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Toward a Geodesign Process Analytics

Verso un'Analisi di Processo di Geodesign

Complexity in current spatial planning practice is mainly linked to the multi-dimensional context characterizing its processes. Recent advances in design methodologies and digital techniques promise unprecedented opportunities not only for managing multiple issues and actors, but also for tracking the evolution of the design options toward the final plan. In this context, the paper explores the potential offered by the collaborative Planning Support System Geodesignhub to record the process workflow and open new path to the design dynamics understanding. We will present the first research efforts toward the development of a geodesign process analytical framework taking account of both theories and cases studies.

La complessità delle attuali pratiche di pianificazione territoriale e urbanistica è legata al contesto multidimensionale che ne caratterizza i processi. I recenti sviluppi nel campo delle metodologie e delle tecnologie digitali di progettazione offrono opportunità senza precedenti per supportare la gestione dei processi e per documentare l'evoluzione del progetto. In questo contesto, l'articolo propone i primi risultati di uno studio volto a esplorare le potenzialità dell'analisi dei dati di log di sistemi informatici di supporto alla pianificazione che documentano l'evoluzione dei processi progettuali e i relativi flussi informativi e decisionali, al fine di comprendere le dinamiche del processo di pianificazione. I risultati attuali contribuiscono a definire la struttura di un framework analitico dei processi di geodesign, e più in generale dei processi di pianificazione spaziale.

Keywords:
Geodesign, Geodesign Analytics, Planning Support Systems, Spatial Planning and Design
Parole chiave:
Geodesign, Geodesign Analisi, Sistemi di Supporto alla Pianificazione, Pianificazione e Progettazione Spaziale

1. INTRODUCTION

Contemporary planning efforts are often confronted with a high number of tasks and requirements, and understanding their interconnections, sequence, iterations, and interactions may be a cumbersome endeavor. Still it is urgent to find methods and tools to grasp the complex planning and design process dynamics, in order to foster transparent, responsible, and democratic spatial planning, policy-making and governance. Indeed, sustainable development principles and recommendations, which underscore the importance of "developing policies and strategies through an inclusive and transparent process" (Rio Declaration - UNGA, United Nations General Assembly, 1992) and taking advantage of "scientific and technical information and knowledge" (Agenda 21 - UN, United Nations, 1992), if properly applied may facilitate the achievement of the former objective. In full respect of all the principles contained in the Rio Declaration on Environment and Development, Agenda 21, specifically, highlights the importance of improving the decision-making process in order to ensure, on the one hand, the progressive integration of environmental and developmental issues toward sustainability, and, on the other hand, a broader public participation. Furthermore, two of the Agenda 21 forty chapters are specifically dedicated to the role of the scientific and technology community in sustainability, and to the role of information in decision-making. Therefore, working towards sustainability requires a profound re-thinking of traditional local and national planning and policy making practices. In this regard, Strategic Environmental Assessment (SEA) was introduced in Europe in 2001 by the Directive 2001/42/EC with the aim of providing a systematic way to enrich spatial planning and policy-making processes facilitating the inclusion of environment and sustainability issues in planning procedures and contributing to achieve transparent and participatory decision-making processes. Operatively, SEA can be defined as a "structured, rigorous, participative, open and transparent environmental impact assessment-based process applied to plans and programs" (Fischer, 2007). After more than a decade from its adoption the implementation of the SEA Directive is widespread in Europe thanks to its transposition in national and regional legislation frameworks (Campagna, 2014).

According to the SEA principles, planning, as an evidence-based participatory and collaborative process, should involve a large number of actors with different background and knowledge, who often defend conflicting interests and priorities. This multi-dimensional context (i.e. multi-actor, multi-objective, multi-criteria, multi-scale) makes contemporary planning both complex and complicated. As a matter of fact, in traditional participatory methods, such as hearings and public meetings, the dynamic of the planning process, which explains the interactive actions of different actors along the iterative sequence of activities and tasks, is often difficult to record and to understand. Above all, the shift from knowledge to action is perhaps the most critical and unclear phase of the process in real world practices. Moreover, various authors argue that there are a range of problems and pitfalls in SEA application at the regional and local level in European Member States (Fischer, 2010; COWI, 2009; Parker, 2007). Particularly, in planning practices it is not always clear how environmental concerns inform the creation and evaluation of design alternatives (which are often limited to one in reality), and subsequently how they lead to the final choice.

In this context, recent advances in design methodologies and digital techniques promise unprecedented opportunities not only for avoiding informal or ill-defined steps, but also for recording the dynamic of the planning process and contributing to address some of the most urgent issues of implementing the SEA Directive principles (Campagna et al., 2018). While, the six-model operational framework of geodesign (Steinitz, 2012) facilitates a systematic and holistic view of the multiple issues and actors involved, the use of digital technologies and Planning Support Systems (PSS - Harris, 1989; Geertman & Stillwell, 2004), which supports the implementation of the models, allows recording information such as time sequence, authorship, semantics and topology, on any design option that contributes to the final design.

On the basis of this premises, the paper presents early research results toward the development of some novel analytics which is expected to contribute to explaining the evolution of design alternatives along a geodesign process, the contribution of the different participants along time, and the influence of the knowledge base on the final decision. It is argued that breaking down the digital workflow and using quantitative metrics may help to understand how a design alternative is produced and the design dynamics that characterized the interaction of those individuals and groups involved in the planning process.

This introduction has outlined some of the issues relating to complexity in current planning practices examining the role of new technologies in possibly solving them, and it places the subsequent sections within this context. The next paragraph briefly describes the geodesign methodology and it details the main steps of a planning workshop implemented with the collaborative PSS Geodesignhub, which will be used as case study to demonstrate the assumptions. The path toward a full-fledged geodesign process analytics is then presented taking account of both theories and cases studies, mixing a deductive with an inductive approach.

2. GEODESIGN APPROACH AND GEODESIGNHUB COLLABORATIVE PSS

Geodesign is an integrated design methodology that combines environment-oriented planning principles, geospatial technologies and stakeholder inputs to address the planning problem from an interdisciplinary point of view in order to make informed and evidence-based design choices (Lee et al., 2014, Van Der Hoeven, 2016). In 2012, the concept of geodesign has been formalized by Carl Steinitz in his book "A Framework for Geodesign", where he proposes a framework guiding the process definition based on six models. Although not strictly necessary, the application of the framework is usually supported by extensive use of digital information technologies, to deal with complex land-based planning and design issues. The geodesign framework (GDF) encourages the use of spatial analysis techniques and impact simulation processes, in order to evaluate interactively the effects of possible development scenarios, augmenting the real-time interaction in the design process dynamics. In particular, the first three models of the GDF (i.e. the representation, process and evaluation models) focus on the knowledge-building process, examining existing conditions in the study area in the evaluation

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phase. Whereas the last three models of the GDF (i.e. the change, impact and decision models) constitute the intervention phase of the process, defining desirable design alternatives and assessing their potential impacts on the territory to reach an informed and negotiated final plan based on consensus.

Among other existing supporting digital technologies, the collaborative PSS Geodesignhub (GDH) (https://www.geodesignhub.com/) addresses in an integrated way the core, and possibly the less understood and practiced, part of the design process, the intervention phase. Many geodesign workshops testing the opportunity of the GDH-PSS technology have been held worldwide (Rivero et al., 2015; Campagna et al., 2016b, Zyngier et al., 2017, McElvaney, 2012). Such workshops usually take place as one or two-day intensive planning study where participants with different institutional roles, interests and backgrounds work together to create several design alternatives and iteratively negotiate towards a final agreed design solution. During the pre-workshop phase a multidisciplinary team of experts and professionals collect data to describe the study area and analyze ongoing territorial dynamics. Eventually, the output of the evaluation model consisting of a series of maps with standard classification and color-codes is uploaded in the platform supplying a spatial representation of possible risk and opportunities for future changes, which represents a common base to inform design (Figure 1).

In figure 1, the three main actions performed by the actors involved in a Geodesignhub project along the workshop workflow, and the related output data, are represented. Thanks to the software built-in sketch planning tool, single actors at the beginning, or group members at a later stage, draw geo-referenced individual design proposals as lines or polygons, diagrams. In a second phase, each group is asked to select different combinations of diagrams to create a design alternative, or synthesis, as the result of an early negotiation among team members and in line with their development goals and interests. In a similar way a coalition group selects diagrams among two or more synthesis to create a negotiated design. All the data relating to the above tasks are recorded within the Geodesignhub database. Hence, it is possible to download each diagram as a shapefile layer with geographic and thematic attributes representing their semantics. Each synthesis can be also downloaded in a shapefile where every spatial feature is a diagram contributing to compose its design.

The GDH platform, therefore, records and stores each incremental step of the fast-paced collaborative design process, that can afterwards be easily broken down into its basic elements and analyzed. Diagrams are the

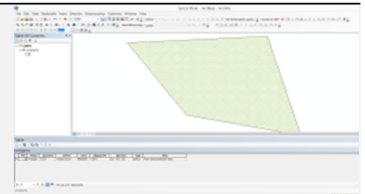
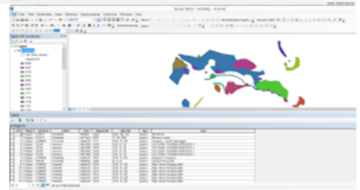
Type of Actors	TOOL/Action		TOOL/Output	
Single actor/ Group	**"ADD A DIAGRAM"** Draw design proposals		**"DIAGRAMS DOWNLOADER"** Download diagrams as a shapefile layer	
Group	**"SAVE DESIGN"** Combine diagrams in a synthesis		**"DOWNLOAD SHAPEFILE** Download synthesis as a shapefile layer	
Coalition Group	**"NEGOTIATED DESIGN"** Recombine diagrams among two or more synthesis		**"DOWNLOAD SHAPEFILE"** Download synthesis as a shapefile layer	

Figure 1 - The main types of actions performed by the participants involved in a geodesign workshop with Geodesignhub.

output basic elements. More specifically, the planning data generated by the software are individual project and policy represented as vector spatial features, which compose the different change alternatives in an iterative negotiation process toward the final agreed design. The data structure of a diagram (Figure 2) differs from traditional geographic information for it combines the traditional spatial components with the time dimension (i.e. time sequence, project implementation timing), user information (i.e. authorship, preferences), as well as the traditional thematic attributes (i.e. project type, relevant territorial system), and in some cases complementary multimedia data (i.e. photo, video, tag). Each diagram also has a title which encode its semantic.

3. TOWARDS A NOVEL DESIGN PROCESS ANALYTICAL FRAMEWORK

In the context of design processes, in order to earn insights on the possible perspectives influencing the creation of an analytical framework, it may be relevant to look both at the process and at its output. In his book (2012) Steinitz distinguishes between design as a verb and design as a noun, highlighting the double meaning of the term design: a process, and the product of the process respectively. With regards to the former (i.e the process), we may refer to sociology theory and the science of team (Stokols et al., 2006). A possible starting point is to look at the (design) process as a list of inter-related actions taken by the actors working in teams. The type of (design) actions and how they are combined define and specify different design models, strategies, and methods (Jones, 1980, Rowe, 1987). In order to understand and classify strategies it is necessary to analyze in more depth the actors' actions. Social action as defined by the sociologist Alfred Schutz (1972) is reflexive and intentional, and involves goal-oriented human activity. According to his phenomenological approach, a social action has a specific temporal structure. In fact, action refers to a human conduct lead by a mental "project" of the actor, and characterized by a physical process, "act", in which the actor enacts the project to produce an output as final "result" (figure 3). Furthermore, two different reasons influence the decision to realize a mental project: i) the "point

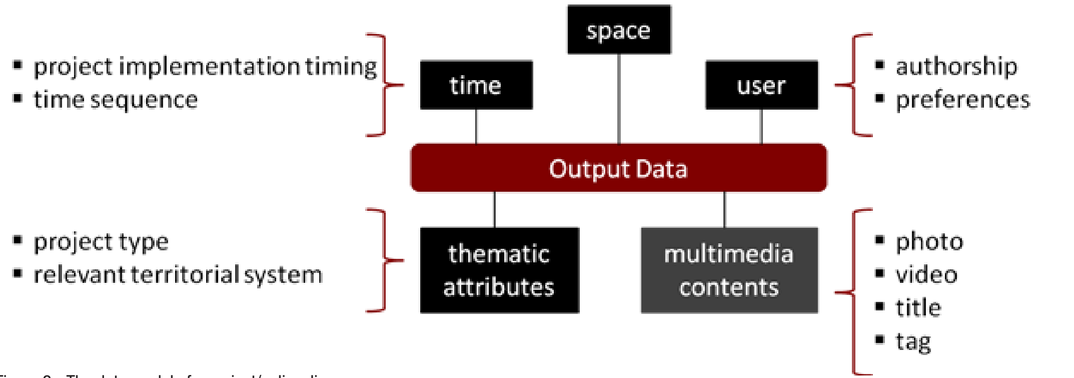


Figure 2 - The data model of a project/policy diagram.

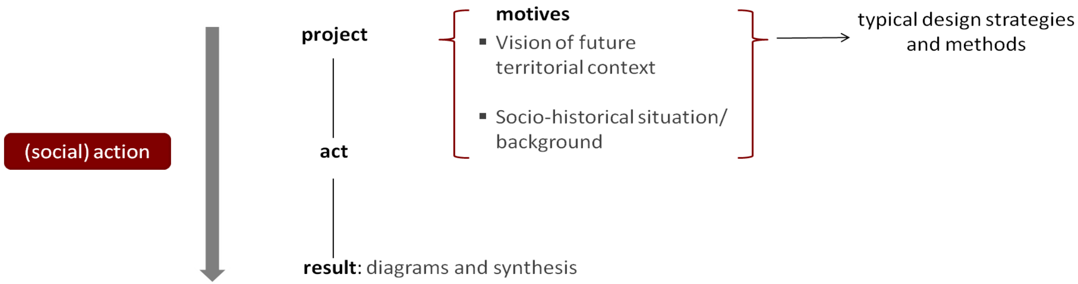


Figure 3 - The phenomenological approach of Alfred Schutz applied to actor's actions in Geodesignhub.

to reach", and ii) the actor's "stock of knowledge" and "biographical situation", which generate typical kinds and ways of behavior for known situations. Consequently, for understanding intentional actions we have to take into account all the temporal process.

With reference to a geodesign process, the actors involved in a geodesign study are driven, on the one side, by their different socio-historical situation and backgrounds, on the other side by their motivation to narrow the gap between the actor's definition of the current territorial context and their future vision. The pathway toward geodesign analytics to investigate the dynamic of the planning process (i.e. design as a verb) starts from the results of actors' actions (i.e. design as a noun). More specifically, in order to understand typical design models, strategies, and methods we can start analyzing diagrams and synthesis but we should not forget to interpret the possible motives behind, and the relationships among the two should be made explicit. The analytics tools, therefore, should cover two types of measures (Figure 4): a) those related to design aspects such as scale, geography and time, and semantics; and b) those linked to the social aspects of the planning process and of the participants characteristics (e.g. socio-historical situation, background, personality, and the like). In order to achieve this target however, it should be noted that the specific data model of the diagrams requires the integration of traditional spatial analysis methods with expertise and contributions from various disciplines such as statistics, social psychology of decision making, science of teams and semantic analysis.

Geodesignhub offers early interactive analytical tools to assess the process during and after

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its implementation. It deconstructs the digital collaborative process and produces a detailed history for each design that help understand how diagrams are used by the actors as they iterate on a design and negotiate to make changes. These tools offer a first set of metrics to analyze the design process. However, there is a need to extend it with a more robust analytical framework developing a novel analytics in order to allow explaining how and why actors behave along the evolution of design options toward the final plan. In order to do so, a mixed approach is adopted in this research and both deductive and inductive methodologies are considered and combined (Figure 5). On the one side, starting from process and design theories related to various disciplines a series of assumptions and important questions regarding the actors-process relationships (Jankowski and Nyerges, 2001) are identified and formulated, such as which is the contribution and influence of the different actors along time on the process unfolding and its output? Are there any relations of power (Forester, 1989)? Are there and what are typical or recurrent group dynamics? On the other side, starting from the exploratory analysis of the GDH output log data it is possible to elicit and reveal relationships and patterns among the social and the design dimensions. Guided by this approach and considering the dimensions available for analysis, basic and multi-dimensional metrics are currently under development in order to identify the relationships among data attributes and users' characteristics, verify the initial assumptions, answer the underlying research questions, and ultimately to contribute to a better understanding, assessment, design and management of the process.

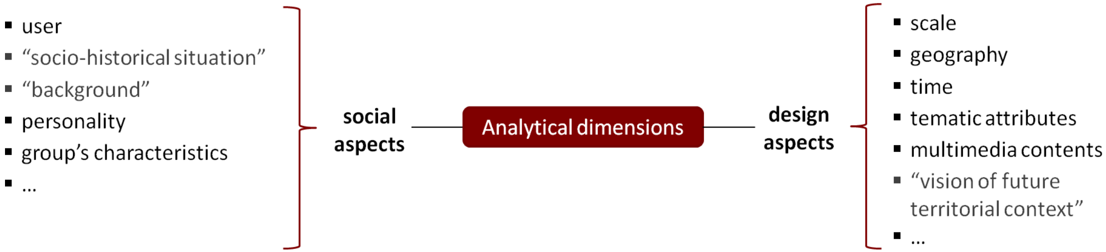

Figure 4 - The analysis dimensions of an actor's action.

The application of the inductive bottom-up data-centered approach of this research which is described in the reminder of this section is based on the data analysis of the case study of the Cagliari geodesign workshop (Campagna et al., 2016b). Geodesignhub was used to support the design of collaborative sustainable future scenarios for the new Cagliari metropolitan area in Italy.

A total number of 214 diagrams has been created during the workshop. Each of the six groups selected different combination of diagrams during three consecutive design cycles, and the two coalitions did likewise throughout two rounds of negotiations, with an average of 45 diagrams per synthesis. Geodesignhub API provides access to the log files stored under a specific project. The collected data can be easily handled in a GIS environment integrating spatial statistics software to construct metrics and find relationships among both the social and design aspects.

To this end, the integration of GIS with the statistical software R (r-project.org) is used to take full advantage of all its libraries and functions as a

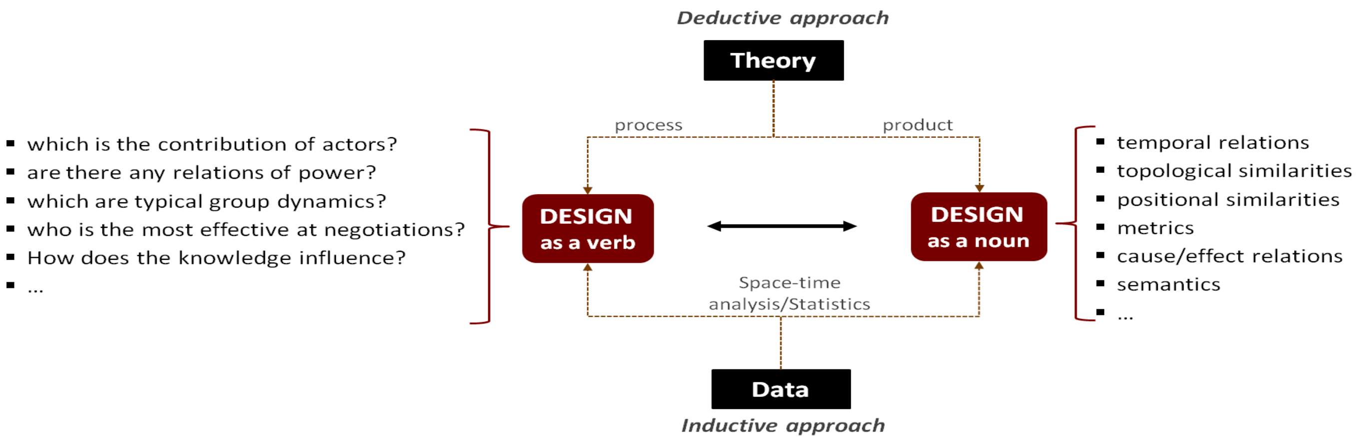

Figure 5 - The deductive and inductive approaches guiding the development of the analytical framework.

complement to the spatial statistical analysis and mapping powers of a GIS (Figure 6a). Altogether, the analytical process is aimed to define a detailed set of metrics that enables the investigation of the design dynamics of a Geodesignhub project.

While an early study by Freitas and Moura explored the spatial topological relationships among diagrams (Freitas & Moura, 2017), the analysis examples presented in the remainder contribute to demonstrate how it possible to elicit quantitative measure on design process dynamics. The analyses were carried on in an exploratory way to test the suitability of the data model of the GDH systems, diagrams, and synthesis output database (depicted in UML - Figure 6b) to support the calculation of quantitative measures. These measures are expected to supply the basis to move a step forward in this ongoing research for framing useful metrics with a theory based deductive approach.

The chart in figure 7a shows the trend of the global evolution of the synthesis, where it is possible to observe as the number of diagrams grows moving from the first to the third synthesis. As highlighted by Steinitz (2012) the first design synthesis is usually never the final one due to inherent limits of a first draft. Therefore, during the geodesign workshop, each of the six groups (Metropolitan government-METRO; Regional government-RAS; Green and NGO-GREEN; Cultural Heritage Conservation-CULTH; Developers-DEV; Tourism Entrepreneurs-TOUR) was asked to shortly present its initial proposal and then to produce iteratively few rounds (usually up top three) of revisions. From the data analysis it is reasonable to assume that the iterative design process help the participants to enhance their understanding of the issues and opportunities for change. (Figure 7a).

The presentation of the syntheses of the different team, although usually based on a different set of priorities may be a complementary but important part of the learning process within each team and among teams. A similar pattern was previously observed by the authors in the ex-post analysis of the Pampulha geodesign workshop (Campagna et al., 2016a) contributing to confirm this hypothesis. In addition, despite the fast pace with which these steps are carried on, this phase of the workshop can i) facilitates dialogue and mutual

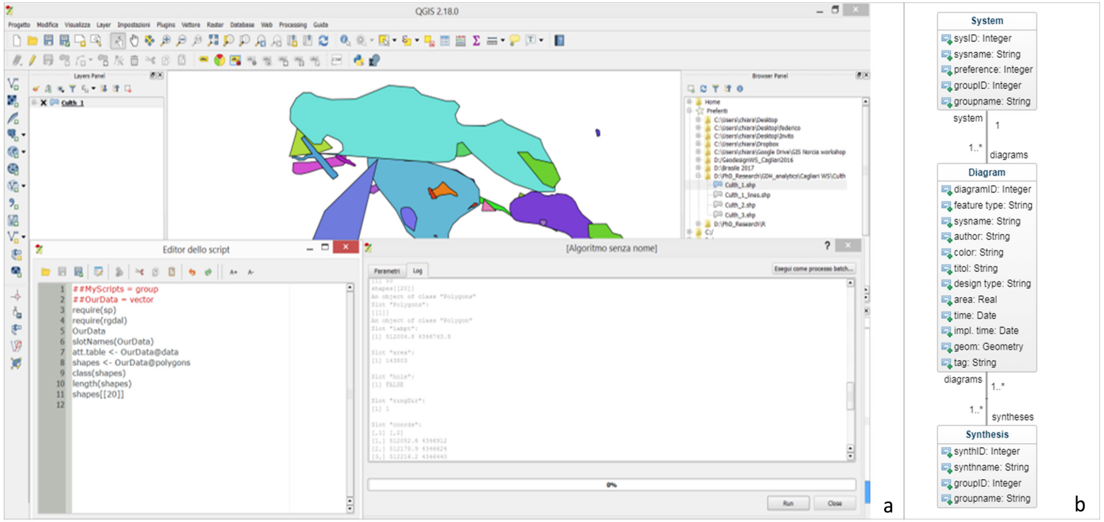

Figure 6 - (a) Current research working environment: QGIS software and the built-in R statistical package; (b) the GDH output database represented with UML modelling language.

learning between stakeholder groups as suggested by transactive planning theory (Friedmann, 1981), and ii) broaden the different shareholders' interests as it seems demonstrated in the diagram in Figure 7b: it shows how in the early syntheses the teams focus more on their highest priorities, while in the following revisions they broaden the scope of the design including diagrams from systems of lower priority. In the Cagliari workshop, in the last two syntheses, four of six groups have, in fact, selected a greater number of diagrams from those systems, that they have defined of medium or low priority following their initial objectives.

Another trend worth of interest is the fact that the most productive participants, in terms of total number of diagrams creation, have a higher influence on the final design (Figure 7c). More specifically, the negotiation process leading to the agreed choice is shown in figure 7f, in which the initial six groups were divided in two big coalitions according to their mutual interests, while the group of DEV worked independently. The negotiation efforts of the two coalitions are different (figure7d). The results of the TOUR-CULTH-RAS coalition group has the same total number of diagrams as TOUR third synthesis. A finer analysis shows that they are almost the same – with minor differences (i.e. diagrams in the system "hydrogeological hazards"). The group of Tourism Entrepreneurs was indeed the one which obtained most positive assessments from all the other groups and, therefore, which affected most the negotiation. By contrast, in the second case, the negotiated design of the GREEN-METRO coalition has far fewer diagrams of the initial two single-group syntheses. This alliance was less consistent then the first one and probably the negotiation has been more difficult (figure 7e) resulting in a smaller set of diagrams accepted by both. Eventually, the DEV forth synthesis and the results of the two negotiation efforts were combined in a final agreed design.

The analysis above are just a few examples of the quantitative measure of the process dynamics. This working assumptions should be applied to a wider range of geodesign workshops both already carry out and organized for experimental purposes in order to verify and test the above described phenomena, design strategies and methods. To this end, it worth noting that the same case study was carried out four times in separate independent workshops with different research and training settings in Cagliari, Istanbul, Delft and Bernburg. The evaluation maps on which the design was based were common to all the workshops, while the participants were different: only in the first case professionals with a previous knowledge of the study area were present, while in the other cases participants had no previous knowledge on the study area. Hence, the process data of the Cagliari case study represent an interesting knowledge base which can be analyzed comparatively to identify analytical dimensions and metrics, especially related to social aspects which were different in the four workshops, which may represent the influence of the social dynamics on the design.

At the time of writing, further measures are currently under investigation in order to enrich the process analytics framework. However, it is already reasonable to affirm that GDH output data and the use of simple spatial and statistical analysis allows to measure quantitatively several aspects of the design process revealing dynamics previously unknown or not sufficiently analyzed. In the future development of this research, the metrics are planned to be displayed in a dynamic dashboard making available a real-time process analysis tool to the workshop conductor. This opportunity will be also subject of dedicated investigation in the future development of this research.

4. CONCLUSION

While the development of a geodesign analytical framework is still in its early stages, this paper aims at sharing the structure of the framework and the first results of its application, which somehow demonstrate its feasibility and interest for further investigation. Further research is currently ongoing and more extensive results are expected to be available in the near future.

So far however, it is already possible to confirm that the use of digital tools and PSS compared to traditional ways of recording or tracking the process workflow (i.e. actor interviews or video recordings) can supply a set of quantitative metrics which may contribute to grasp many facets of the complex design dynamics, and to offer more advanced and reliable tools for the

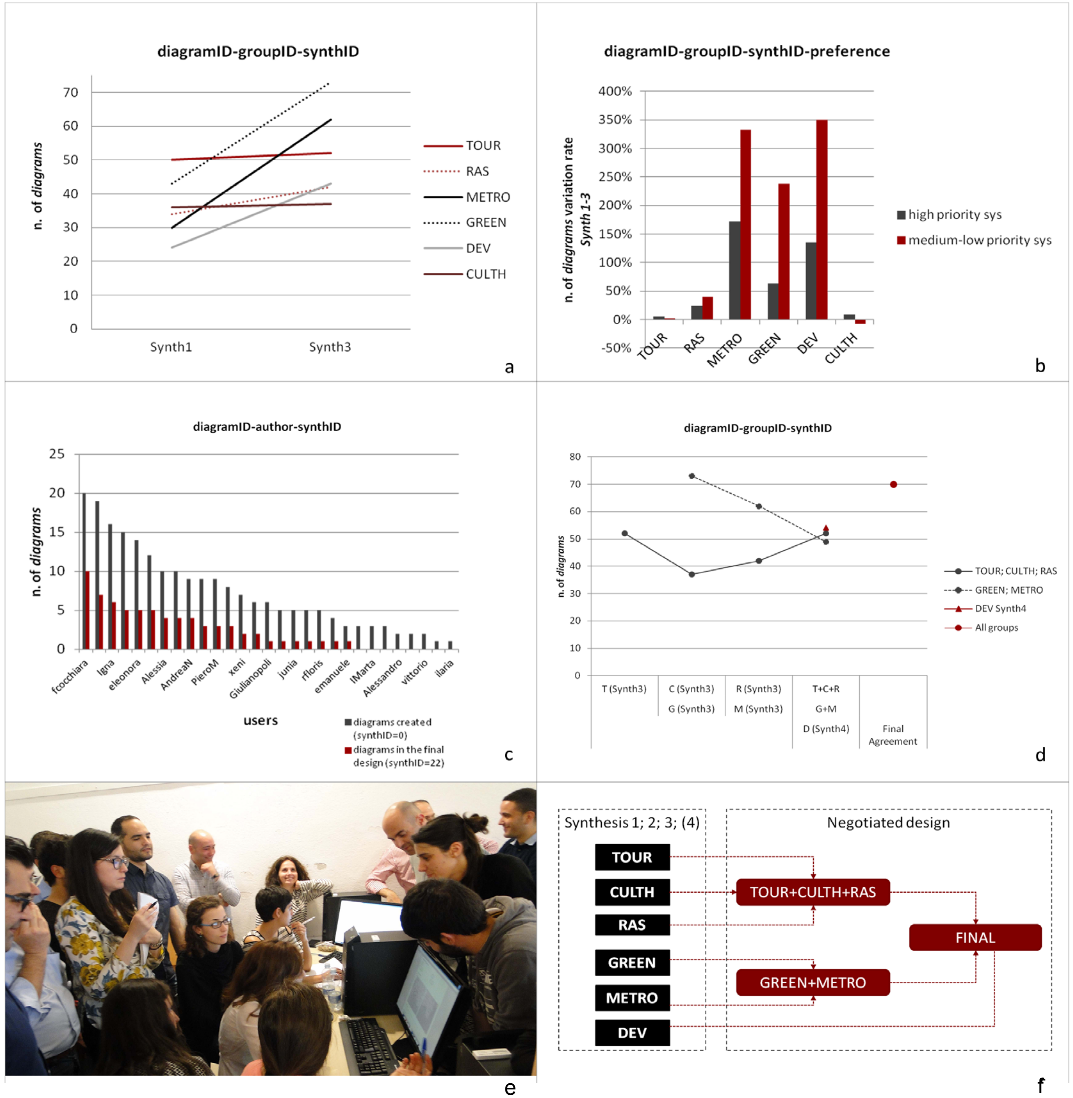

Figure 7 - Early quantitative measures of the GDH process dynamics.(a) Global evolution of the initial syntheses for each group; (b) variation rate of the number of diagrams, respectively in high and medium-low priority systems; (c) participants' performance; (d) global evolution of the syntheses in the negotiation.

design-process data analysis and management. To this purpose, Geodesignhub demonstrated to be effective in contributing both to manage the complexity of a planning effort and to implement a transparent and participatory development process, and to support the implementation of geodesign workflows in a native digital form. The process can be, therefore, easily break down into its basic elements and analyzed accordingly. The use of a common systematic framework for geodesign studies allows for a direct comparison between the dynamics of different process instances, which may lead to the detection of recurrent patterns in the behavior of involved actors. Indeed, the fact that the Cagliari geodesign study was carried out in different social contexts can help understand the role of social dimensions in the planning process. To this end, the next step in the research will be applying the process metrics analysis comparatively.

In this research, a combined inductive and deductive methodology can help taking full advantage of both underlying theories and empirical data in a complementary way. In summary, this stage of research it seems already reasonable to assume that an ex-post analysis of the design dynamics can offer useful insights for understanding the unfolding of the decision process clarifying the influence of the knowledge base, the values and actions of the different actors and the presence of recurring design patterns. Indeed, as highlighted by Steinitz in his book, the "ways of designing" differ for every group or individual, scale and size of the area. However ultimately, earning new insights and knowledge about the geodesign process dynamics can contribute in turn to better design and manage the complexity of planning and design processes, as envisaged by the metaplanning approach (Campagna, 2016), eventually narrowing the gap between knowledge and action for more sustainable and democratic spatial governance.

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