Digital Creativity

A Survey for the Project Invisibilia

Antonio Pizzo, Andrea Valle

Introduction

The concept of digital creativity has appeared in recent years and has overcome (and partially absorbed) a sort of informal set of definitions that included terms as multimedia, virtual, new media, digital art, net art, and many others. This represents a shift in a terminology that, although still unstable and unpredictable, demonstrates an important advancement in both the history and practices, and, even more, it depicts a new theoretical framework. Though as preliminary basis, we believe that this step is the result of a more marked difference between what is considered as code and what is perceived as language material. In the field of artistic production, digital media came into play first as a language material available to be used in different and creative practices. For example, in the field of performance, digital video followed the course of electronic video, therefore it was used as a new element available on stage (see for example the early works of The Wooster Group in USA or Falso Movimento in Italy)[1]. In fact, the notion of digital media as a linguistic material appears very clearly in the field of theatre and performance in which the new opportunities where at first incorporated as elements of the set design. In this configuration, just as linguistic material, the focus was on the peculiarities of the object / sign and its phenomenological characteristics. This can be briefly summarized as a cultural behaviour that focuses on technology; thus digital arts are those arts that were carried out using production methods, or objects, derived from the language modules of computer science. Computerized light console, music and audio editing software, video recording and video projection systems, for example, are at the core of this approach. As remembered by Manovich for Bitstreams (the exhibition at Whitney Museum, 2001), «the show on new media art did not include any computers or interactive works. Instead, new media was reduced to flat images

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[1] For an introduction at the work of The Wooster Group cf. David Savran, *Breaking The Rules*, Theatre Communications Group, New York 1986; for a overview on Falso Movimento's activity cf. Laura Ricciardi, *Mario Martone regista teatrale. Dalla scena alla parola 1977•1992*, and *Mario Martone regista teatrale. Dalla parola allo spazio 1993•2012*, Artstudiopaparo, Napoli 2014.

on the walls: stills presented as digital prints, or moving images presented with projectors or plasma screens. The descriptions of the works were positioned within the familiar and well-rehearsed narratives and categories of standard 20th century art text-books. In short, new media was neutralized, diluted, and rendered harmless, similar to the way commercial culture now takes over most of the new radical cultural developments, from hip-hop to techno»[2].

But, as it has happened with television and the web, over time, the changing of the production practices has triggered a new, shared aesthetic awareness and, consequently, a specific code. In other words, the new digital tools have been gradually taken for granted, therefore the cultural focus has moved toward the artistic principles that govern the work of art. This coincides with the emergence of the so-called interactive media that oriented the investigation toward a more specific identity of digital art. In fact, if we were keen to provide a formal description to account for an interactive object of art we ought to face a complete displacement of the traditional elements of art (such as space, body, sound, shapes, colours, dynamic). Overall, the use of digital and interactive media contains this sort of variation of the traditional elements of the arts. This new awareness has surpassed the particular productive technology and has affirmed an autonomous code. We assume that from this perspective one can see the panorama of artistic creation in a new light. In this sense, it follows that a series of works of art emerges, featuring a new language. Despite the fact that this is not enough to configure a proper aesthetic of the digital, in this framework it is fairly possible to foresee a common ground, and this that is what we describe as digital creativity.

Within the project INVISIBILIA, and following the considerations in a previous project called DigiLine, we believe that there are the conditions to verify and measure this common ground[3].

Discipline boundaries do not work here. It is almost impossible to cluster the manifestation of digital creativity in terms of theatre, film, music, fine art, etc., as it is clear if we browse the archive of Ars Electronica, one of the major exhibitions in this field[4].

Furthermore, the artistic productions found within the common area called digital creativity are invisible cultural objects. They are the embodiment of an oxymoron: non-existent objects. As in some sense they may be seen as *unrealized*, they escape the canons of modernism and postmodernism. They communicate some meaning and provide an aesthetic experience; in their existence we can recognize a production history. Hence they behave partially like an object,

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[2] Manovich, Lev, *Ten Key Texts on Digital Art: 1970-2000*, «Leonardo», 35, 5, October 2002, pp. 567-569.
[3] Cf. Giulio Lughi, *Creatività digitale e reincanto tecnologico,* «MEDIASCAPES JOURNAL», 1 (2013).
[4] Cf. <http://www.aec.at/about/en/>.

but something else is missing; they are kind of displaced and ephemeral as something that does not exist materially; thus, they behave like a concept.

Although the project INVISIBILIA aimed at a definition, scalable and ready for use, of the concept of digital creativity, nevertheless we realized that the first step should be to verify *if* it was possible and *how* it could be done. In other words, we felt the need to assess the existence of digital creativity as a category rather than to try a comprehensive description.

With this goal in mind we have addressed some epistemological questions and follow an interdisciplinary perspective.

We decided to follow a sort of bottom-up methodology according to which the existence of the concept would emerge from the literature that is already available. In other words, although there is not yet a canon that define digital creativity, our idea was to preliminary map the network of ideas and concept that are foundational among the digital art literature.

Of course, a consolidated canon of literature references that are considered foundational for the definition of the concept is still missing.

Therefore, in the limited scope of the project, we focused our effort on individuating shared references in literature. Rather than relying on our personal expertise and competences, we tried to follow a less biased path. Thus, in a preliminary attempt (that has to be considered as a first coring in a field yet to be fully explored) we have asked the fellow historians and theorists in the project (from different art-related disciplinary fields) to provide a short list of essays that they believed most relevant for the digital media in their field.[5]

Hence we started to develop a survey that led to a database of bibliographic entries. From the suggestion we have gathered from the scholars interviewed, we select a list of 21 books, following a criteria that privileged the works indicated from more than one person. Then we selected the scientific papers following the same criteria, and we forced the inclusion of the 10 most quoted articles from the journal «Digital Creativity»; this led to a list of 52 scientific papers. All those 73 works in total represent our "source database". This database is not intended to exhaustively map the multimedia domain. Rather, it has been carefully chosen in order to provide a sort of canonical set of multimedia texts, slightly biased towards the Italian context. On the contrary, most bibliographic analyses try to consider large bibliographic sets in order both to exhaustively cover the chosen domain and to minimize statistical errors. While this approach is indeed valuable, and is widely adopted, it is typically applicable to more structured, organised, scientific communities. On the contrary, our preliminary

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[5] We choose to follow Manovich's approach from the previously quoted *Ten Key Texts on Digital Art: 1970-2000*.

hypothesis is that multimedia is an amorphous field, in which authors share some common backgrounds but differs in specific interests and competences, while still belonging to the same field.

From a methodological point of view, we created a second, "citation" database. For each work in the source database, we populated the citation database by including the work itself and all the works that the latter cited. The citation database thus included 4594 entries, including both those that have been read from the source database, and those that are cited-only.[6]

The citation database has been studied from two perspectives.

On one side, we attempted to summarize the approaches to digital art and discuss the emergence of a concept of digital creativity. The study was conducted by associate researcher Damiana Spadaro as the final dissertation of a post-doc assignment under our supervision[7]. The conclusions of this study define digital creativity according the following criteria. (1) As a "second semiological system", i.e. building a new meaning from a previously given sign. (2) As the most powerful mechanism of contemporary thought capable of widening and narrowing the mesh of the semiophere. (3) As a phenomenon that insists on the notion of "complementarity": it does not introduce completely a new code, but is an on-going remediation of previous media codes. (4) As different from digital innovation that accounts for the experimental and avant-garde use of technology information technology. (5) As a most influent factor on the notion of space, considered in the double sense of physical space and cyberspace, especially when it is applied at museum space and urban design.

On the other side, we changed radically perspective by favouring an analytical rather than a synthetic approach such as the one that led to the previous definition. Thus, we have conducted a bibliographic analysis of the whole citation database. This led to the results that we discuss in the next section.

Some introductory remarks

As we saw, the citation database has been built by annotating for each entry its citation list. For each text, all the bibliographic entries have been inserted into the database, without duplication. As our database has been created purposely from

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[6] From a technical point of view, we have annotated the bibliography in the bibtex format (see http://www.bibtex.org/), widely used in the scientific community as it is integrated in the LaTeX typesetting system that is the standard for scientific papers. All the TeX formats are text-based, thus allowing to be written/read directly by the annotator (typically by means of some editor) and to be easily processed by machines.

[7] Damiana Spadaro, *Definizione di un modello di creatività digitale: Realtà, corpo e spazio nell'era cibernetica*, Relazione assegno di ricerca, anno accademico 2013-2014, supervised by Antonio Pizzo and Andrea Valle, Università degli Studi di Torino.

scratch, its size, even if not irrelevant, is still manageable without recurring to sophisticated statistical analytical tools. But, on the other side, exploring relations among more than 4500 items may undoubtedly benefit from a statistical method to clearly reveal their internal various topologies. With this aim in mind, we have chosen a mixed approach that included both qualitative and quantitative considerations. In particular, we decided to explore the citation database by investigating citation graphs[8]. Citation graphs are graphs representing relations among citers and cited, and have a fair long tradition in bibliometrics as tools to understand relations among contents and authors in a certain scientific domain[9]. The study of citation graphs has largely benefited from computational tools that have allowed researchers to see and visually manipulate large bibliographic databases available from various sources. Sophisticate tools are available, that are capable of computing citation graphs on very large datasets[10]. Given the purpose of our task, we have constrained the activity to exploit only some basic properties of graphs that nevertheless allow us to reveal the most important features in the database structure.

In our case (Figure 1), one feature is represented by a set of vertices CE representing citation entries. This means that each entry in the citation database is represented by a vertex. In Figure 1, a square labelled with a number is an entry, thus CE is the set of all entries. It is possible to define a relation Citation among the set CE, in the form [citer, cited], that represents the citation of a cited entry by a citer one. In Figure 1, the relation is represented by the arrow, and all the possible citations are [1,3], [1,4], [2,4], [2,5], [3,2].

Thus, a citation graph CG like the one in Figure 1 is the set defined by the set CE (vertices, e.g. squares) and the set made up of all the Citation relations (edges, e.g. arrows). CG is indeed a "direct" graph because the Citation relation is ordered. This simply means that, as indicated by arrows starting from an entry and going to another one, citing is not symmetrical: to cite is not to be cited. As a result of the Citation relation, the set CE includes two subsets, the citers (c_r, all the entries that cite) and the cited (c_d, all the entries that are cited). The two subsets can have an intersection, the set $c_r c_d$ (shown in grey in Figure 1), representing the case of citers that are also cited.

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[8] Cf. An, Yuan and Janssen, Jeannette and Milios, Evangelos E., *Characterizing and Mining the Citation Graph of the Computer Science Literature,* «Knowledge and Information Systems», 6, 6, Springer-Verlag, 2004, pp. 664-678.

[9] Cf. De Bellis, Nicola, *Bibliometrics and Citation Analysis: From the Science Citation Index to Cybermetrics*. Lanham, Md, Scarecrow Press, 2009.

[10] An example is the Bibtex project, Gómez-Villamor, Sergio, Soldevila-Miranda, Gerard, Giménez-Vañó, Aleix, Martínez-Bazan, Norbert, Muntés-Mulero, Victor, Larriba-Pey, Josep-L., BIBEX *a Bibliographic Exploration Tool based on the* DEX *Graph Query Engine*, *EDBT '08 Proceedings of the 11th international conference on Extending Database Technology*, *Advances in database technology*, ACM, 735-739.
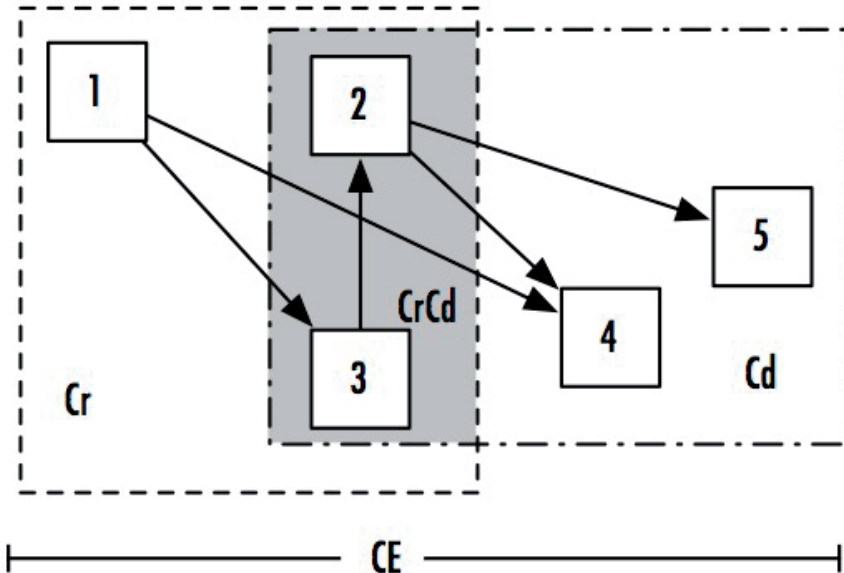
Figure 1: A citation graph CG

We have explored the Citation relation by processing our database in order to automatically generate graphs that can be displayed visually, as visual representation allows an easier recognition of citation patterns. The visual organisation of a graph layout is notoriously not a trivial task. In order to visually explore the citation graphs, we have exploited the well-known DOT language[11] which provides a simple and compact notation for graphs, and can be used to feed various rendering programs implementing different layout strategies.

Figure 2 shows our processing chain. The bibtex source file is processed in order to reconstruct the data structure representing citation relations by the Parser. The Generator module is responsible for creating the DOT file. Finally, the latter is rendered to a graphic format by means of one of the layout programs in Graphviz[12].

In the following, we will discuss some citation graphs CG.

Considerations on bibliographic entries

A preliminary observation may concern the relation between citers (4594) and cited

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[11] John Ellson, Emden R. Gansner, Eleftherios Koutsofios, Stephen C. North, Gordon Woodhull, *Graphviz and dynagraph – static and dynamic graph drawing tools*, in *Graph Drawing Software*, Springer-Verlang, 2003, pp. 127-148.
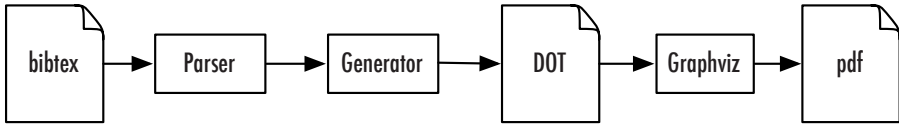[12] <http://www.graphviz.org/>.

Figure 2: Processing chain for graph citation generation

(73). The average number of citations for each source is slightly more than 71 (4594/73), a measure that is typically representative both of a content (humanities, vs. "hard" sciences) and of a genre (books, vs. journals articles or conference papers).

An interesting feature is the connection index ci that can be defined as citers/cited. When $ci = 1$ and $c_r = c_d$ then the graph CG will be totally connected, meaning that each vertex is both a citer and a cited. This would be the case of a maximally related group of works and authors that are in some sense isolated from other communities, as they only cite (and are cited by) themselves. Indeed this is not our case, as we already know that cited are almost 4.600 while citers are 73.

This means that the graph CG would be very sparse, that is, with many citers citing texts that are not cited by anyone else. This may lead to a topology in which citation vertex subsets (that is, set of cited vertices related to a citer) are reachable only from that citer. This is exactly what happens when the complete graph CG of our citation database is plotted. The resulting graph has indeed a very complex topology, with many sparse subsets. Its topology cannot be easily explored visually as it is very difficult to represent. By means of an interactive exploration it is easy to detect the low connection feature. Cited are much more than citers, and many citers are isolated terminal vertices. This means that they are present in the set CE as cited by only one citer. Informally, terminals can be considered as the boundaries of the graph, and, in our case, as pointers to other conceptual domains. A large set of terminal thus indicates a high level of dispersions towards other conceptual domains.

In order to deal with this sparse topology, it is possible to explore subgraphs that take into consideration only a subset of the cited set c_d that includes those entries cited at least n times. With $n = 2$, the topology is still very complex, while with $n \geq 3$ some more interesting features emerge.

The case of $n \geq 3$ is shown in Figure 3, in which "pure" citers (i.e. citers not cited) are in dark grey and cited (that eventually may be also citers) are in light grey. Entry names cannot be read, but this is not relevant at this level.

Apart from trimming the dispersed terminals and thus showing more important cited, two interesting features can be observed.

First of all, an unexpected phenomenon is the presence of "grand citers". This means that the ranking n of cited seems to be related also to a limited group of
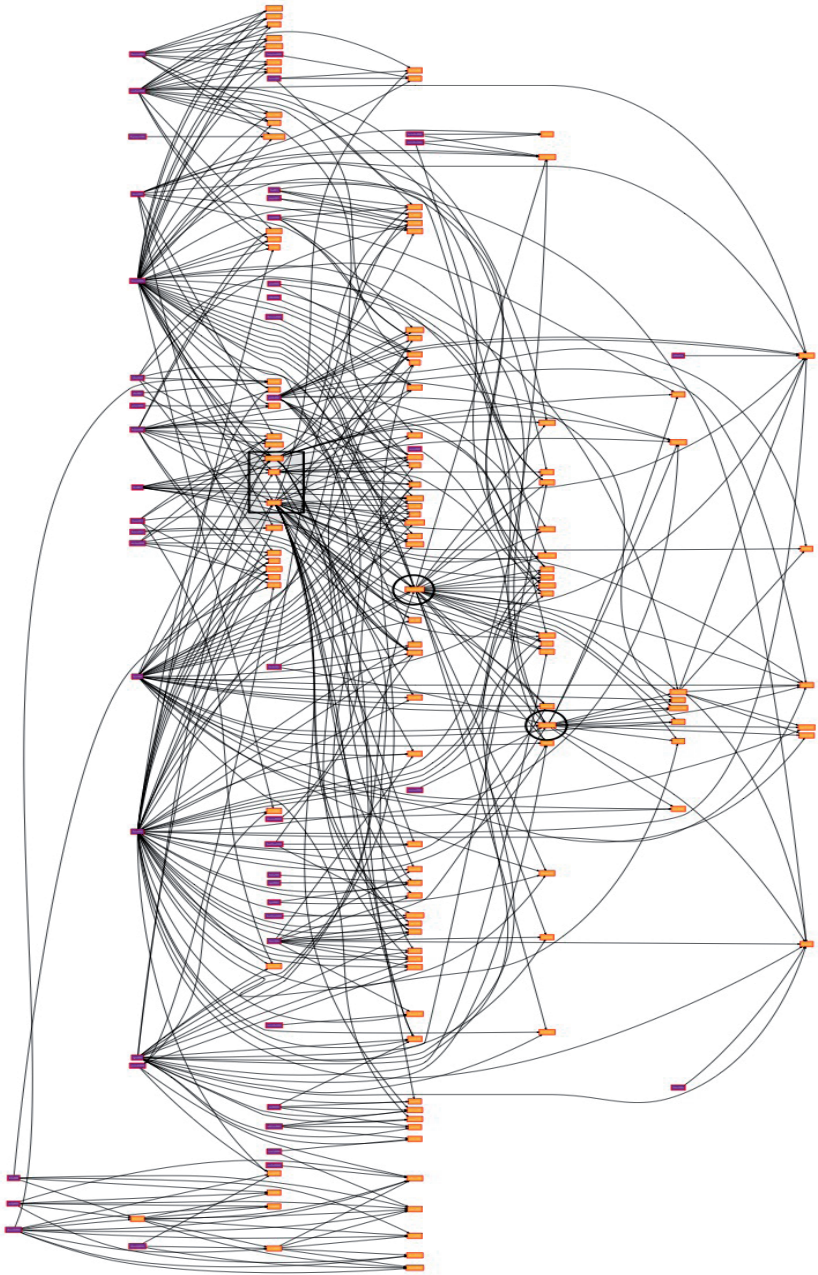
Figure 3: Entry citation graph for n ≥ 3

important citers that share a set of core items. The feature is unexpected because for the same ranking other topologies would be possible. The obvious alternative would be a dispersed, large set of citers referring to fewer cited. In short, in our corpus this would mean that many citers are isolated and thus connected to terminal cited: a cloud of peripheral citers surrounds -so to say- a core of more integrated citers.

The second feature emphasizes the first one. A 2-level organization is visible in the graph, as many cited are also citers (the set that we have defined as $c_r c_d$ in Figure 1), as apparent from the column-like layout of the graph. This "cited citers" operate like mediators between pure citers and pivotal items, that will stand up with a higher ranking *n*. In Figure 3 some of these major cited/citers have been surrounded by square/circles. They are Manovic's *Language of New Media*, Levy's *Qu'est-ce que le virtuel?*, Landow's *Hypertext 2.0.*, Bolter and Grusin's *Remediation,* Rheingold's *Virtual Community Homesteading on the Electronic Frontier*. As these entries are both major sources and targets of citation, they might be said to be at the core of the domain, as they are most read but at the same time they have defined a canon of other texts to be read.

The relevance of this layer of mediators is confirmed by a ranking n ≥ 4. The graph in Figure 4 shows cited that have at least 4 citations and their citers.

Here, cited that cite disappear. This means that they are relevant for medium ranking but they do not affect highest cited. Rather, two issues can be discussed in relation to the graph. First of all, a topological block of connected entries related to a subset of authors that seems to indicate an integrated scientific community is apparent at the bottom of the graph.

By considering this topological block, we see that citers are:

- Dixon, *Steve, Digital Performance: A History of New Media in Theater, Dance, Performance Art, and Installation*
- Giaccardi, E. and Fischer, G., *Creativity and evolution: a metadesign perspective*
- Edmonds, Ernest, *The art of interaction*
- Woodruff, Allison and Aoki, Paul M., *Conversation analysis and the user experience*
- Edmonds, Ernest and Bilda, Zafer and Muller, Lizzie, *Artist, evaluator and curator: Three viewpoint on interactive art, evaluation and Audience Experience*
- Bilda, Z. and Costello, B. and Amitani, S., *Collaborative Analysis frame-work for evaluating interactive art Experience*
- Muller, L. and Edmonds, E.A. and Connell, M., *Living laboratories for interactive Art*
- Candy, L. and Amitani, S. and Bilda, Z., *Practice-led strategies for interactive art research*
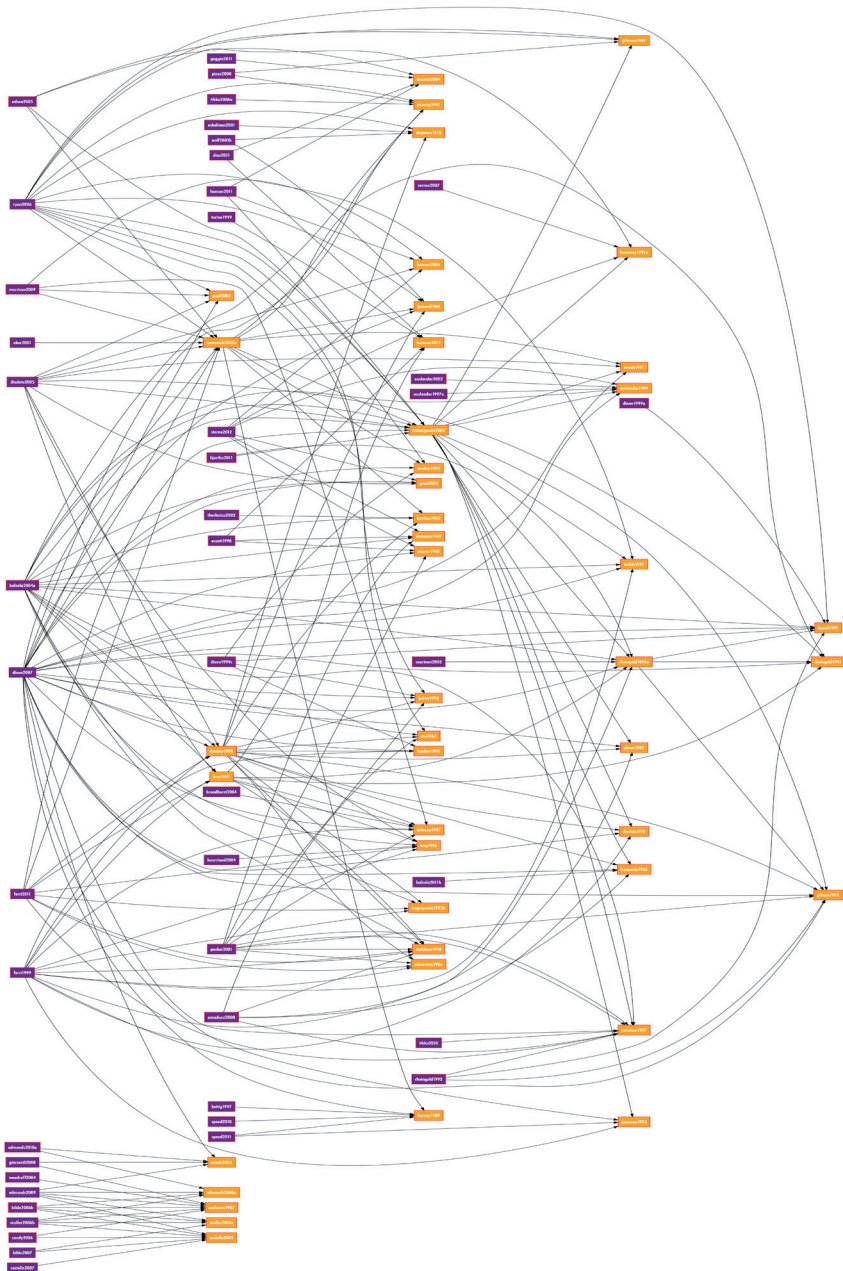
Figure 4: Entry citation graph for n ≥ 4

Figure 5: Entry citation graph for n ≥ 6

Figure 6: Author citation graph for n ≥ 7

- Bilda, Z. and Candy, L. and Edmonds, E., *An Embodied cognition framework for interactive Experience*
- Costello, Brigid, *A pleasure framework*

While cited are:

- Candy, L. and Edmonds, E.A., *Explorations in art and Technology*
- Edmonds, E.A. and Muller, L. and Connell, M., *On creative engagement*
- Suchman, L.A., *Plans and situated actions*
- Muller, L. and Turner, G. and Khut, G. and Edmonds, E., *Creating Affective Visualisations for a Physiologicallly Interactive Artwork*
- Costello, B. and Muller, L. and Amitani, S. and Edmonds, E., *Understanding the Experience of interactive art: lamascope in Beta_space*

This block seems to provide a case for a typical co-citation effect, that is, more authors (entries, in our case) share the same "citation environment". Since Small's pioneering paper, co-citation is a typical indicator for content proximity[13]. The second issue is a consequence of the first one. Apart from Giaccardi and Dixon, all the previous authors are mostly co-authors (in various combinations) while most entries refer to *Digital Creativity* and *CoDesign* journals. A citation of Candy and Edmonds' *Explorations in art and Technology* by Dixon connect this niche environment to the rest of the database.

Co-citation does not seem to be a general property of our database, rather it seems to be a relevant feature of some authors that share a "scientific" style of citation while "humanities" style seems to be more dispersed. This property of groups of entries sharing a massive connection by means of co-citation rise up again in case of $n \geq 6$ (Figure 5). In this case, the previous topological block is definitively disconnected from a larger subgraph (as can be seen on the top of the Figure). An apparent feature with $n \geq 6$ is the emergence of "pivotal" entries. This limited "pantheon" is indeed confirmed with $n \geq 7$ (Figure 6). Here, the topological block definitively disappears, and the maximally cited entries are defined. These maximally cited entries are 8, while their citing basin is made up of 20 entries, a basin to which 3 citing that are also cited can be added. This means that a limited group of entries (less than 1/3 of the source database) is responsible for the maximally cited entries. If we consider the citers that cite only one of the most cited, we see that they are 7. In this sense, the most cited entries (almost all above 5 citations) are cited by a small group of 16 citer entries.

The cited subset with $n \geq 7$ is indeed a foundational core for our database. But on

[13] Small, Henry, *Co-citation in the scientific literature: a new measure of the relationship between two documents*, «Journal of the American Society for Information Science», 1973, 24, pp. 265–269.
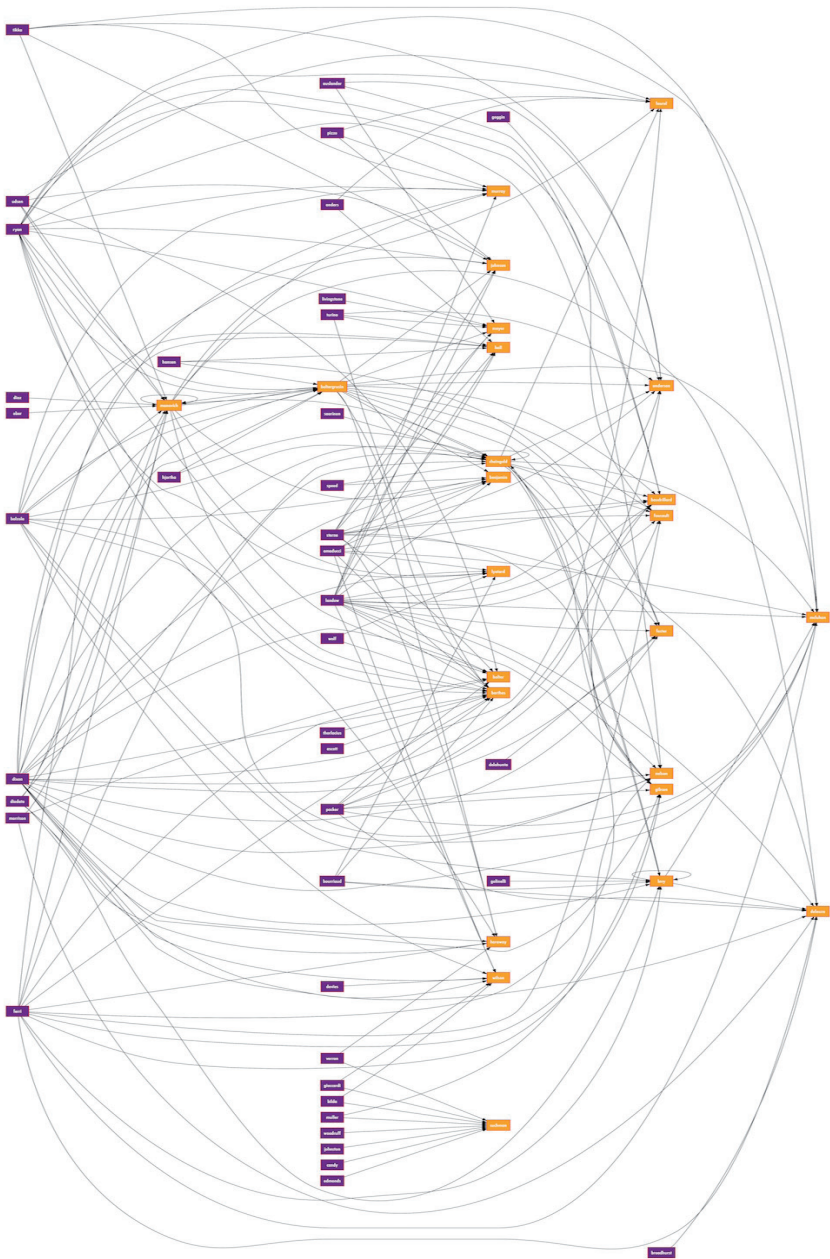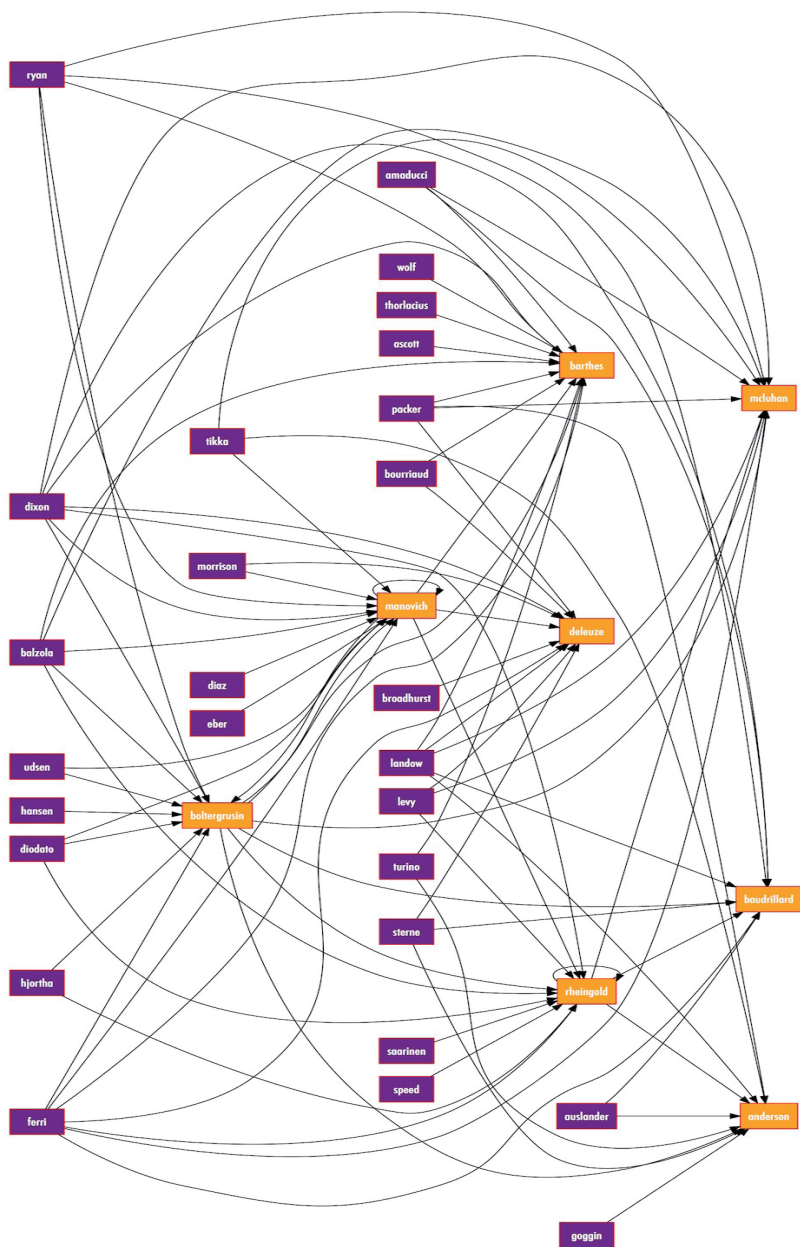
Figure 7: Author citation graph for ≥ 7

Figure 8: Author citation graph for ≥ 9

the other side, it also defines a small tightly integrated citer subset. The graph in Figure 6 thus is the real core of our database.

By considering the cited subset, we can try to group the most relevant entries. While the results are in some sense expected, they are indeed supported by a quantitative analysis. Two entries can be considered as the foundation of mass-mediology by Marshall McLuhan: *The Gutenberg Galaxy: the Making of Typographic Man* and *Understanding Media*. Four entries can be considered as references for contemporary media: Brenda Laurel, *Computer as Theatre*; Howard Rheingold, *Virtual Community Homesteading on the Electronic Frontier*; J.D. Bolter and R. Grusin, *Remediation. Understanding new media*; finally, Lev Manovich, *The Language of New Media*. Then, there are two isolate works. One is William Gibson's novel *Neuromancer*, that, while not an essay, provide an imaginative, narrative framework for the digital creativity domain. The last one maybe seen as Gibson's philosophical counterpart, the also abundantly received *Mille plateaux* by G. Deleuze and F. Guattari.

Considerations on authors

Our previous considerations have dealt with entries. In this sense, they identify the most relevant textual items that define a core background for digital creativity. While not in contrast with the previous analysis, some other elements can be added, by taking into account authors rather than entries. The graph in Figure 7 shows the cited authors for $n \geq 7$ (again light grey for cited and dark grey for citers).

This most cited set counts 24 elements. An analysis of the authors confirms but also make more complex the previous discussion on foundational entries. In particular, authors can be grouped in some macro-areas, sometimes internally articulated in sub-areas. A list follows:

-   xx Century Philosophical foundations: the two main names here are Heidegger and Benjamin;
-   Structuralism and Post-structuralism, with references to media and representation issues. This macroarea can indeed be organised into subareas:
    -   a more politically-oriented background is provided by Lyotard, Jameson and Baudrillard;
    -   the philosophical context is defined by Foucault, Deleuze, Derrida;
    -   the semiological side is based on Eco and Barthes;
-   Mass-mediology foundation is indeed McLuhan, but also to Nelson;
-   Contemporary mediology references are more varied, as they define a sort of "core cloud": Murray, Levy, Bolter, Landow, Anderson, Turkle, Campbell, Bolter and Grusin, Manovich, Suchman, Rheingold, Ascott;
-   Narrativity reference is indeed important, as it emerges from the citations of Mitchell, White, Laurel, Bruner;

- a Feminist perspective is provided by Haraway;
- as we have already seen, Gibson is present as an imaginative foundation, thus underlining the relevance of Cyberpunk attitude towards technology;
- Also, Design appears as relevant, by the various references to Norman. Interestingly, this reference was hidden in the entry graphs;
- Finally, some cases are difficult to place in context. They could also result from a bias depending on our limited database (Hall, Johnson, Foster, Meyer, Wilson).

This theoretical panorama is not affected if considering the case for $n \geq 8$ that yields 15 authors. A slight change in perspective happens when considering $n \geq 9$ (Figure 8).
Here, the multi-faceted landscape becomes a simpler picture. Three macro-areas remains, with 8 dominating names:

- Structuralism and Post-structuralism: Barthes, Deleuze, Baudrillard;
- Mass-mediology foundation: Mcluhan;
- Contemporary mediology references: Anderson, Manovich, Rheingold, Bolter and Grusin.

Conclusions

The analysis that we developed in our task for the project INVISIBILIA confirms that the term digital creativity represents a disperse notion in which a number of different definitions developed along last decades are merged. The dispersion of the concept emerges from the bibliometric analysis that has used a set of seminal essays and articles and has created a citation database. Nevertheless our analysis reveals that the discussion about the notion is still gemmed out of a core of pivotal figures in the field of structuralism, mass-mediology and new media. On the other hand this seems to lead to the conclusion that the digital creativity as a field is less influenced by computer science scholars and still lacks of a specific canon.