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**The DensityDesign lab :**  
communication design experiments  
among complexity and sustainability

**Abstract**

Social complexity requires new processes fundamentally attuned to the social and conversational nature of decision making and design work; they should tend to enable a more and more valuable interaction and dialogue among the actors of a social system.

Heeding the perspective of Design discipline dealing with languages, the Communication Design could afford the creation of visual and interactive languages relevant to the representations of Complex systems, creating shared visions within multi-actor contexts. In this sense it can facilitate dialogues within participatory actions and verify the potential of communication artifacts in supporting and externalizing sustainable and self-adaptive learning processes.

Assuming this contribution of design in the multidisciplinary framework of sustainability, a didactic and research initiatives has been established since 2004 at the Master Degree in Communication Design at the Milan Polytechnic. Using complexity as a keyword to understand reality, combining it with a continuous research for information aesthetics and representation, the The DensityDesign lab explores the emergent relationships among communication design, information visualization and complex systems. The paper will discuss the relevance of this approach in dealing with the social issues and the data dimension, and the impact of this practice in the master students' comprehensive background.

1. Introduction

Among the different approaches for sustainability and sustainable development, a common belief arises: the economic, environmental and social dimensions are strongly interlinked and it is necessary to deal with them as a whole. This observation, endorsed by the major institutions committed in sustainability development policies, finds a more general correspondence in the assumption that the world could be seen as networked and as a complex system (Capra 1996; Castells 1996). Over the past forty years complexity theory has become

a broad field of study; the increasing regard in system thinking and science of complexity showed by economic, environmental and social disciplines and, more germane to our field of study, by planning in social systems and decision-making, seem to reinforce the link between sustainability and Complexity.

The disclosure of systemic approaches lies in the coherent integration of the action and the understanding of phenomena, transcending the limits of analytical traditional modeling techniques. Even if a well-defined "toolbox" for sustainable changes based on the findings of system thinking and complexity science has not yet been found, there is enough convergence on two pillars that can be used to shape new tools:

- the need for trans-disciplinary sustainable development approach based on a systemic perspective. This statement is supported by the relation established between trans-disciplinary and complexity;
- the interpretation of sustainable development as a learning process. Discussing the integration of the science of complexity, knowledge management and organizational learning disciplines, McElroy (2000) states that "complex systems are, by any other definition, learning organizations", and adds, on the other side, that "knowledge is the product of natural innovation schemes inherent to all living systems". If sustainable development means to drive change and to make it happening in complex systems, it has to take part to the learning processes underpinning complex systems behaviors.

It can be argued that sustainable changes need methodologies and tools able to support a learning process in a complex system with a trans-disciplinary approach. Moreover, this learning process should be collective; Holman says (2007):

"Effective, sustainable change are sessions in which people collectively explore each other's assumptions, seek and expand common ground, shape a desired future, and jointly take ownership of the solutions to the issues at hand".

In the next pages will be discussed why and how design should be a discipline integrated in the changing process, in planning and decision-making.

2. The role of Communication Design within Complexity Framework

One of the most important challenges of complexity science researchers is to facilitate connections among knowledge domains apparently distinct and separated towards themselves, approaching system to be known in a systemic way. This basic idea is confirmed by Gell-Mann [19], he describes a way about carrying on this approach:

"[...] some efforts just getting under way to carry out such a crude study of world problems, including all the relevant

aspects, [...]. The object of the study is [...] to identify among the multiple possible future paths for the human race and the rest of the biosphere any reasonably probable ones that could lead to greater sustainability”.

This, which seems to be more a challenge than an actual reality, has to recall disciplines by their own nature situated at the edge of different competences domains. Design discipline is one them. There is a need for integrating competencies, labelled by Gell-Mann as “a crude look at the whole”. In this sense, the hypothesis that design may join those disciplines of “looking at whole” outlining a designer profile whose task is to select results from heterogeneous disciplinary fields activating a trans-disciplinary circulation of concepts [30], is made. This means adopting and developing a new attitude based on a theoretical framework that overlaps systems science and complexity theory [17].

Designers should use their skills to facilitate the emergence of the system; they should no longer focus on finding solutions to specific problems but on the ability to develop tools that can be self-adaptive, continuously modifiable and improvable. Acting within complexity requires considering the impossibility to reach an exhaustive knowledge of the system in which one operates. It could be passed by developing a strategic stance that allows facing the system changes and evolution. Development models often relate expert knowledge to social needs with a top-down approach, thus being not able to cope with the issues of a complex world. Effective changes in social systems arise from iterative and dialogic processes in which information and knowledge are exchanged between heterogeneous actors, to build-up a common background that enables shared hypothesis.

Social complexity requires new processes fundamentally attuned to the social and conversational nature of decision making and design work; they should tend to enable a more and more valuable interaction level and dialogue among the actors of a social system. Heeding the perspective of Design discipline dealing with languages, the Communication Design could afford the creation of visual and interactive languages relevant to the representations of Complex systems, creating shared visions within multi-actor contexts. The design approach outlines the ability to select results from heterogeneous disciplinary fields activating a trans-disciplinary circulation of concepts. Designers should use their skills to facilitate the emergence of the system; they should no longer focus on finding solutions to specific and well identified problems but on the ability to develop tools that can be self-adaptive, continuously modifiable and improvable by the ongoing process of wicked problems transformation.

In this sense it can facilitate dialogues within participatory actions and verify the potential of communication artifacts in supporting and externalizing sustainable and self-adaptive learning processes. Therefore the possibility to consciously face social issues and orient the behavior of complex social systems could benefit from the use of communicative tools and methodologies, in order to support collective learning processes and build-up a common vision, shared by different stakeholders.

The centrality of communication and learning processes when dealing with complex systems -especially social ones - has been explored and criticized in several domains by different disciplines: from the theory of social systems (Luhmann 1984) to knowledge management (McElroy 2000). How these processes should be handled and shaped in order to be effectively and collectively able to drive and orient the evolution of a complex social systems seems to be less explored and clear. We believe that the communication design capabilities go beyond the necessary and general approach of taking into account complexity, developing a systemic perspective, consider its limits and opportunities; the communication design, as we are exploiting, has the necessary skills to concretely and actively insert in each kind of process that aim to dialogue with complexity to intervene and enable a system change.

The design discipline create innovation by pursuing relationship and newly twining elements that are not new at all. If we can summarize [38] the design capabilities in see (understand the context), show (visualize the information) and foresee (critically predictions), the communication design surely is able to engage the capability of make complexity visible, understandable as much as possible, accessible at least, and more easily practicable; it has the capabilities of give visibility to the shape of what is complex, and in some way to give it a shape, making it cognitively handled.

The importance of the concept of shape grounds the systemic thought, that permanently moves the focus from single parts to the whole, and sustain, as a cultural reference to the Gestalt, in order to understand a complex system, the need of understand the specific configuration of relationships, that is technically called pattern: to understand a system means understand and reveal the pattern, and to reveal a pattern is necessary to design it. Understanding and intervening in a complex system requires to perceive it as an integrated structure, to get those properties that characterize the system and that don't belong to any component; these properties emerge from relationships and interactions between the single elements.

To make a system visible by its complexity, means make visible what is latent, that is the early step to conceive access and intervention to the system itself. Design discipline and complexity theory both refers to the domain of possibility and hypothetical, and this ability to make a phenomenon visible, a problem, a pattern, is considered in the theories of RED a feature that really based the user centered approach, together with the ability to assume the point of view of users and that one of build prototypes as cognitive tools, for testing and reflective learning.

So the communication design discipline is able to concretely contribute to the complexity of contemporary problems thanks to skills of visual manipulation of the shape, and to capabilities to a better problem setting.

These are the hypothesis that ground the experience that we are presenting in the paper, the The DensityDesign Lab. In our researches and students activities we assume the idea that the distinctive pattern of complex system belong to the

visual domain of networks, as Capra suggested [8]; the network is a concept that involve every discipline, from biology to management, and currently represent the basic pattern of all the discipline that consider the systemic thoughts and it is firstly the common organizational structure that belong to all living being.

These are not just some kind of formal inspirations; the teaching and research program that we want to propose and discuss critically explores and develops the visual power to display networks and its features; complexity is a keyword to understand reality, and it is combined with a continuous research for information aesthetics and representation, that nurture and inspire emergent relationships among communication design, information visualization and complex systems. So, the didactical framework has been defined with the aim of educating designers in the exploitation of visual languages to deal with social complexity. The didactical initiative has been experimentally launched to answer the following question: How visualization and communication design can be applied to support collective learning processes and decision making in complex systems? After five years of continuous improvements and the development of specific conceptual and operative tools, a didactical framework has been defined with the aim of educating designers in the exploitation of visual languages to deal with social complexity. The paper describes the framework theory and outcomes.

### 3. The DensityDesign Laboratory: complexity, density and communication design

The DensityDesign lab has born in 2004 as didactic initiative with the aim to experiment visual representation languages able to facilitate the sharing and the development of knowledge within groups of heterogeneous actors that are engaged in the same complex system, that is considered as subject to change and further change. In other words, let's imagine an hypothetical decision making or negotiating table around which different stakeholders of the system gather together; students experience the concept and the design of communication artifacts that would be able to visualize the system as a complex whole, creating by the artifacts a shared knowledge base between the different involved actors; the target and the goal of these artifacts is primarily to be mean of dialogue between interlocutors, enabling more conscious and relevant perspective in decision making strategies.

The complex system that we observe and we are dip into, by the evidence of its uncertainty and unbalance, are dynamic and adaptive systems, that express creativity and innovation by the feature of self learning and self adaptive behavior in the context.

Then the communication artifacts that we intend to design cannot be considered as the solution to a ongoing wicked problem; mostly they are cognitive tools, that help to better (or thicker) understanding in order to better acting, taking into account both by conserving than visualizing, also uncertainty and unpredictability. In the most of the case is a process of pattern recognition, the process of understanding the schema of relations between elements, that usually is unbalance in

complex systems, but unpredictably emerge mostly without any centralized concept. This is the field of comprehensive representation, of the systemic vision, that tend to connect and join also in order to underline unexpected relations, that avoid atomic separation of discrete levels and look for continuous and mutable settings.

#### 3.1 - The DensityDesign lab tools: the diagram as a cooperation visual device

In our perspective, the communication artifacts that the students are called to design during the laboratory are conceived as negotiational tools and decision making tools, dedicated to defined interlocutors and improper for a general audience. The communication design build through a visual language the mediation and dialogical tools that allow to depict common and shared understanding and the emergence of common interest and goals in multi-actor contexts. Since the beginning, we called these artifacts with the generic term of maps, that evolved, by the support of doctoral researches and progressively has been redefined in the concept of diagrams, open to the widest visual opportunities, and include those communication artifacts that has a revealing ability as maps, scenarios, schemas, storyboards, etc. and represent visions behind visualizations .

In our meaning, diagrams shall provide to the complexity of the system (or in a wider sense to a complex problem) an understandable and sharable shape, that could be able to overcome constraints related to the technical and disciplinary languages. It's widely recognized that the traditional models of development based on the direct relation between expert knowledge and social need, and managed by a top down approach are increasingly less relevant in efficiently dialogue with the problems of complex reality. Diagrams can and should visualize not just quantitative data, but also ideas, concepts, point of views and perspective and qualitative and value assets of complex systems observers.

The interest in diagrams is less in the result itself but mainly in the visual/discursive tool, the generator of dialogical actions; not a definitive solution, but an instrument for a better framing of the issue. An apparatus in the hands of the visual designer, that enhance not only his ability to see but, primarily the one of the others; it creates a collective vision of the form that keeps together the elements of the issue or the complex system. A precious skill - even essential - when facing phenomena and shifts of the contemporary society. Problems that, to be solved, needs a participative and collaborative approach:

To speak of a problem and to engage with solving it is to engage in a conversation among stakeholders (people who care about the outcome). In my thinking about wicked problems, I like to introduce the notion of 'social complexity' as inseparable from problem wickedness. There are no single stakeholder wicked problems. [13]

To make visible the relational structure of the complex system, and to describe the dynamics that animate this structure, combining various tools and visual patterns, is the skill that the communication design can add, facilitating the

exchange between the stakeholders, enabling negotiations and mediation and to underline common visions and intents. The communication design can develop the capacity of the diagram in turning it into the mediator between discipline experts and users, clients, administrators; the importance in building collaborative and dialogic interventions in social issues, brought us to develop visual artifacts as tools for decision making, aimed to a heterogeneous audience, interested and/or expert, capable and motivated to face the necessary complexity of the visual representation of a complex system.

These tools by nature are not easily accessible and still they require additional discussions, far from being univocal and reductive. The design and production of diagrams, and a diagrammatic approach, are primarily useful for the design itself, especially when facing complexity: applying a design process, oriented to sustainability, open to social and political affairs, benefits from the communication design in developing diagrammatic tools.

#### 4. The structure of DensityDesign framework

Since 2004, we defined and improved the process of build and structure the visual languages. The method and procedures of visual analysis and representation of systems has slightly changed, and after five years of continuous improvements and the development of specific conceptual and operative tools, the initiative reached in the last editions its ripeness (2009). In the following section we will briefly describes the process approached during the laboratory activities, and some artifact will be presented and described as samples of the progressive results.

The potentialities of visualization are experimented in two complementary domains: 1) the visualization of Data, Information and Knowledge (DIK); 2) the visualization of the structure of complex social phenomenon (structural visualization).

In the first domain, students work to improve the cognitive processes that bring from data to information and from information to knowledge. Within these processes, any visualization acts as a translator: it identifies and visually represents relations between data and information in order to communicate it and leverage knowledge. In the second domain, the focus is on the form of the social phenomenon, assuming that understanding a system means understanding its form, and understanding the form means to see and to visualize a pattern. In this domain, visualization aims to amplify the pattern finding human capability (Ware, 2004), connecting the actors and/or the forces that drive the complex system or the social phenomenon dynamics.

By this features, any actor within complex systems is continuously involved in data production, information gathering, knowledge exploitation, in order to support and nurture its own position and interest within this collective undertaking. Data, information and knowledge are structural and basic elements of representation theories, and in a general way, of communication and cognitive disciplines. The connection among these elements and visualizations is a key issue in communication

design field.

#### 4.1 - The DensityDesign lab experiments and outcomes

During the years, the number and the typology of the didactical modules have been refined, together with the range of disciplines involved and integrated. The choices have been made according to the outcomes produced by students and the evaluation of the projects in real contexts.

The first draft of the Density framework involved the students in locate a social system of interest, in data gathering and description; then students defined the diagrams, providing a visual representation of the systems that basically intended to provide a comprehensive description of the system able to better single out its current configuration and dynamics. These kind of maps supported the further design action: starting from the maps students would articulate a communication design strategy relevant and useful to the system dynamics, and then use the diagrams again to depict the impact and the new configuration of the system after interventions. At that stage, the basic intentions was to reflect about the selective process that give the shape to a map, and to refine the visual language and empower the ability of represent these different views by the exploitation of details.

A more reflective capability has been explored in the next years, and the framework evolved towards a more articulated definition of the representation modules of the density of data. We interested more and more in analysis by visual and in visualization techniques and process, and we finally arrived at the current structure of four visualization modules. We progressively avoid the idea of a necessary design interventions in the systems, and stop conceiving the maps just as a preliminary cognitive artifacts. In the initial perspective diagrams could provide the description of current, possible, foreseen configurations and by this could support interventions. The framework developed refining the theory and practice of visualization and clarify the diagrammatic capability, by pointing out diagrams that are differently connected and configured according to communication goals.

The current structure of the framework is composed by four modules: two modules – information visualization and motion graphics - belong to the first visualization domain previously mentioned (DIK visualization); the others - causal diagrams and system maps - are expression of the structural visualization domain, according to the need of understanding the social system/phenomenon as a whole.

We are going to briefly described these modules by displaying and describing some sample outcomes; this distinction between the diagrammatic modules and the infovis modules refers to different intentions of the visualization process: diagrams more exploit the system analysis and display, as well as infovis more explore narrative techniques and the conversation between the form and the meaning.

##### 4.1.1 Information visualization

The challenge of information visualization module is to nurture and clarify the process of translation from data to information to knowledge. In this modules complex data sets

are explored and transformed in visual representations that aim to clarify the meaning of data and make them usable to further knowledge.

Our last experiments explore socio-economic phenomena that present both representational and visual problems. Economic statistic concerns the understanding complex, multidimensional, ambiguous and dynamic phenomena building formal representations (models) based on statistical data. Communication Design addresses complex phenomena to interact with them building multidimensional visual representations based on statistical data. The goal is to contribute to the construction of representation and visualization model respecting and preserving the inner structure of the analyzed phenomena, allowing users to know (see) them as a whole.

We started from 2007 official data (provided by the ISTAT) about poverty and social exclusion conditions in Italy, and the students have been individually called to provide visualizations about the poverty in Italy, using data as primary even not comprehensive reference.

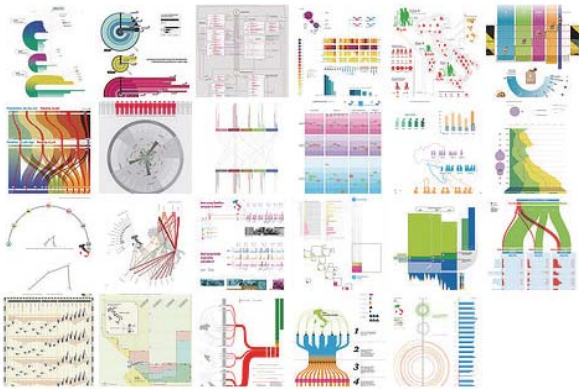


Figure 1 –from data to information: an overview of the different maps designed with the ISTAT Italian national report about poverty

Exclusion is a socio-economic status where people are placed on the margins of society, because of their economic, psychological, physical, cultural conditions. To evaluate its forms and intensity requires models that consider a multitude of dimensions: the determination of poverty status cannot be reduced to simple and single indicator. The representation of socio-economic problem is not reducible to a problem or purely algorithmic technology, but not because of the quantity of data: complexity, multi-dimensionality and ambiguity are difficulty reduce into algorithmic computations. This module requires developing new visual grammars and communication tools that do not superimpose artistic or vaguely appealing elements over the representation of the phenomena, but should be able to build narratives deeply consistent with its inner structure. Visualization artifacts, diagram and maps, have to respect the robustness of scientific approach on phenomena while remaining consistent with the structure of cognitive and logic capability of the observer.

#### 4.1.2 Motion graphics

The module of motion graphics mostly explore the narrative

power of information visualization. In this case data become information, and then knowledge, and the visual languages are made devoted to define a relevant narrative. Motion graphics techniques are used not to the systemic representation of complexity, but represents thick descriptive tool that are able to reduce the distance between the data, the pattern and the meaning in a narrow perspective of the system.

The information visualization in this case serve the purpose to thick describe a single perspective, and to visually clarify the way the specific point of view is related and interconnected with the wider configuration.



Fig 2 – from information to knowledge: screenshot from the video Choice, motion graphics about the Poverty System and Food, <http://www.vimeo.com/4002528>

#### 4.1.3 Causal diagrams

The module of casual diagrams is a structural tool of visualization that aim to fully describe the actors and the variables of the system, and to exploit their influence and directions. It is a kind of representation that better describe the structural part of the system, pointing out the elements as single and detailed, and the main structure and influences. Casual maps is necessary to fix the mechanism of the system, and it's the primary schema of the understanding of its behavior.

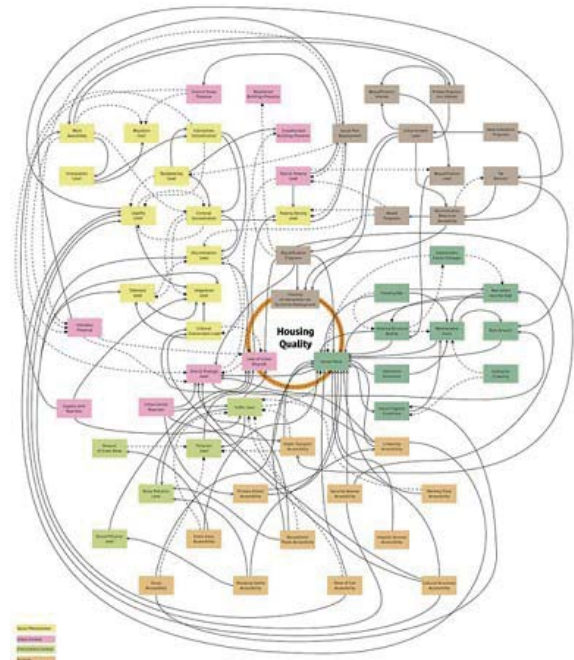


Fig. 3 –a casual diagram about the system poverty

A causal loop model has been developed in order to help understand the complex systemic structure of poverty in all its dimension. System diagramming is here a loose term used to describe the activity of conceptually representing and visualizing a system in its constitutive elements: the elements, the relationships and the system boundary distinguishing what does and does not belong to the set. The system has been visualized in the particular format of a causal loop model: the system's elements (factors, variables) are represented by boxes, and the causal relationships between two variables are represented by arrows. The variable at the tail of the arrow has a causal effect on the variable at the point.

#### 4.1.4 System maps

The final artifact provided is the system map, that can be consider an overall perspective of the system, some kind of bigger picture that describe the components, the dynamics and the contextual characteristics. The system maps emerge from an hybridization from the previous diagrammatic artifacts and a deep visual description of all the contents; it aims to suggest the form of the system, by the visualization of the found pattern. System maps doesn't emerge just from data analysis. They necessary are connected to some previous knowledge that is itself depicted within the maps; it composes with raw data and structured information and is finally able to provide a wide scale representation.

Maps exploit the knowledge layer related to experience, and should be able to activate dialogues and discourses about the system itself. Map represent the final step of the cycle between data and knowledge, and transform and elaborate previous contents in order to rich a collaborative and shared knowledge layers.

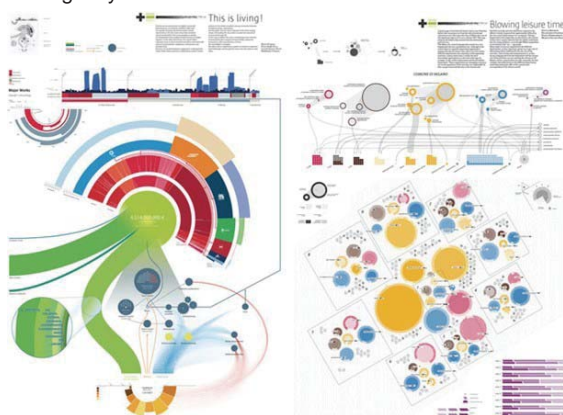


Fig. 4a,b –the system map, Poverty&Housing, Poverty&Leisure

In this module the possibility to evaluate the projects in the real contexts is more coherent and relevant, and is the occasion to display the effectiveness of the contribution of communication design in the understanding and practice of complex systems. To find an evaluation contexts for the projects always mean to face with institutions, organizations, identity structures, and represents itself a concrete example of negotiation and decision making that is supported by the visual languages. In some case the process has been success full, and the students as first could verify the effectiveness of their

design, and to better improve it.



Fig. 5a, b, c: discussion of scenarios that emerge from the Energy system maps, with the interlocutors at ENEA consortium.

#### 5. Conclusion

In these pages we try to systematize both the theoretical than the artifacts outcomes that we experiences in the development of The DensityDesign Lab. The theory and the results are ongoing tensions that we continuously consider in research and teaching practices, and that we mainly try to get across at concrete evaluation stages by prototyping (in case of interactive artifacts) as well as the participation to decision making tables. In fact, the more important perspective in future works ask for a further extension in the practice of evaluation in real context and, and the more recent activities suggest fertile horizon in this direction. The challenges that the global changes provide to us require a collective disciplinary engagement, and the design is called and strongly aspire to participate to the solutions and the critique toward the changes.

The research and the teaching activities are synergic: didactic naturally suffers of school limitation in time and space, even if it offers a plenty of cases, themes and design occasions; the researches evolve towards a more and more theoretical ripeness and allow a constant reflective thought about the different cases collected. Through the The DensityDesign lab approach we intend to contribute to any actors involves in undergoing global changes with a cognitive and practical visual tool, a generative machine that allows a discourse about the system that changes, and facilitate a more conscious approach to its complexity. These visual tools aim to origin from common objectives, and from there develop shared perspectives.

This requires to continuously refine the nature of the team, and open interesting perspective for future works: the didactical framework proposed here is intended as multidisciplinary platform, where visual design is the core and leading discipline, successfully complemented in the year by the integration of semiotics, statistics and network science.

The more refined become the process of visualization, the more articulates become the strategy of data gathering. These are the basic tensions that we tie to the concept of visual languages as a multidisciplinary cognitive device.

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