques were collected from published literature (Appendix 4). Many of these methods were developed only to affect a particular portion of the design process (e.g., 'Brainstorming' is generally used in the idea generation phase of design, 'Ranking methods' are used for idea evaluation, etc.). Since creativity is often related to the idea generation phase of design, most creativity enhancing methods are found to focus on supporting idea generation. Work by Cross et al. [20] provides an extensive analysis of methods used during design activities.

While some methods are meant to be used by individuals working alone, others are for individuals working in groups. For instance, methods like 'Bug Listing,' 'Five Ws and H,' and 'Fish Bone Diagram' are primarily meant to be used individually even though these could also be used in groups; whereas methods like 'Pin Cards,' 'Quality Circles,' and 'Panel Consensus,' are effective in creative problem solving only when there is a group of four to eight individuals (see Appendix 4 for details of some of these methods).

---

[2] Finding problems, requirements or criteria for evaluation help to enhance the solutions [56]. Thus, it could be argued that certain factors might indirectly influence the 'ability to judge the usefulness of ideas products or solutions.' Hence we mention 'probable factors' for the factors that affects the 'ability to judge the value (or usefulness) of products or solutions.'

10.2 Clustering creativity methods and analysing them

Literature reveals that many creativity methods such as Brainstorming have both positive and negative aspects. In order to eliminate the negative aspects and to customize these methods, researchers have developed various modified versions of an original method. For instance, the method 'Brain Sketching' is a modified version of 'Brainstorming,' where, instead of sentences, drawings are used to express ideas. Similarly, 'Gallery Method,' 'Pin Cards' and 'Greetings Cards' are all similar techniques with little variations. These methods are enlisted in Appendix 4. 'Similar methods,' in Appendix 4, are those that are broadly similar to the main method under which they are categorized.

When a method is partially different from a generic, main method, this method is classified as a 'variant' of the main method. For instance, the method 'Morphological Forced Connections' is a variation of 'Attribute Listing.' The categorization of the methods resulted in 17 clusters (Appendix 4). The first cluster is shown below.

Cluster 1: General method type: Brainstorming

Classical Brainstorming:

1 Arrange a meeting for a group of typically 4-8 people
2 Write the topic on a whiteboard
3 Review the ground rules: Avoid criticising ideas / suspend judgement
4 Generate ideas to solve the problem without criticizing any idea
5 After a certain time period when generation of ideas has ceased to continue - evaluate the ideas, build upon other's ideas and then select the best
6 Similar methods: Value Brainstorming, Rolestorming

Brain sketching:

1 A group of 4-8 people sit around a table, little far from each other
2 The problem statement is agreed, and discussed until understood
3 Each participant privately draws one or more sketches
4 Then they pass each sketch on to the person on their right when it is finished
5 Participants take the sketches passed on to them and either develop or annotate them, or use them to stimulate new sketches
6 The sketches are collected, displayed together and discussed, evaluated and selected
7 In short - Present starter ideas, Private brain writing, Change sheet, Repeat
8 Similar methods: Pin Cards, Brainstorming, Brain Writing, Force Fit Game
9 Variants: Brain Writing, Brain Writing Pool, Brain Writing 6-3-5, Idea Card Method, Brain Writing Game, Visual Brainstorming, Collective Notebook Method (CNB Method), Crawford Slip Writing, Nominal Group Technique(NGT)

Imaginary Brainstorming:

1 Define the problem making sure it has a subject - who is acting as a verb - the action.
2 Later perform classical brain storming

Bullet Proofing:

The Bullet Proofing technique aims to identify the areas in which a plan might be especially vulnerable: What may possibly go wrong? What are some of the difficulties that could occur? Later perform classical brain storming. Similar methods: Negative Brainstorming, Potential Problem Analysis. Variants: Help Hinder

Sculptures:

This technique entails physical production of a 3-dimensional theoretical 'sculpture' of a problem and promotes physical activity, collaborative work and the playful attribution of new meanings to physical materials.

Super Heroes:

1 Prepare in advance a set of general information on each superhero. This could include name, special powers, weaknesses, pen picture, background, picture etc. You can also provide props if you have an extrovert group
2 Display and discuss the problem
3 Select a superhero and think about him
4 Start by getting each superhero to voice a few ideas. Allow other superheroes to trigger off the others' ideas
5 When you have sufficient number of ideas, evaluate them as usual

Highlighting: Starting from a large list of ideas (e.g. from brainstorming):

1 Draw out ideas that seem intriguing or interesting (regardless of viability)
2 Sort into clusters of related ideas, each cluster being a hotspot
3 Recognise the 'hotspots' that mean something to you - does it have any 'associations,' perhaps it has unusual consequences or implications?
4 The final solution is the 'hotspot,' or combination of several hotspots, that best suit your needs
5 Similar methods: Consensus Mapping

The above clustering shows only overall similarity among techniques. What we need is a more detailed understanding of what exactly each step does. To find similarities between clusters, each step of all the creativity technique have been compared with one another. This analysis led to a much deeper understanding of the techniques with respect to the intension of each step in the method. With this analysis, we developed a more generic set of clusters, shown in Appendix 5. Appendix 5 shows clusters of methods having similarity in terms of their steps, thereby comparing them at a higher level of abstraction.

Table 7 Method clusters

From the definition	Method Steps (general description, see Appendix 5)	Methods examples (Appendix 4)
Better process of creating ideas, products and solutions	General methods (process based consisting of most of the stages of problem solving)	Creative Problem Solving (CPS): Phases of Integrated Problem Solving (PIPS), DO IT: Simplex
Methods enhancing idea generation	'Make a group,' 'Problem given,' 'Generate concepts individually and build upon others ideas' , 'Suspend judgment,' 'Evaluate and select'	'Brainstorming: Value Brain Storming, Role Storming,' 'Brain Sketching: Brainstorming, Brain Writing, Force Fit Game'
Methods for better product design	'Identify the product to improve,' 'Identify alternative ways to achieve each attribute,' 'Combine one or more of these alternative ways'	'Attribute Listing: Heuristic Ideation Technique (HIT),' 'Morphological Forced Connections, Slice and Dice'
Methods for better solution generation	'Describe the problem,' 'Ask a set of questions'	Check List: Criteria for idea finding potential, Exaggeration (magnify or minify)

10.3 Linking clusters of the methods with the common definition of creativity

According to Definition 3, creativity-enhancing methods are those that help agents to 'generate ideas, products or solutions that are novel and valuable.' From the analysed list (Appendix 5), none of the methods seemed to support this directly. Therefore, this statement has been further divided into sub parts with the hope that two or more clusters of methods applied together would help attain the overall aim (Table 7). Table 7 shows part of the definition, and identifies applicable methods that could be categorized under each part. The assumption was that a combination of these selected methods should help in enhancing creativity.

Table 8 Linking among definition, measure, factors and methods

Sl	Definition of creativity	Tests derived from the definition	Factors derived from definition	Possible enhancing methods
1	Creativity occurs			
2	through a process	Whether the process is creative	Factors affecting creativeness of a process	Better process for creating ideas, products and solutions (Table 7)
3	by which an agent			
4	uses its ability	Whether the agent possesses creative abilities (Section Development of a common set of measures for creativity)	Agent based factors: Ability to generate ideas, products or solutions that are novel and useful (Table 6)	Methods enhancing creative abilities of an agent. (Table 7)
5	to generate ideas, solutions, and products	Measure for generation of ideas, solutions, or products	Generation of ideas, solutions, or products (Table 6)	Methods to enhance the abilities of the agent to enable generation of ideas, solutions, and products (Table 7)
6	that are novel	Measure for novelty of the generated ideas, products or solutions	Novelty of the ideas, solutions, or products (Table 6)	Methods for the generation of novel ideas, solutions, or products
7	that are value (or usefulness)	Measure for value or usefulness of the generated ideas, products or solutions	Value or usefulness of the Ideas solutions, or products (Table 6)	Methods for the generation of valuable ideas solutions, or products

11 Application - using the 'common' understanding

In the previous sections, we have seen how one can associate creativity tests, factors and methods of creativity with the common definition of creativity. In this section, we connect all of them together to have a comprehensive overview of creativity. First, the generic or common definition of creativity is divided into a number of sub-divisions. Next, associated tests, influencing factors and enhancing methods are identified. This provides us with a comprehensive understanding of creativity as captured in Table 8. For instance, in Rows 5-7 of Table 8, where the goal is generation of novel ideas, solutions or products, we see that measures for these would respectively be in terms of measures for the ability to generate ideas, solutions or products. The corresponding factors are those that can influence these abilities. These factors could be enhanced using methods for enhancing idea, solution or product generation. Now, Table 7 could be used to select

methods that could help an agent in idea, product or solution generation, and the outcome of using these methods could be evaluated with an outcome-characteristic based test. Similarly, from Row 6-7, we can argue that both novelty and usefulness of the outcome of a design process should be assessed in order to ascertain the creativity of an individual.

This linked network (Table 8) of aspects of the common definition, measures, factors and methods of creativity can be used as a checklist for enhancing training, assessment and nurture of creativity. Table 8 is a kind of landscape of creativity, and could be used in several ways:

- Developing appropriate tests for creativity: As stated, there is no test for assessing an agent's creativity with respect to its ability to generate novel and valuable ideas, solutions, or products. Table 8 indicates a need for developing tests that assess an agent's creative abilities by assessing novelty and value (or usefulness in the context of design) of its outcome.
- Development of appropriate creativity enhancing abilities: Tables 7-8 indicate that there is no available method for improving not only 'the ability to generate ideas, solutions, and products' but also making them 'novel' and 'valuable.' Using Table 8, one could focus on the area of method development. For instance, methods should be developed for enhancing the ability of an agent to generate multiple ideas, solutions, and products, to evaluate them for their novelty and value, and to select the best one.
- Recruiting creative individuals: One could measure creative ability of individuals through the measurement of abilities, such as, divergent thinking and cognitive abilities, and abilities that help in judging novelty and usefulness of outcomes. Possessing skills such as problem finding, problem construction and definition may also be important. This can be done using tests like 'past creative activities measuring tests.' The outcomes could be assessed using 'product characteristic based tests' (selection of agents with creative abilities, using row 4 in Table 8).
- Enhancing the creative ability of existing creative individuals: Creativity of existing staff members of a company could be enhanced by offering courses in which creativity methods are used to help individuals to generate many ideas, solutions, and products (Table 7). Next, the individuals could be encouraged to select, using assessment methods, those outcomes that are both novel and valuable.

12 Conclusions and further work

A 'common' definition and related 'common' factors of creativity have been proposed. With an initial compilation of 164 definitions of creativity, 50 'expert' definitions from creativity researchers were subsequently selected and analysed for commonalities across them, leading to the construction of a 'common' definition, using two different methods viz. majority analysis and relationship analysis.

It should be noted here that we tried to develop the common definition of creativity from work of established researchers. Thus, it is possible that the final definition matches with some of the researchers' definitions, for instance, with the definition proposed by Amabile [4]. Ideally, it should have been matching with all the definitions, and we could have said that the term 'creativity' means the same to all researchers across all the research areas. In the absence of such a situation, we developed the common definition. This generic definition of creativity, as developed by merging the definitions created using two different methods, provides a more collective notion of creativity, which expresses that creativity essentially has two important measures – novelty and value (which becomes usefulness in the context of product development). It was also found that most (45 out of 50, Appendix 1) of the definitions used a single noun or a noun phrase to characterize 'creativity.' This seems to mean that most authors think that creativity can be judged by considering its outcomes (noun).

With the common definition, we identify appropriate tests, factors, and methods of creativity. Zampetakis [92] states that "the most difficult task in evaluating creativity is to define what is to be measured; that is, to define creativity." This is exactly what we have tried to achieve in part of this work- identity the

appropriate test from the definition. Ideally, we should have a test for agents that measures as to whether the agent for many years has been developing multiple outcomes, which are novel and valuable (useful). However, in the absence of such as a situation, we encourage use of 'product characteristics based tests' (for novelty and usefulness) and 'determination of past creative activities based tests' (for assessing duration) for assessing creativity of agents.

In Section 9, we have noted that even though there are many factors that claim to influence creativity, none of these aims to judge creative outcomes based on both its novelty and value (usefulness). However, still we can identify a set of factors (Table 6) that when considered together could be considered appropriate for influencing creative outcomes of agents.

We analyse 93 creativity methods. However, from the analysed list (Appendix 5), none of the methods seem to directly support enhancing generation of outcomes that are both novel and useful. The corresponding definitions considered for these factors differ considerably and often are non-existent. However, in Table 7, we identify a cluster of methods that could be used by organisations to achieve similar outcomes when applied together.

Together, we categorized various factors, tests, and methods for enhancing creativity and proposed potential common factors, tests, and methods for creativity by relating them to the common definition. This correlation, as shown in Table 8, should help attain a more comprehensive understanding of creativity, in which the definition, measures, influences and methods are linked with one another. Depending on the focus on the major factors of creativity, derived from the common definition, an organisation can select a specific set of tests and methods suitable for its purpose.

This work shows the wide range of creativity definitions that exists. These definitions are synthesized into a common definition of creativity. Using this definition, we could identify creativity tests that can assess creativity of people, factors affecting creativity, and creativity enhancing methods.

In this work, we define creativity with the common understanding from the domain experts, mainly from product design. Thus, the creativity definition is more inclined towards tangible product assessment. However generic this definition is, from the point of art, this definition may or may not be fully applicable. Similarly, it is not clear as to whether this definition and this work would be fully applicable in assessing creativity of works of literature, poetry, music, and drama. However, the generic definition of creativity consisting of novelty and value should be applicable for assessing the outcome of any tangible solutions, including architectural work. Value could perhaps be expressed in terms of liking of people - the emotional value of experiencing a piece of art.

The work has potential benefits or implications for design professionals and design education. We believe that this work would be useful to many companies in several ways. With appropriate tests, companies should be able to select appropriate creative persons, measure their outcomes, compare products, and select methods for enhancing creativity of employees. We argue that the work as a whole contributes to the understanding of creativity in general and design creativity in particular. We also show how appropriate tests, factors and methods can be selected with the common definition of something, here creativity. Similar work could be done in other areas, such as innovation or competitiveness. Additionally, using this methodology, creativity tests, factors, and methods could also be found related to the domain of art. In

design education, for instance, educators could use this approach to select appropriate tools to measure creativity of students.

This work opens up many possibilities for further research. Even though a large corpus of research has been conducted on creativity over several decades, research in certain specific areas is still needed. From the common definition, we see that 'novelty' and 'value' (or 'usefulness') are the main measures of creativity. However, in Section 9, we have not found a direct correlation of the factors of creativity with these measures. Besides, in Section 10, no test was found that aims to measure the ability in an individual or an outcome, for both its novelty and value.

This research shows that further work is required for developing tests to assess novelty and value, and methods for enhancing the ability of individuals to generate outcomes that are both novel and valuable. One way to develop an appropriate creativity test would be to propose a comprehensive test by combining the essential test parameters of multiple tests under 'product characteristics based tests' (for novelty and usefulness) and 'determination of past creative activities based tests.' Similarly, creativity enhancing methods could be proposed for enhancing an agent's (i) ability to develop many outcomes that are both novel and useful (ii) and to simultaneously judge them using an appropriate creativity test. Later, this method could be assessed against creative individuals for statistical validation.

Bibliography

[1]   **Adams JL** (2001) Conceptual blockbusting: A guide to better ideas, Basic Books
[2]   **Amabile TM** (1983) The social psychology of creativity, Springer Verlag, New York
[3]   **Amabile TM** (1988) A Model of Creativity and Innovation in Organizations. In In B Staw & LL Cummings eds Research in Organizational Behavior 10, 123-167
[4]   **Amabile TM** (1996) Creativity and innovation in organizations, Harvard Business School, 5:9 396-239
[5]   **Amabile TM** (1996) Creativity in context: Update to "the social psychology of creativity." Westview press
[6]   **Amabile TM Conti R Coon H Lazenby J** and **Herron M** (1996) Assessing the work environment for creativity, Academy of management journal 1154-1184
[7]   **Barron F** (1995) No rootless flower: an ecology of creativity, Cresskill, Hampton Press NJ
[8]   **Barton JH** (2000) Reforming the patent system, Science (Washington), 287:5460, 1933-1934
[9]   **Batey M** (2012. The Measurement of Creativity: From Definitional Consensus to the Introduction of a New Heuristic Framework. Creativity Research Journal, 24:1 55-65
[10] **Bilton C** (2007) Management and creativity: From creative industries to creative management, Wiley-Blackwell
[11] **Boden MA** (1999) 18 Computer Models of Creativity. In Handbook of creativity, Cambridge University Press, 351
[12] **Bonk CJ** (2003) Creativity Test: Overview [www.indiana.edu/~bobweb/Handout/cretv_6.html]
[13] **Brown RT** (1989) Creativity: What are we to measure? In Glover JA Ronning RR and Reynolds CR eds, Hand book of creativity, Phenum, New York, 3-32
[14] **Bruner JS** (1962) The conditions of creativity. In Contemporary Approaches to Creative Thinking, 1958, University of Colorado, Atherton Press
[15] Cambridge Advanced Learner's Dictionary (2014) Cambridge University Press
[16] **Chakrabarti A** and **Bligh TP** (1996) An approach to functional synthesis of mechanical design concepts: Theory, applications, and emerging research issues, AI EDAM, 10:4 313-331
[17] **Craft A** (2001) An analysis of research and literature on creativity in education. Qualifications and Curriculum Authority
[18] **Cropley A** (2006) In praise of convergent thinking. Creativity Research Journal, 18:3 391-404
[19] **Cropley AJ** (2000) Defining and measuring creativity: are creativity tests worth using? Roeper Review, 23:2 72-79
[20] **Cross N Christiaans H** and **Dorst K** (1996) Analysing design activity, Wiley
[21] **Csikszentmihalyi M** (1998) Creativity and genius: A systems perspective. Genius and the mind: Studies of creativity and temperament 39-64
[22] **Cziulik C** and **Driscoll J** (1997) Conceptual design evaluation based on function metrics, Schriftenreihe WDK 411-416
[23] **Dasgupta S** (2008) Creativity in invention and design, Cambridge University Press
[24] **Davis GA** (1998) Creativity is forever, Kendall/Hunt Publishing Company

[25]   **Davis GA** and **Belcher TL** (1971) How Shall Creativity be Measured? Torrance Tests, RAT, Alpha Biographical, and IQ, The Journal of Creative Behaviour 5:3 153-161
[26]   **De Bono E** (1992) Serious creativity: Using the power of lateral thinking to create new ideas, HarperCollins
[27]   **De Sousa FC** (2008) Still the elusive definition of creativity, Tarptautinis psichologijos žurnalas: Biopsichosocialinis požiūris, 2 55-82
[28]   Dictionary OE (2014), Oxford University Press, Oxford
[29]   **Dorst K** and **Cross N** (2001) Creativity in the design process: co-evolution of problem-solution. Design studies, 22:5 425-437
[30]   Encarta MSN (2014). Dictionary
[31]   **Eppinger SD Whitney DE Smith RP** and **Gebala DA** (1994. A model-based method for organizing tasks in product development, Research in Engineering Design 6:1 1-13
[32]   **Feldhusen JF** and **Goh BE** (1995). Assessing and accessing creativity: An integrative review of theory, research, and development, Creativity Research Journal 8:3 231-247
[33]   **Ford DY** and **Harris III J** (1992) The elusive definition of creativity, The Journal of Creative Behavior 26:3 186-198
[34]   **Gogatz A** and **Mondejar R** (2005) Business creativity: breaking the invisible barriers, Palgrave Macmillan
[35]   **Götz IL** (1981) On defining creativity, The Journal of Aesthetics and Art Criticism 39:3 297-301
[36]   **Grady MF** and **Alexander JI** (1992) Patent law and rent dissipation, Va L Rev 78 305
[37]   **Hausman CR** (1979) Criteria of creativity, Philosophy and Phenomenological Research, 40:2 237-249
[38]   **Im S** and **Workman Jr JP** (2004) Market orientation, creativity, and new product performance in high-technology firms, Journal of Marketing 114-132
[39]   **Isaksen SG** and **Treffinger DJ** (1985) Creative problem solving, Bearly
[40]   **Isaksen SG Dorval KB** and **Treffinger DJ** (2010) Creative approaches to problem solving: A framework for innovation and change, Sage
[41]   **Jay R** (2000) The ultimate book of business creativity: 50 great thinking tools for transforming your business, Capstone
[42]   **Kampylis PG** and **Valtanen J** (2010) Redefining Creativity—Analysing Definitions, Collocations, and Consequences, The Journal of Creative Behaviour, 44:3 191-214
[43]   **Kerr B and Gagliardi C** (2003) Measuring creativity in research and practice
[44]   **Khatena J** (2004) Myth: Creativity is too difficult to measure, Creativity and Giftedness 63-67
[45]   **Klausen SH** (2010) The notion of creativity revisited: A philosophical perspective on creativity research, Creativity Research Journal, 22:4 347-360
[46]   **Kunce C** (2007) How can creativity be developed in graphic design students? Creativity, December
[47]   **Lopez-Mesa B and Vidal R** (2006) Novelty metrics in engineering design experiments, Proceedings of the 9th International Design Conference, 557-564
[48]   **Ludden GDS Schifferstein HNJ** and **Hekkert P** (2008) Surprise as a design strategy, Design Issues, 24:2 28-38
[49]   **Mauzy J Harriman RA** and **Harriman R** (2003) Creativity Inc: building an inventive organization, Harvard Business Press, Cambridge
[50]   **Mayer RE** (1999) Fifty Years of Creativity Research, Handbook of creativity 449
[51]   **McClelland DC** (1987) Human motivation, Cambridge University Press
[52]   Merriam-Webster (2014). Merriam-Webster's Collegiate Dictionary,Merriam-Webster
[53]   **Michalko M** (2006) Thinkertoys: A handbook of creative-thinking techniques, Ten Speed Press
[54]   **Michalski WJ** and **King DG** (1997) Tool Navigator: The Master Guide for Teams, Productivity Press
[55]   **Newell A Shaw JC Simon HA** and **Calif RCSM** (1959) The processes of creative thinking, Defense Technical Information Center
[56]   **Nidamarthi S** (1999) Understanding and supporting requirement satisfaction in the design process, PhD Thesis University of Cambridge
[57]   **Nyström H** (1990) Organizational innovation, In West MA and Farr JL eds, Psychological and organisational strategies, John Wiley NY 143-161
[58]   **Ogilvie DT** (1998) Creative action as a dynamic strategy: using imagination to improve strategic solutions in unstable environments, Journal of Business Research 41:1 49-56
[59]   **Ottosson S** (1995) Boosting creativity in technical development, In Proceedings of the Workshop on Engineering Design and Creativity 35-39
[60]   **Passow AH** (1979) The Gifted and the Talented, Their Education and Development, NSSE
[61]   **Paul S Vera I** and **Silvester I** (2012) Sustainable development and the arts, International Journal of Technology Management 60:1/2
[62]   **Paulus PB** and **Nijstad BA** (2003) Group creativity: Innovation through collaboration, Oxford University Press
[63]   **Perkins D** (1993. Person plus: A distributed view of thinking and learning, In Salomon D ed, Distributed cognitions, Cambridge University Press NY 88 - 110
[64]   **Plucker JA** and **Renzulli JS** (1999) Psychometric approaches to the study of human creativity, Handbook of creativity 35-61
[65]   **Plucker JA Beghetto RA** and **Dow GT** (2004) Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research, Educational Psychologist 39:2 83-96

[66] **Potur AA** and **Barkul Ö** (2006) Creative thinking in architectual design education, In 1st International CIB Endorsed METU Postgraduate Conference Built Environment & Information Technologies, Ankara 113-125

[67] **Puccio GJ Cabra JF Fox JM** and **Cahen H** (2010) Creativity on demand: Historical approaches and future trends, Artificial Intelligence for Engineering Design, Analysis and Manufacturing 24:2 153

[68] **Ramirez MR** (1994) A meaningful theory of creativity: design as knowledge: implications for engineering design, in Proceedings of 24th Conference Frontiers in Education IEEE 594-597

[69] **Rhodes M** (1961) An analysis of creativity, The Phi Delta Kappan, 42:7 305-310

[70] **Rogers CR** (1954) Toward a theory of creativity, ETC: A Review of General Semantics, 11 249-260

[71] **Roozenburg NFM and Eekels J** (1995) Product design: fundamentals and methods, John Wiley

[72] **Schön DA** (1983) The reflective practitioner: How professionals think in action, Basic Books

[73] **Sefertzi E** (2000) Creativity Tools [www.urenio.org/tools/en/creativity.pdf]

[74] **Shah JJ Smith SM** and **Vargas-Hernandez N** (2003) Metrics for measuring ideation effectiveness, Design Studies 24:2 111-134

[75] **Shalley CE** (1991) Effects of productivity goals, creativity goals, and personal discretion on individual creativity, Journal of Applied Psychology 76:2 179

[76] **Shalley CE** and **Gilson LL** (2004) What leaders need to know: A review of social and contextual factors that can foster or hinder creativity, The Leadership Quarterly, 15:1 33-53

[77] **Shrivastava P** (2014. Special volume on Organizational Creativity and Sustainability Theme "Paths for Integrating Creativity and Sustainability", Journal of Cleaner Production 30 1e3

[78] **Simonton DK** (1988) Creativity, leadership, and chance, The Nature of Creativity: Contemporary Psychological Perspectives 386

[79] **Stein MI** (1953) Creativity and culture, The Journal of Psychology 36:2 311-322

[80] **Sternberg RJ et al** (1999). Handbook of creativity. Cambridge University press

[81] **Stevens G Burley J** and **Divine R** (1999) Creativity business discipline= higher profits faster from new product development, Journal of Product Innovation Management, 16:5 455-468

[82] **Torrance EP** (1988) The nature of creativity as manifest in its testing, The Nature of Creativity, 43-75

[83] **Torrance EP** (1968) A longitudinal examination of the fourth grade slump in creativity, Gifted Child Quarterly 12:4 195-199

[84] **Torrance EP** (1969) Creativity. What Research Says to the Teacher (ED078435) 1-36 [http://files.eric.ed.gov/fulltext/ED078435.pdf]

[85] **Torrance EP** (1988) The nature of creativity as manifest in its testing, The Nature of Creativity, 43-75

[86] **Treffinger DJ** and **Poggio JP** (1972) Needed Research on the Measurement of Creativity, The Journal of Creative Behaviour 6:4 263-267

[87] **Unsworth K** (2001) Unpacking creativity. Academy of Management Review 289-297

[88] **Urban GL** and **Hauser JR** (1980) Design and marketing of new products. Prentice-Hall Englewood Cliffs NJ

[89] **Weisberg RW** (1993) Creativity: The myth of Genius, Freeman New York

[90] **Woodman RW Sawyer JE** and **Griffin RW** (1993) Toward a theory of organizational creativity, Academy of Management Review 293-321

[91] **Young JG** (1985) What is creativity? The Journal of Creative Behaviour 19:2 77-87

[92] **Zampetakis LA** (2010) Unfolding the measurement of the creative personality. The Journal of Creative Behaviour 44:2 105-123

[93] http://members.optusnet.com.au/charles57/Creative/Techniques/index.html

[94] http://www.brainstorming.co.uk/

[95] http://www.elsevier.com/wps/find/homepage.cws_home

[96] http://www.google.com/

[97] http://www.mycoted.com/Main_Page

[98] http://www.springerlink.com/?MUD=MP

[99] http://www.ststesting.com/

[100] http://www.tandfonline.com/

[101] https://sites.google.com/site/creativitydata/home

Appendix 1: Analysis of selected creativity definitions

Definition 1: Creativity is the process resulting in novel work accepted as tenable, useful, or satisfying at some point in time (Brown AE) [79]. Phrase (V-Verb Phrase, N-Noun Phrase): process (N). Qualifier ('Adverb' if phrase is verb or 'Adjective' if phrase is noun): novel work accepted as tenable, useful, or satisfying at some point in time (adj.)

Definition 2: Creativity has sometimes been called the combination of seemingly disparate parts into a functioning and useful whole (Adams JL) [1]. Phrase: combination (N). Qualifier: disparate parts into a functioning and useful whole (adj.).

Definition 3: Creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers (Amabile TM) [2]. Phrase: quality of products or responses judged (N). Qualifier: by appropriate observers (adj. or adv.).

Definition 4: The process by which something judged (to be creative) is produced (Amabile TM) [2]. Phrase: process (N). Qualifier: something judged (to be creative) is produced.

Definition 5: 4Ps conception of creativity: Process, Product, Person, Press (situation) (Brown RT) [13]. Phrase: Process, Product, Person, Press (situation) (N).

Definition 6: The creative process is the emergence in action of a novel relational product, growing out of the uniqueness of the individual on the one hand, and the materials, events, people, or circumstances of his life on the other (Rogers CR) [70]. Phrase: growing out (V), process (N). Qualifier: Uniqueness of the individual on one hand, and the materials, events, people, or circumstances of his life on the other (adv.) novel relational product growing out of the uniqueness of the individual on the one hand, and the materials, events, people, or circumstances of his life on the other (adj).

Definition 7: Creativity consists of coming up with many ideas, not just that one great idea (Thompson C) [80]. Phrase: coming up with many ideas (V). Qualifier: not just that one great idea (adj.)

Definition 8: Creativity is socially defined, i.e.: Society determines what is considered to be creative; this differs between societies; in all societies it changes over time (Czikszentmihalyi M) [21]. Phrase: socially defined (N). Qualifier: differs between societies changes over time (adj). Similarly, for other definitions, phrases and qualifiers are found out. Only the definitions are given below. To see all the clusters refer to the website [101].

Definition 9: Process extended in time, characterized by originality, adaptiveness, and realization (MacKinnon D 1975) [51].

Definition 10: The attribute 'creativity' is a property of some cognitive act or process in this case, this being the process that produced the idea or the invention or the design concept called microprogramming. However, the process is deemed to be creative only because of, or only as the consequence of, set of independent attributes or properties attached to the product of that process, in this particular instance, the product being the concept of microprogramming (adj) (Dasgupta 1994) [23].

Definition 11: At the simplest level 'creative' means bringing something that was not there before (De Bono E) [26].

Definition 12: Imagination, which involves the generation of ideas not previously available as well as the generation of different ways of seeing events, is important to achieve creative actions (Ogilvie DT) [58].

Definition 13: Fluency, flexibility, originality, and sometimes elaboration (Torrance EP) [83].

Definition 14: Creativity is the ability to respond adaptively to the need for new ways of being (Barron F) [7].

Definition 15: The ability to bring something new into existence (Barron F) [7].

Definition 16: Phases a person goes through in the creative process:

- Preparation -acquiring skills, background information, resources, sensing and defining a problem
- Concentration – focusing intensely on the problem to the exclusion of other demands – a trial and error phase that includes false starts and frustration
- Incubation – withdrawing from the problem; sorting, integrating, clarifying at an unconscious level; often includes reverie, relaxation, solitude
- Illumination - The AHA! Stage, often sudden, involving the emergence of an image, idea, or perspective that suggests a solution or direction for further work
- Verification, Elaboration - testing out the idea, evaluating, developing, implementing, convincing others of the worth of the idea (Wallas 1926) [3, 1]

Definition 17: Creativity is the ability to produce new ideas and solutions (Heikkila 1996) [22]

Definition 18: The occurrence of a composition which is both new and valuable (Miller H 1996) [46].

Definition 19: A creative solution, either new or recombined, must have value. A novel idea is not a creative idea unless it is valuable or it implies positive evaluation (Higgins 1999) [73].

Definition 20: An act that produces effective surprise, this I shall take as the hallmark of a creative enterprise... I could not care less about the person's intention, whether he intended to create. The road to banality is paved with creative intentions (Bruner JS) [14].

Definition 21: Creativity is the paradoxical integration of doing and being. Thus, it is a flexible encounter with our world, an active letting go, an aggressive receptivity, a passive responding. It is the assimilation and integration of polarities to find new directions, new solutions, a fresh viewpoint. It is the integration of our logical side with our intuitive side, our left brain with our right brain. It is all these and more (Young JG) [91].

Definition 22: Creativity is perceived as three dimensional, consisting of the person, the environment, and the cosmos – this last component to include the supernatural forces that illumine creativity at the highest or genius levels (Khatena J 1969) [44].

Definition 23: Process that results in a novel work that is useful (Stein M 1953) [51].

Definition 24: Ways that 'creativity' is commonly used: Persons who express unusual thoughts, who are interesting and stimulating in short, people who appear to be unusually bright. People who experience the world in novel and original ways. These are (personally creative) individuals whose perceptions are fresh, whose judgments are insightful, who may make important discoveries that only they know about. Individuals who have changed our culture in some important way. Because their achievements are by definition public, it is easier to write about them (Csikszentmihalyi M) [21].

Definition 25: Creativity is any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one...What counts is whether the novelty he or she produces is accepted for inclusion in the domain (Csikszentmihalyi M) [21].

Definition 26: Generation of imaginative new ideas, involving a radical newness, innovation or solution to a problem, and a radical reformulation of problems (Newell and Shaw 1972) [73].

Definition 27: A special class of problem solving characterized by novelty (Simon Newell and Shaw) [55].

Definition 28: Production of something new and valuable (Rothenbergin R) [51].

Definition 29: Given the process framework, one could deduce that creativity is a chance juxtaposition of events or components that produces a valuable artefact - one that derives its value from accomplishing certain tasks in an ingenious and original way. The chance or random characteristic is often suggested because of the detached manner in which the synthesis takes place: detached in the sense that there is little or no conscious control over the process (Ramirez MR) [68].

Definition 30: 4Ps conception of creativity: Process, Product, Person, Press (situation) (Rhodes M) [69].

Definition 31: There is some consensus in the creativity research community concerning what to study: Creativity occurs when someone creates an original and useful product (Mayer RE) [50].

Definition 32: Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others (Franken FR) [51].

Definition 33: Creativity is the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive concerning task constraints) (Sternberg RJ) [80].

Definition 34: Creative refers to novel products of value, as in 'The airplane was a creative invention.' 'Creative' also refers to the person who produces the work, as in, 'Picasso was creative.' 'Creativity,' then refers both to the capacity to produce such works, as in 'How can we foster our employees' creativity?' and to the activity of generating such products, as in 'Creativity requires hard work (Weisberg RW) [89].

Definition 35: Creativity is the process of bringing something new into being (Rollo May) [37].

Definition 36: Process, Product, Person, Press (situation), Persuasion (of others of the value of the work) (Simonton DK) [78].

Definition 37: Artefacts are labelled as creative if they are both novel and appropriate; individuals are regarded as creative if they produce creative works (Sternberg RJ) [80].

Definition 38: Creativity is the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive concerning task constraints) (Lubart TI) [80].

Definition 39: A set of abilities, skills, motivations and states linked to dealing with problems (Torrance 1979) [32].

Definition 40: Defines creativity broadly as the process of sensing a problem, searching for possible solutions, drawing hypotheses, testing and evaluating, and communicating the results to others. He adds that the process includes original ideas, a different point of view, breaking out of the mould, recombining ideas or seeing new relationships among ideas (Torrance 1969) [17, 84].

Definition 41: A set of general cognitive processes, which contribute to. Specific creative or divergent thinking abilities and critical thinking skills, which lead to Complex methods of problem solving and decision making (Treffinger DJ) [40,39].

Definition 42: Creativity is the ability to produce new ideas and solutions (Tuomaalain 1995) [22]

Definition 43: Creativity is the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive concerning task constraints) (Oche) [80].

Definition 44: Creativity is usually defined as the successful solution to the problem that requires some degree of insight (Strenberg and Davidson) [80].

Definition 45: Creativity involves production of novel statements of the form 'A is like B' or statements involving novel modifiers for A (Martindale C) [80].

Definition 46: Creativity has often been defined as the process of bringing into being something novel and useful (Sternberg and Hara) [80].

Definition 47: Creativity occurs when a person makes a change in the domain, a change that will be transmitted through time (Csikszentmihalyi M) [80].

Definition 48: Creativity is the generation of ideas that are both novel and valuable. Ideas, here is intended in a broad sense to include concepts, designs, theories and melodies, paintings, sculptures and so on. The novelty may be defined with reference, either to the previous ideas of the individual concerned or to the whole of human history. The former definition concerns P creativity (P for Psychological), the later H creativity (H for historical). H creativity pre supposes P creativity, for if someone has a historically novel idea, then it must be new to the person as well as to others (Boden MA) [80].

Definition 49: Creativity is reflected in the generation of novel, socially valued products.

Creative people are people who characteristically produce creative products. Novelty is often cited as one of their distinctive characteristics, and some form of utility: usefulness, appropriateness and social value (Mumford RP and Redmond G) [80].

Definition 50: Creativity is viewed as an interaction between a person, a task and an environment (Sternberg and Hara) [80].

Appendix 2: Creativity tests

These tests are referred in several literature [43, 24, 94, 97, 99]. The entire summarized list, too long to be published in this paper, has been provided in a website [101] by the authors and can be referred. The tests names and their categorization are mentioned below:

1 Ability Based Tests (42 tests out of 74 tests-57 % of the total number of tests considered): The 42 tests within this category are: Guilford's battery of tests, Torrance Tests of Creative Thinking (TTCT), The Abbreviated Torrance Test for Adults (ATTA), Thinking Creatively in Action and Movement (TCAM), Creatively with Sounds and Words (TSCW), The Torrance Monograph Series, Khatena-Torrance Creative Perception Inventory (KTCPI), The Brief Demonstrator -Torrance Test of Creative Thinking (BD-TTCT), Khatena-Morse Multi-talent Perception Inventory, The Creativity Assessment Packet, The PYTHAGORAS B/C, The Preconscious Activity Scale, Wallas and Kogan's assessment of creativity, Remote Association Task, Kirton Adaptor Innovator Inventory (KAI - creativity style), Structure of the intellect (SOI) Creativity Tests, Thrustone Primary Mental Abilities Schema, Christensen Guilford Fluency Tests, Associations IV Test, Creativity Fostering Teacher Index, Creativity Tests for Children by pg, Denny Ives Creativity Test, Gross Geometric Forms Creativity Test, Independence of Judgment Inventory, Insightful Mathematics, Creativity Self Report Scale, Instruments for Assessing Creativity, Letter Sets Test -I-1, Lewis-Mussen Scale for evaluating Artistic Creativity, The Miller Analogies Test (MAT), Match Problems V, Meeker Creativity Rating Scale, Personal Creativity Assessment, Plot, Purdue Creativity Test, Scales of Creativity and Learning Environment, Selected Creativity Tasks, Spatial Rotation, The Wechsler Abreviated Scale of Intelligence, WASI, The Runco Ideational Behavior Scale, Modes of Thinking, Insight Problems.

2 Character Based Tests (20 tests -27 %): The 20 tests within this category are: Gough's Adjective Check List, The Myers-Briggs Type Indicator, The NEO Five Factor Personality Inventory, The Rorschach Inkblot Test, Thematic Apperception Test (TAT), Luscher Colour Test, PRIDE, How Do You Think, Barron Welsh Art Scale, California Psychological Inventory (CPI), Classroom Creativity Observation Schedule, Creative Attitude Survey , Scales for Rating the Behavioral Characteristics of Superior Students , Crayola Creativity Program Skills Assessment Record, Creativity and Risk-Taking: The Creatrix Inventory, Creativity/Innovation Effectiveness Profile, KEYS : Assessing the Climate for Creativity (originally called the Work Environment Survey), Social Interaction and Creativity in Communication System, Attitudes About Creativity, Creative Ideas and the Strong Interest Inventory.

3 Determination of Past Creative Activities (6 tests- 8 %): The 6 tests within this category are: Biographical Inventory for Students, Biographical Inventory, Parental Evaluation, Bull and Davis Statement of Determination of Past Creative Activities, Creative Behaviour Inventory, Things Done on your Own.

4 Outcome Characteristics Based Tests (3 tests -4 %): The 3 tests within this category are: Creative Product Semantic Scale (CPSS), The Student Product Assessment Form, The Consensual Assessment Technique (CAT).

5 Environment suitability Tests (3 tests -4 %): The 3 tests within this category are: Breakthrough Creativity Profile, Creativity Audit, Group Creativity Index (GCI).

Appendix 3: Categorized intrinsic and extrinsic factors

Tables 9 and 10 list the influences on creativity that have been collected from the literature. For the entire list of factors with sources and description please refer to the website [101].

Intrinsic Factors or Individual Factors

Table 9 List of intrinsic or individual factors

Feeling	A firm sense of self as creative
Attitude	Have serendipity, Having broad interests, open minded, Works hard and uses strenuous mental energy and time on doing creative activity, organized disciplined, committed to work Autonomy, independence, Introversion aloofness, unfriendliness, lack of warmth Self-confidence, Egotistical, arrogance, Dominance, Impulsive and takes risks, not daring to differ, allows ambiguity, taking advantages of chance, challenges assumptions Argumentative, lack of conscientiousness, Norm doubting, non-conformity, hostility, Childish and absent-minded, Neurotic and hyperactive, anxiety affective illness, emotional sensitivity, Sensitive to problems, gives time for oneself to think, reflect and solve problem Attracted to complexity, Artistic, perceptive, Ethical
Abilities	Original in doing things, Concentration and persistence: ability and inclination to engage in deep concentration for long periods, Willingness to occupationally fail an accurate memory Having medium level of intelligence, Visualization/imagination ability: capacity for fantasy and imagination. Can independently judge: Can recognizing patterns, can making connections, can use both sides of the brain effectively, can use heuristics effectively, analogical/ morphological thinking, able to predict outcomes, consequences, analysis, evaluation, logical thinking, able to guess, having intuition and insight, Divergent thinking: Idea fluency, flexibility and synthesis The cognitive ability to modify and create new concepts from existing knowledge, Have skills such as problem finding, problem construction and definition, combination, and idea evaluation Ability to integrate and use the diverse and inconsistent cues existing in these environments and retrieve more information Can work with autonomy: Ensure that new ideas are not abandoned very soon, Ability of designers to share ideas with each other
Motivation	Drive ambition, Having high motivation, curious, having high energy and thrills seeking -Intrinsically motivated
Other factors that may influence	Mental disorder- mental disorder may stimulate crazy associations. Birth order- first born or only child is creative in science, politics or other socially valued areas, while later-borns may excel in artistic and other noon-conformist areas. Traumatic experience- like unhappy childhood can also influence creativity.
Knowledge,	Depth and breadth of knowledge-Domain-specific knowledge

Extrinsic Factors

Table 10 List of extrinsic factors

Experience and education	Individual's level of education, training, expertise, and knowledge within a particular context Openness to experience Education: exposure to a variety of experiences, viewpoints and knowledge bases, use of experimentation and divergent problem solving skills, multiple and diverse perspectives and more complicated schemas. Openness to experience, flexibility of thought, achievement
Information processing	Information retrieved from internal and external sources and connected, synthesized, and encoded in a creative manner. Information retrieval includes a search - collection of existing concepts and creation of new concepts through the connection and modification of existing concepts. Collection and application of diverse information: Access a variety of alternatives, example solutions, or potentially related ideas with the time needed to search that information Communication of ideas and information along with interactions with other functional areas-freely sharing information with others and give input into decisions
Problem and solution factors	Problems are ill-defined, Constraints not imposed until actual idea or solution generation has begun., Idea generation: problem identification and construction, identification of relevant information, generation of new ideas and elaboration, and the evaluation of these ideas abstraction, concept utilization, decomposition
Job type and group factors	Jobs are complex and demanding, Management must set clear organizational goals, indicating creativity goals. Exposed to highly creative people, creative models and cognitive modelling training program focusing on techniques to enhance innovative problem solving
Organizational factors	Values, beliefs, history, and traditions of the organization. Less authoritarian management and less bureaucratic procedure, Stimulate creative talent- by supportive organizational climate and use of techniques, Supportive, non-controlling supervisors create work environment fostering creativity. Constructive controversy- explored, understood, accepted, and combined workers' arguments, Availability of appropriate amount of resources.
Human resource handling	Freedom to use creative talent: Individuals should know that creativity is important in their work from work culture, and they have some autonomy over either how their time is allocated or how their work is to be done. They should also know that the decisions would be taken in a just manner (employees expect to receive constructive, developmental feedback on their work, avoiding negative feedback from leaders). Employees themselves should be involved in many decision-makings. Recognize the creative ability of the team members, Supervisors worked to build employees' self-confidence and modelled activities central to creative performance, employees believed that they had creative capabilities. If creativity is a role expectation, it should be rewarded appropriately. Rewards can be monetary or non-monetary, such as recognition or praise.

Appendix 4: Creativity methods: clusters and description

These creativity methods are collected from many sources [24, 94, 53, 54, 93]. Each method was summarized from multiple sources, before carrying out the analysis. The entire list is provided in a website [101]. Some the clusters are mentioned here.

Clustering of methods has been done based upon the apparent similarity of methods. 'Similar methods' are those that are highly similar. 'Variants' includes those methods that are dissimilar in some steps only.

- ***Cluster 1***: General method type: Brainstorming (discussed in the main text).
- ***Cluster 2***: General method type: Attribute Listing

Attribute Listing:

1 Identify the product or process you are dissatisfied with or wish to improve.
2 List its attributes. E.g. pen, this might include: material, shape, target market, colours, textures, etc.
3 Identify alternative ways to achieve each attribute.
4 Combine one or more of these alternative ways of achieving the required attributes. 5. Use randomly chosen combinations to stimulate ideas.

Similar methods: Heuristic Ideation Technique (HIT). *Variants*: Morphological Forced Connections, Slice and Dice

Assumption Surfacing:

1 Identify a particular choice you have made, and ask yourself why you feel it is the best choice i.e. what assumptions guide this choice.
2 List the assumptions, and beside each write a counter-assumption - not necessarily its negation, but the opposite to the issue it represents.
3 Work down the list and delete ineffective assumption/counter-assumption pairs, i.e., list assumptions as attributes and remove them.

Similar methods: Listing pros and cons, PMI (Plus, Minus, Interaction), Personal Balance-Sheet. *Variants*: Assumption Smashing

Listing:

1 Identify the sort of product you would like to produce (e.g. bathroom equipment).
2 Identify an area in which these exist (e.g. bathroom); catalogue as many objects, products, etc. as you can that exist in that area (e.g. sink, bath, shower, toilet, etc.).
3 Sketch a triangle.
4 For each unit, use free-association to come up with possible ideas.
5 What sort of new bathroom product does bath/shower suggest to you?
6 Choose the top ideas for additional assessment.

Morphological analysis:

1 Define the problem
2 Identify the sub-functions of the system.
3 Find alternatives of the sub functions by using any method
4 Select a link connecting each sub-function
5 Several combinations possible
6 Identify incompatible pairs of solutions
7 Create a solution tree

Similar methods: Analysis of Interactive Decision Areas (AIDA)

Dialectical Approaches: The dialectical approaches use creative conflict to help identify and challenge assumptions to create new perceptions. For instance, the Devil's Advocate Approach is useful in exposing underlying assumptions, but has a tendency to emphasise the negative, whereas Dialectical Inquiry has a more balanced approach.

Variants: Idea Advocate, Assumption Smashing.

Bug Listing: A bug list is simply a list of things that bug you. It may well be the most specific thinking you have ever done about precisely what small details in life bother you. If properly done; a bug list should spark ideas in your mind for inventions, ideas, possible changes, etc.

Ideatoons:

1 Divide your challenge into attributes.
2 Describe each attribute by drawing an abstract graphic symbol. Each drawing should represent a specific attribute and be on a separate index card. Draw whatever feels right for you. Allow the image of the attribute to emerge in its own way - to state what it wants to say. On the back of the card, write the attribute.
3 Place all of the file cards on a table with the graphic symbols facing up.
4 Look for ideas and thoughts that you can link to your challenge. Try to force relationships. Try free-associating. Record the most idea-provoking arrangements.

Cluster 3: General method type: Boundary Relaxation (Attribute Listing)

Boundary Relaxation: First, identify the elements of the boundary; then see how far they can be loosened. The boundary can be identified and defined by a number of different techniques: Checklist, Brainstorming etc. Once a boundary feature has been identified clearly, ask: Would it help if this part of the boundary could be altered? If so, how and when?

Boundary Examination:

1 Write down an initial statement of the problem.
2 Underline key words.

3 Examine each key word for hidden assumptions. A good way to do this is to see how the meaning of the statement changes if you replace a key word by a synonym or near-synonym.
4 Having explored how the particular choice of key words affects the meaning of the statement, see if you can redefine the problem in a better way.
5 The aim is not necessarily to change the position of the boundary, but rather to understand more clearly how the wording of the problem affects our assumptions about the boundary.

Paraphrasing Key Words:

1 Identify key words in the sentence, substitute them one at a time with other words that have the equivalent general meaning, and create different emphases and a different rhetoric.
2 Select grammatical keyword pair.
3 Generate synonyms.
4 Select some interesting word pairs.
5 Use these to trigger ideas.
6 Similar methods: (Boundary examination with trigger word technique)

Multiple Redefinition: Open-ended problems by definition are not well defined - the boundaries are fuzzy - and different stakeholders may have varying boundary perceptions. The solver is unlikely to have a suitable description at the outset of the exact problem in hand and finds redefinition of the problem throughout the project.

Table 11 List of methods (Part 1)

General description	Genre name: Variants or Similar methods
Make a group Problem given Generate concepts individually and build upon others ideas Suspend judgement Evaluate and select	Brainstorming: Value brain storming, role storming Brain sketching: brainstorming, brain writing, force fit game, BrainWriting, BrainWriting Pool, BrainWriting 6-3-5, Idea Card Method, BrainWriting Game, visual brain storming, Collective Notebook method (CNB method), Crawford slip writing, nominal group technique (NGT), Imaginary Brainstorming Bullet proofing: Negative Brainstorming, potential problem analysis. Greetings Cards, Card Story Boards, TILMAG, Storyboarding, Gallery Method: Metaplan or presentation method Help hinder, Sculptures, Super heroes, Highlighting: Consensus Mapping
Identify the product to improve. Identify alternative ways to achieve each attribute Combine one or more of these alternative ways	Attribute listing: Heuristic Ideation Technique (HIT), Morphological forced connections, Slice and Dice Assumption surfacing: Listing pros and cons, PMI (Plus, Minus, Interaction), Personal Balance-Sheet, Assumption smashing, Listing Morphological analysis: Analysis of Interactive Decision Areas (AIDA) Dialectical Approaches: Idea advocate, Assumption smashing Bug listing, Ideatoons Special form of Attribute listing (Boundary relaxation): Boundary examination, Paraphrasing Key Words, Multiple Redefinition
Describe the problem Ask a set of questions	Check list: Criteria for idea finding potential, Exaggeration (magnify or minify), CATWOE, Stakeholder Analysis, SCAMPER, sequential attributes matrix, SCAMPER, Goal orientation, Implementation checklists Reversals: Problem reversal, False faces Repeatable Questions, Ask questions: Dimensional Analysis, Ask questions, Repeatable Questions, Clarification, ISQ, Ideal design
Draw spurs coming off the backbone, one for every likely cause of the problem that the group can think of; and label each at its outer end.	Fish bone diagram: Flow chart action planning
One starts in the centre of the page with the main idea, and works outward in all directions, producing a growing and organized structure composed of key words and key images.	Mind Maps, Concept Fan Free Association Lotus Blossom Technique

Appendix 5: Finding commonality among creativity methods

Each method is clustered by identifying the commonality among them in their respective steps (Tables 11 and 12).

Table 12 List of methods (Part b)

General description	Genre name: Variants or Similar methods
Moving sideways when working on a problem to try different perceptions, different concepts and different points of entry.	Lateral thinking: Bunch of Bananas, Provocation
Have a bag full of thousands of words Randomly pick some. List its attributions or associations with the word. Then apply each of the items on your list and see how it applies to the problem at hand.	Random Input: Metaphorical thinking (style), Stimulus Analysis (working with not related problem) Trigger Sessions; Trigger Method Forced Analogy: Relational Words The Discontinuity Principle (style), With the concept of randomness, Technology Monitoring (similar): Pictures as Idea Triggers Excursions, Browsing, Notebook – guideline, Keeping a Dream Diary: Working with Dreams and Images (advanced version) Collective Notebook (CNB) Fresh eye and Networking
Scenarios are qualitatively different descriptions of plausible futures: (i) Identify the major environmental forces that impact on the decision. (ii) Build four scenarios based on the principal forces. (iii) Build your scenarios around these forces.	Alternative Scenarios Methods based on analysis: Gap Analysis
These techniques aim to aid visualization power which in turn helps to solve problem.	Drawing and visualization techniques. Some of them are: Controlled imagery, drawing and visual thinking, imagery for answering questions, relaxation. Story writing, unconscious problem solving, visualization as goal
General methods (Process based- consisting of almost stages of problem solving)	Creative Problem Solving (CPS): Phase of Integrated Problem Solving (PIPS) DO IT: simplex, Quality Circles, Strategic Choice Approach, Strategic Management Process. Panel Consensus, TRIZ: Contradiction Analysis, ARIZ Value Engineering, Delphi, Systematized Direct Induction (SDI), Syntactic, Decision Seminar
Combinational/ part of	Paraphrasing Key Words =Boundary examination + trigger word technique Pin Cards = Brain-writing with gallery method Free Association= Classical brainstorming + mind mapping Successive Element Integration= combining ideas
Other individual techniques	Anonymous voting, Imitation, Laddering, LARC - Left and Right Creativity, NLP Techniques, Six Thinking Hats

Aims and scope

Today's design strongly seeks ways to change itself into a more competitive and innovative discipline taking advantage of the emerging advanced technologies as well as evolution of design research disciplines with their profound effects on emerging design theories, methods and techniques. A number of reform programmes have been initiated by national governments, research institutes, universities and design practices. Although the objectives of different reform programmes show many more differences than commonalities, they all agree that the adoption of advanced information, communication and knowledge technologies is a key enabler for achieving the long-term objectives of these programmes and thus providing the basis for a better, stronger and sustainable future for all design disciplines. The term sustainability - in its environmental usage - refers to the conservation of the natural environment and resources for future generations. The application of sustainability refers to approaches such as Green Design, Sustainable Architecture etc. The concept of sustainability in design has evolved over many years. In the early years, the focus was mainly on how to deal with the issue of increasingly scarce resources and on how to reduce the design impact on the natural environment. It is now recognized that "sustainable" or "green" approaches should take into account the so-called triple bottom line of economic viability, social responsibility and environmental impact. In other words: the sustainable solutions need to be socially equitable, economically viable and environmentally sound.

IJDST promotes the advancement of information and communication technology and effective application of advanced technologies for all design disciplines related to the built environment including but not limited to architecture, building design, civil engineering, urban planning and industrial design. Based on these objectives the journal challenges design researchers and design professionals from all over the world to submit papers on how the application of advanced technologies (theories, methods, experiments and techniques) can address the long-term ambitions of the design disciplines in order to enhance its competitive qualities and to provide solutions for the increasing demand from society for more sustainable design products. In addition, IJDST challenges authors to submit research papers on the subject of green design. In this context "green design" is regarded as the application of sustainability in design by means of the advanced technologies (theories, methods, experiments and techniques), which focuses on the research, education and practice of design which is capable of using resources efficiently and effectively. The main objective of this approach is to develop new products and services for corporations and their clients in order to reduce their energy consumption.

The main goal of the International Journal of Design Sciences and Technology (IJDST) is to disseminate design knowledge. The design of new products drives to solve problems that their solutions are still partial and their tools and methods are rudimentary. Design is applied in extremely various fields and implies numerous agents during the entire process of elaboration and realisation. The International Journal of Design Sciences and Technology is a multidisciplinary forum dealing with all facets and fields of design. It endeavours to provide a framework with which to support debates on different social, economic, political, historical, pedagogical, philosophical, scientific and technological issues surrounding design and their implications for both professional and educational design environments. The focus is on both general as well as specific design issues, at the level of design ideas, experiments and applications. Besides examining the concepts and the questions raised by academic and professional communities, IJDST also addresses

the concerns and approaches of different academic, industrial and professional design disciplines. IJDST seeks to follow the growth of the universe of design theories, methods and techniques in order to observe, to interpret and to contribute to design's dynamic and expanding sciences and technology. IJDST will examine design in its broadest context. Papers are expected to clearly address design research, applications and methods. Conclusions need to be sufficiently supported by both evidence from existing research (reference to existing design research knowledge) as well as strong case-studies from any design discipline. A paper must contain at least one chapter on research questions, methodology of research and methods of analysis (the minimum length is 1500 words). The concluding chapter (the minimum length is 1000 words) will summarise the paper and its results. The concluding chapter also examines and discuss applications, advantage, shortcomings and implications of the investigation for both professional and educational design communities as well as for the people and the society. Also authors are also encouraged to include in this chapter a discussion of the possible future research that is required or is possible in order to enhance the research findings.

The papers considered for IJDST cover a wide range of research areas including but not limited to the following topics: Design research, design science, design thinking, design knowledge, design history, design taxonomy, design technology, design praxeology, design modelling, design metrology, design axiology, design philosophy, design epistemology, design pedagogy, design management, design policy, design politics, design sociology, design economics, design aesthetics, design semantics, design decision-making, design decisions, design evaluation, design sustainability, design logic, design ontology, design logistics, design syntaxis, design ethics, design objective, design responsibility, design environment, design awareness, design informatics, design organization, design communication, design intelligence, design evaluation, design education, design theories, design techniques, design methods, design operations, design processes, design products, design users, design participation, design innovation, design inspired by nature, design case studies, design experiments, etc.

International Journal of Design Sciences and Technology is devoted to further exploration of all themes and issues that are directly or indirectly relevant to the exploration, introduction, discussion of design sciences and technology, cross referencing domains and any other themes emerging in the future.

Instructions for Authors and Review Process

Pre-review Stage (Editor Global Review): Papers can only be considered for review when they deal with a subject relevant to the content of the journal. In addition all papers submitted must follow the journal's paper structure and Author Instructions before they can be considered for review. ***These instructions also affect the content of the paper.*** Authors can choose to submit a short paper (about 5000-8000 words). The preferred size of a paper (monograph) is about 10000 words (maximum 15000 words). The title must not be longer than seven words. Subtitles are not permitted. The maximum length of the abstract is 150 words. All papers must contain an introductory chapter with extensive literature review of similar research. The paper devotes at least one chapter to detailed discussion of research questions, research analysis and research methods. The conclusion will summarise the research and its results. In addition this chapter includes a detailed discussion of applications, advantage, shortcomings and implications of the investigation as well as future research for both design professionals and the design education. Submit a paper at this stage as PDF.

Review Stage (Peer Review): Only papers meeting all IJDST requirements can be considered for review. All papers are blind-reviewed by at least two expert reviewers. The main author of a reviewed and accepted paper will be notified with instructions to resubmit the paper. All reviewed and accepted papers have to be resubmitted, implementing reviewers and editors comments and/or suggestions. Only accepted papers conforming to instructions will be considered for publication in the International Journal of Design Sciences and Technology. A paper should follow the IJDST paper structure. The review process will be repeated until all requirements are met.

The first page of the paper must contain the full title of the paper as well as the Name (no initials) & Surname, affiliation, address, telephone, fax and email of the corresponding author to whom all correspondence to be directed. If applicable please also mention the Name (no initials) & Surname, affiliation, postal address, telephone, fax and email of the co-author(s).

The second page contains the full title of the paper (maximum 7 words), the sub-title is not permitted, an abstract of about 50 to 150 words summarising the content of the paper and 3-5 keywords for the purpose of indexing (the use of references in the abstract is discouraged). The length of a short paper is about 5000-800 words. The preferred size of a paper (monograph) is about 10000 words (maximum 15000 words). The use of Footnotes is permitted (maximum length is about 50 words). Footnotes should be numbered consecutively. For instance: [[17 A 'footnote' reflects additional information, a reference or the URL of a website]].

 The paper will be written in the UK English. It will be single-spaced with 30 mm margins on all sides (paper size A4). Use Times New Roman for the main body of text (size 10), figures (size 8) or tables (size 8). The use of Bold, Italics, ALL CAPS, SMALL CAPS, etc. is discouraged. All chapters should be numbered consecutively (more than two level sub-headings is discouraged). All Figures and Tables with their respective captions should be numbered consecutively. They should each, be placed on a separate page, at the end of the paper. Give an approximate insertion point for figures and tables, between double square brackets. For instance: [[insert Figure 5]]. You will be asked to resubmit tables, figures and images if necessary. **The paper must be submitted in plain text.** Do not layout your paper. *Do not use any styles or any automatic layout system*. Please do not use 'Track Changes'.

All tables should be clearly referred to in the main body of text as Table 1, Table 2, etc. All Figures should be clearly referred to in the main body of text as Figure 1, Figure 2, etc. Line drawings should be of good quality. Use light background if possible (white is preferred). Photographs and screen-shots should also be submitted separately as JPEG files (use high resolution for better results). Authors should prepare high quality figures and drawings. The use of colours in your illustrations is permitted although the hardcopy of the journal is not published in colour. Maximum width and height of a figure are respectively 150 mm and 190 mm. Maximum width and height of a table are respectively 115 mm and 170 mm. All Equations will be numbered consecutively and should be clearly mentioned in the main body of text.

All references will appear at appropriate places in the main body of text. References are collected at the end of the paper and are arranged in alphabetical order (numbered consecutively) by the first author's surname, followed by initials. All authors should be mentioned. Dates will appear between brackets after the authors' name(s). This is followed by the title of the book, name of the publisher, place of publication and page numbers (if applicable). To refer to a journal paper, add the full title of the journal followed by **V**olume:**N**umber and page(s), for example 20:2 89-124.

The number of references to the author's own previous publications will not exceed 5% of the total number of references. References that are not mentioned in the main body of text are not allowed. Examples of references to a book, a journal or a website are shown below:

[1] **Beckett K L** and **Shaffer D W** (2004) Augmented by Reality: The Pedagogical Praxis of Urban Planning as a Pathway to Ecological Thinking, University of Wisconsin, Madison

[2] **Blackman, D A** (2001) Does a Learning Organisation Facilitate Knowledge Acquisition and Transfer? Electronic Journal of Radical Organization Theory, 7:2 [www.mngt.waikato.ac.nz/Research/ejrot/Vol7_1/Vol7_1articles/blackman.asp]

[3] **Buxton, W** (1997) Living in Augmented Reality: Ubiquitous Media and Reflective Environments. In: Finne K, Sellen A and Wilber S eds, Video Mediated Communication, Erlbaum, Hillsdale N.J., 363-384

[4] **Dixon, N M** (2000) Common Knowledge: How companies thrive by sharing what they know, Harvard Business School Press, Boston, MA

[5] **Djenidi H**, **Ramdane-Cherif A**, **Tadj C** and **Levy N** (2004). Generic Pipelined Multi-Agents Architecture for Multimedia Multimodal Software Environment, Journal of Object Technology, 3:8, 147-169

[6] **Gorard, S** and **Selwynn, N** (1999) Switching on to the learning society? Questioning the role of technology in widening participation in lifelong learning, Journal of Education Policy, 14:5, 523-534

[7] **World Bank** (2002) Social assessment as a method for social analysis, World Bank Group [www.worldbank.org/gender/resources/assessment/samethod.htm]

The definitive paper is submitted as plain text MS Word file for the PC (MS Word RTF format for the Macintosh). In addition, a formatted version of the paper (including images and tables at their approximate places) will be submitted in PDF format (to be used as a guideline for the layout). All figures must be submitted separately in high resolution jpg format. Submit your paper as an email attachment addressed to the Editor-in-Chief [Submit2IJDST@Gmail.com].

Author(s) of an accepted paper have to complete, sign and return a Copyrights Transfer Form to the publisher. This copyrights transfer assignment will ensure the widest possible dissemination of information. Papers published in the International Journal of Design Sciences and Technology cannot be published elsewhere, in any form (digital, paper-based or otherwise) without a prior written permission from the publisher.

The author(s) are responsible for obtaining permission to utilize any copyrighted material. For more details about this subject, please contact the publisher at an early stage.

A paper can be rejected at any stage if the requirements are not met. The decision of the Editor-in-Chief on all matters related to the International Journal of Design Sciences and Technology including the review process, publication of papers, etc. is final and cannot be disputed.

There is no deadline for the publication of an accepted paper that will be published online within one to four months after the final re-submission is accepted. The hardcopy book of the volume will be published when 8 papers are published online. The corresponding author of a paper published in the International Journal of Design Sciences and Technology will receive a digital copy of the author's paper free of charge. Hard copies of any individual paper (minimum 100 copies) and the hardcopy of the IJDST Volume (containing 8 papers published online) can be purchased from the publisher (ask for an invoice from the publisher IJDST@europia.org).

How to Order

IJDST-online

You can view and download a digital version of individual papers free of charge from the journal's website.

IJDST Hardcopies

Hardcopies of individual papers (minimum order 100 copies) and volumes (minimum order is one single copy of the book containing 2 issues) can be ordered directly from Europia Productions. You need to send your **Request for an Invoice** (preferably by email, Fax or letter) indicating details of your order and the quantities. Please provide your full name and initials, postal address, email and telephone number. An invoice will be sent to you indicating the total amount of your order, the cost of packing/postage and method of payment.

Individual Subscription IJDST Hardcopies

Individuals can subscribe to receive a hardcopy of the book containing 2 issues for € 200.00 (incl. 5.5 % VAT, packing and postage). You need to send your **Request for a Subscription Invoice** (preferably by email, Fax or letter) indicating the IJDST Volume. Please provide your full name and initials, postal address, email and telephone number. An invoice will be sent to you indicating the method of payment.

Institutional Subscription IJDST Hardcopies

Libraries and organisations can subscribe to receive a hardcopy of the book containing 2 issues for € 200.00 (incl. 5.5 % VAT, packing and postage). You need to send your **Request for a Subscription Invoice** (preferably by email, Fax or letter) indicating the IJDST Volume. Please provide details of the library or organisation, name contact person, postal address, email, telephone number and Fax number. An invoice will be sent to you indicating the method of payment.

Other Publications

Other Europia Productions publications can be ordered from the address below. You always need to send your **Request for an Invoice** (preferably by email, Fax or letter) indicating details of your order and the quantities. Please provide your full name and initials, postal address, email and telephone number. An invoice will be sent to you indicating the total amount of your order, the cost of packing/postage and method of payment.

Europia Productions

15, avenue de Ségur, 75007 Paris, France

Telephone +33 1 4551 2607 / Fax +33 1 4551 2632
E-mail: ijdst@europia.fr
URL: http://europia.org/ijdst/

europia