Visualizing Complex System

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CHALLENGING COMPLEXITY BY SYSTEMIC DESIGN TOWARDS SUSTAINABILITY

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# EXHIBITION
# VISUALIZING COMPLEX SYSTEMS

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# INTRODUCTION

Chiara L. Remondino
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The multi-faceted nature of information brought the society towards a radical change, especially in this era where data production and collection are reaching levels that could not even be imagined until a few years ago. From relations to components, from process to systems, the importance to make these elements more visual became essential to enable new scenarios, innovative systems, and creative mindset in an educative and formative way.

The ability to collect, cross-check, visualize and study quantitative and qualitative information about phenomena and their patterns is itself at the core of the project, becoming strategic for enabling new systems thinking and their design application. Identifying the relationship between components, thus guaranteeing personal expression, horizontal communication and visual thinking, is the first step to enhance a more conscious and transparent decision-making process with a perspective of sustainability.

This book aims to offer an overview of the discipline of data visualisation and its application in the investigation and communication of complex systems, also thanks to the analysis of the posters exhibited during the visual exhibition that took place from 23 to 28 October 2018 in Turin, in the frame of the RSD7 - Relating System Thinking and Design symposium.

# Space and time of information design

Paolo Tamborrini

Information has always been good for human survival because choices based on correct knowledge are more likely to generate positive results for the individual, contributing to his survival (Buiatti, 2014). Norbert Wiener, father of cybernetics, defines the term information as "the content of what is exchanged with the outside world as we adapt to it and adjust our corrections to it". He goes on to say that "the process of receiving and using information is the process by which we adapt to the contingencies of the external environment and live concretely in it. To live concretely is to live with adequate information". (Floridi & Bynum, 2009).

Whether they are spontaneous associative processes of forms and meanings, or more dictated by scientific rigor, there are many places, causes, stages, characters that have led over time to the etymological/historical definition of terms such as information design and data visualisation (Stiff, 2017).

In 1952 H. Spencer used for the first time the term "commercial printing" to describe what is now defined as information design; in its most general sense it also included the so-called "utility printing [...] whose main purpose is to inform". In the same year, Typographica 5 - Purpose and Pleasure, a special issue entirely dedicated to the art of printing in the post-war period, told through the practices of fourteen different countries, was published, an edition that included contributions on design and typography from the pens of authors such as Paul Rand and Max Bill. Only a few years later, and more precisely in 1958 at the Hochschule für Gestaltung in Ulm, took shape what can probably be defined as the first Department of Information that, despite being different in methods and purposes from what we now understand as Information Design, set itself the goal of educating writers for the press, broadcasting, television and cinema. It was Ladislav Sutnar who in 1961 freely used the term "designing information" for the first time in his book Visual design in action, and again in the same year, we owe to Anthony Froshaug his reflections on the concept of network as a representation of metropolitan systems, which he says: "this sort of presentation [communication] raises a big problem for design, that a drawing that shows only the necessary information, a drawing that respects parsimony, is actually easier to understand than the one that contains a certain amount of redundant information" (Froshaug, 1961). London 1965, Alastair McIntosh, at that time director of Unwin Brothers, one of the most successful printers in the United Kingdom, coined the term "printing of information" during a radical debate on the redesign of editorial and typographic conventions in the scientific field and in the press; and again in the same year Robert Horn, starting from the theories of learning and cognitive psychology, defined the standard approach for the organization and communication of information, an approach that we still know today as "mapping of information". Exactly one year later, in 1966, Herbert Spencer founded the Readability of Print

Research Unit within the Royal College of Art in London, a unit directly supported by the International Publishing Corporation, which had the aim of investigating 360 degrees everything related to the publication of information. Then came the early 1970s, and it was Maurice Goldring who was attributed the first use of the concept of "Information Design Consultants" to describe his work on the writing paper used for the affairs of Maurice Goldring Associates. It was in 1971 that the head of design at Stafford's College of Art and Design Peter Burnhill decided to use the term "information design" to define the subject of the works on display at Monotype House, an exhibition of the work of the College's students; the same head who only a year earlier had unsuccessfully proposed including in his curriculum a course of "Professional studies in information design". Arriving at the London Business School in the mid-1970s, in 1975, Peter Gorb was perhaps the first to classify the themes inherent to the disciplinary sector of Management, Production and Design, proposing: product design, environmental design and information design, the latter defined as "the use of those things with which the company communicates its aims to all its audiences: customers, employees, shareholders and so on". And it was in 1978 that the first NATO Conference on the visual presentation of information was held in Het Vennenbos, the Netherlands; and only a year later the first international magazine dedicated to it was officially founded: the Information Design Journal.

In this varied scenario, many are the labels that over the years have been used to define the visualisation of information, different definitions that have tried to connote and give a specific meaning to the different facets and declinations of the discipline; and, although very often their names are used in a more or less interchangeable way, it is important to try to define the characteristics that led to a possible classification, even if, in fact, there are no clear boundaries between the areas in question:

— Data Visualisation: refers to the practice of using graphic representation to abstract information in schematic form (Friendly & Denis, 2004), arriving at static or dynamic representations; visual representations that as Alberto Cairo states are able to enable greater analysis and exploration (Cairo, 2012);

— Information Visualisation: while the term data visualisation is usually used as a generic term describing any form of visual representation of data, the term information visualisation is limited to visualisations supported by the computer;

— Scientific Visualisation: visualisation that deals mainly with data of physical, geographical, genomic type;

— Information Aesthetics: a discipline that acts as a link between information visualisation and information art, integrating functional aspects into the art to convey content more effectively (Friedman, 2003);

— Infographics: term usually used in relation to data representations for newspapers, extending the communication to a wider target and less

experienced;
— Knowledge Visualisation: unlike information visualisation, it uses visual representation to transfer knowledge between at least one person or group or persons, rather than for data analysis, using dimensions such as experiential dimensions.

Many attempts to define the discipline then embarked on the path of classification, trying to outline and define all the elements that can be traced back and belong to the same system. For example, many works have found the key to interpretation in the intersection and organization of graphic forms, whose main taxonomy sees the distinction between functional and structural. Functional taxonomies focus on the intended use and purpose of the graphic material; on the contrary, structural taxonomies derive from exemplary learning and focus on the shape of the image with more emphasis on emotions than on its content. In general, this trend derives from the distinction between the different backgrounds of the experts involved: the former generally focused on statistics, computer science and engineering, while the latter usually more akin to disciplines such as graphics and the arts.
One of the most common and well-known examples of functional classification is found in the work of Edward Tufte. He identifies four extremely specific categories of graphic classification: a geographical representation through maps, time series, a visual representation of events and phenomena that develop in space-time, ending with all those methods useful for depicting networks and relationships (Tufte, 1983).

Heer, Bostock and Ogievetesky have also placed the emphasis on functionality, proposing in 2012 an articulated graphic classification more focused on contemporary experience and therefore considering the increasing difficulties caused by the exponential growth in terms of volume of information; specifically, four categories are identified by them: time series, statistical distributions, maps, hierarchies and networks (Heer et al., 2013).
The work of Lohse et al. (Lohse et al., 1990; Lohse et al. 1994) is different in approach. They establish the boundaries of the discipline using characteristics such as meaning and similarity to clarify the main differences between the different graphic forms, thus defining six fundamental structural categories: graphs, time tables and graphs, maps and charts, diagrams, networks and icons. Or, still different are all those works that define the classification according to the type of dataset; Santiago Ortiz and his 45 ways to express two quantities (Ortiz, 2012) or Ben Shneiderman and the proposal TTT (Type by Task Taxonomy) which sees the attribution of seven different types: 1-dimensional data, 2-dimensional and 3-dimensional, time data, multi-dimensional, trees and networks (Shneiderman, 1996).
The taxonomies are many, and those shown do not exhaust probably the

panorama present in literature, offering however a varied scenario.
However, we can identify in the systematization proposed by Isabel Meirelles in the text Design for Information, an interesting and exhaustive key to reading:
— hierarchical patterns: trees. The visualisation of hierarchical structures is today one of the most mature and active branches of information visualisation (Chen, 2006) and often also complexity takes this form (Simon, 1991). In general, hierarchical systems are ordered systems in which the elements are organized according to a precise and specific relationship that varies according to the domain, but defining a typical tree shape. Vertical, horizontal, multidirectional, radial, hyperbolic, figurative (Lima, 2014) thanks to its expressive qualities given by the natural branching at levels, this type of visualisation has become one of the main tools of formal communication, illustrating topics such as family ties, biological species, moral values, organizational systems, computer schemes and much more;
— relational schemes: networks. As the name indicates, relational structures organize data on the basis of fundamental relationships for the system itself, so the importance does not fall on the node but on the link between two of them. Networks decode the interactions between genomes and proteins, capture neuronal connections at the basis of human understanding, tell professional relationships, describe how different communication devices interact with each other through internet or wireless connections, are the heart of many of the most revolutionary technologies of the 21st century, enhancing services such as Google, Facebook, Twitter, etc.. In short, today networks permeate science, technology, nature and human relationships as well as the most original hybridizations between them. In this regard, interesting is the work of Ben Shneiderman and colleagues who, applied in the context of social studies and social networks in particular, shows precisely how "The focus of social network analysis is three people, not within people. While traditional socio-scientific research methods such as surveys focus on individuals and their attributes (e.g. sex, age, income), network scientists focus on the connections that bind individuals, not exclusively on their personal qualities or abilities. This shift in focus from attribute data to relational data has a major impact on the way in which data is collected, represented and analysed. The analysis of social networks integrates methods that focus more closely on individuals, adding a critical dimension that captures the connective tissue of societies and other complex interdependencies. (Shneiderman et al., 2010);
— time patterns: time lines and flows. Time is an abstract concept and for this reason not intrinsically visual, however, these tools have always been used to interpret dynamic and evolutionary phenomena, using a set of causal variables ordered with respect to the same evolution in time;

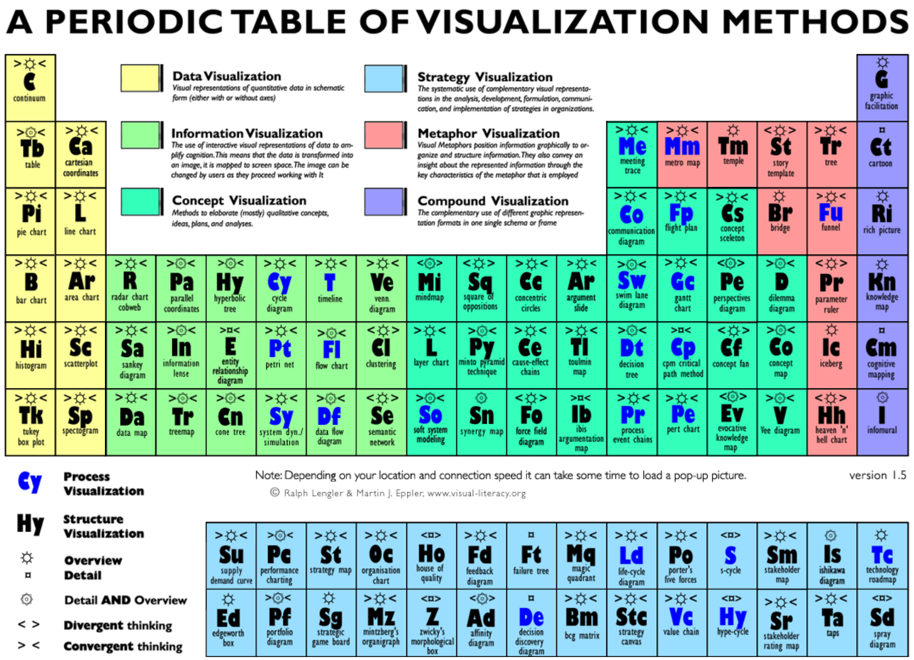


**Fig. 1** Periodic Table of Visualization Methods

— space patterns: maps. "A map is not limited to mapping, but free meaning; it forms bridges between here and there between different ideas that did not know they were previously connected" (Larsen, 2010). The term map, as well as the action of mapping, are concepts shared in different fields of knowledge, but in which they share the characteristic of indicating diagrams or datasets that show a spatial collection. The oldest and most frequent use of maps can be associated with representations of geographical, meteorological, naval and land surface data, however, it was only in the seventeenth century that the combination of cartographic and statistical skills merged into a single representation, about 5000 years after the first cartographic maps engraved on clay plates;

— spatio-temporal patterns. Everything we consider useful for forecasting purposes, be it economic, meteorological, scientific or other, defines a change, a change that very often involves two main variables: a temporal variable and a spatial one. The hybridization between spatio-temporal representations thus amplifies the explanatory power of a multiple-variable visualisation; in this regard, interactive tools become fundamental in the representation of the complexity of dynamic and evolutionary phenomena;

— textual schemes. Advances in information collection and in the computing power of computer tools have facilitated textual analysis; today, large amounts of historical and contemporary documents are available in digital format, opening the door to new and powerful ways of examining and investigating literary data, but at the same time social interactions and online conversations are providing new data sources that are leading to the understanding of social phenomena in ways that until recently were unimaginable.

In addition to taxonomies, today's panorama sees further attempts towards a precise cataloguing and description of visualisation methods, of which Harris, with Information Graphics: A comprehensive Illustrated Reference (Harris, 1996), has certainly given an all-encompassing and specific overview. A further example can be found in the work Periodic Table of Visualization Methods (Lengler & Eppler, 2007), a deliberately less academic approach that through the review of the known periodic table of chemical elements, classifies and relates the different types of graphic visualisation [Fig. 1]. Specifically, all the types of visualisation identified and taken into account for this work are categorized in:

— visualisation of information;
— visualisation through metaphors;
— useful visualisation to outline a strategy;
— hybrid visualisation.

All the elements are then further specified according to the function or type of interaction enabled (overview, detail), to the cognitive processes involved in the analysis (convergent thinking, divergent thinking) or even according to the type of information represented (structure,


**Fig. 2** Data Visualization Collection (C.L. Remondino, B. Stabellini, P. Tamborrini, 2014)

process).
The interest in data visualisation has reached such a level that even outside the academic world has created a very prolific community, often made up of designers, graphic designers, computer scientists and figures with complementary backgrounds, sometimes placed in research centers and other times belonging to independent studies.
These realities have been inserted in the scene and in the discipline not only with works of visualisation, but also with proposals for cataloguing the graphic forms, not proposing new ways or keys of reading, but rather trying to offer tools to facilitate the choice of the correct or best form for the communication of the message. Among these we can cite for example The Data Visualisation Catalogue or the most recent Data Viz Project.
For a more complete and exhaustive study, as a research team on data and visualisation of these, within the Innovation Design Lab of the Department of Architecture and Design of the Politecnico di Torino, we have worked on the collection and cataloguing of existing graphic forms identifying 96 of them, among the most common and those less known as typical of specific sectors. However, although many forms are already specific for some datasets, others are more versatile; it is therefore essential to choose the form correctly according to the message and the data to be represented. For this reason, in addition to the classification of graphic forms, the research work has seen the interweaving with the identification of the functions that these forms can perform, and specifically have been identified 12 such as: text analysis, comparison, distribution, flow, hierarchy, probability/choice, process, proportion, range, relationship, space, time [Fig. 2]. Each graphic representation can generally perform several functions, either in different projects, or simultaneously in the same visualisation through the use of elements such as color, size, or others. An example can be the classic word cloud, a representation in which the size of the words defines the importance of the same, a representation generally used for textual analysis, but which can at the same time perform the function of relation through the spatial arrangement of the present terms (Stabellini et al., 2017).

### Historical notes

The use of graphs, maps, diagrams and tables is not new; this type of representation accompanies us in the course of human evolution facing historical changes in different socio-cultural contexts, spaces and the organization of knowledge on the basis of models increasingly suited to the way in which we “feed” on information. From cave paintings to cuneiform writing, from food administration to Ptolemy’s representation of the earth in spherical form, albeit with different instruments and often discontinuous times, ancient history shows examples of the presence of graphic signs from the primordial instincts of man. Between 1000 and 1300 we witness the massive use of tree structures as a visual metaphor to represent, map and classify knowledge: family trees, trees of life and even sacred trees and trees of knowledge to name a few, a classic figurative expression of growth, fertility, immortality, rebirth (Lima, 2014). In 1600 Descartes perfected the first graphs of analytical geometry based on the axes of the same name, the Cartesian planes. This was followed by the development and improvement of a multitude of works on animal and vegetable taxonomies and, still between 1700 and 1800, there was a real explosion in graphic representation as a result of the expansion of techniques of mathematical, statistical and probability analysis. Finally, chaos. Randomness and complexity are the characteristics that define the new vision that since 1900, still today, distinguishes contemporary thought, a non-linear thought, which feeds on relationships, a systemic thought. W. Playfair, C. J. Minard, J. Snow, F. Nightingale, D. I. Mendeleev, O. Neurath, H. Beck, are some of the names among the milestones in the history of visualisation. These figures, scientists, philosophers, sociologists, highlight a transversality of the instrument, starting from heterogeneous fields, almost never belonging to the domain in question.

Most of the graphs used today in data visualisation derive from the project of William Playfair, a political economist and son of the Scottish Enlightenment, and the mathematician Johann Heinrich Lambert. Together they popularised the idea that the data could be presented to a mass audience. In particular, Playfair's Commercial and Political Atlas included the first table to show the differences between imports and exports from Great Britain and various other countries. He was only the first who, considered in fact the father of data visualisation, understood and grasped the potential of data visualisation. In his 1801 text The statistical breviary, he writes: "[To stimulate insight from statistical information] it occurred to me that appealing to the eye when it comes to proportions and dimensions is the best and easiest way to convey a distinct idea" (Playfair, 1801).

Organizational structures are not exempt from this process; they are also involved in the visualisation of information and, specifically, in 1855 Daniel McCallum created the first experiment of representation of structures of this type, with New York and Erie Railroad - Diagram representing a plan of organization. Here, the railway structure is represented as a central and pivotal element, offering itself as a reading element for the management and coordination of the different activities involved in the transport system. The bottom-up reading emphasizes a branched and hierarchical organization, from the highest and most powerful sphere, to the most extreme branches.

English chemist and philosopher, Joseph Priestley was the first to introduce the concept of time within a graph by representing some bars whose length served to represent the life span of a person, from 1762 when he began to take a keen interest in scientific issues,

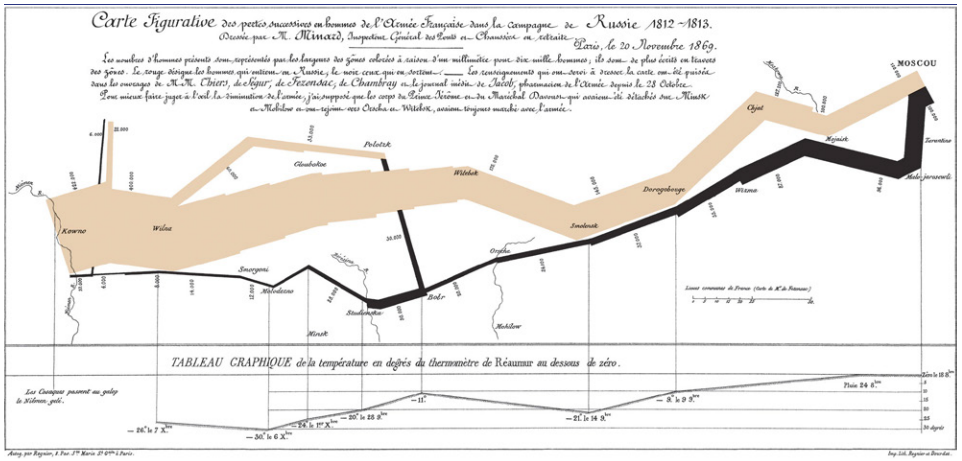


**Fig. 3** Carte figurative des pertes successives en hommes de l'Armée Francaise dans la campagne de Russie 1812-1813 (C. Minard, 1869)

arriving in 1765 with his A Specimen of a Chart of Biography to contribute to the evolution of methods of representation based on the concept of timeline. But it is only later, with the French civil engineer Charles Joseph Minard, that we find perhaps one of the most famous, iconic and visionary spatio-temporal analyses based on our primordial ability to perceive directions, shapes, colours and proportions, beginning to glimpse interesting scientific contaminations in the field of information graphics; he is considered a pioneer in the use of graphics in engineering and statistics. His Carte figurative des pertes successives en hommes de l'Armée Francaise dans la campagne de Russie 1812-1813 [Fig. 3], a flow map published in 1869 that shows with astonishing simplicity Napoleon's disastrous Russian campaign of 1812, while at the same time highlighting different elements such as army size, geographical references, time flow and meteorological variables, is very famous.

The health sector is also involved in the collection and especially the representation of data. Here, two main figures will influence the future work and discipline of information design: the doctor John Snow and the nurse Florence Nightingale, both British. The former, considered one of the pioneers in the fields of anaesthesia, hygiene in medicine and epidemology, owes his fame to the study on the spread of the 1854 cholera epidemic in Soho. Nightingale is instead considered the founder of modern nursing care, as she was the first to apply the scientific method through the use of statistics and proposed an organization of field hospitals, and is described as one of the pioneers in the graphical representation of statistics following the publication of his diagram on the causes of death of patients in military hospitals where he had served, a graphical form of representation still commonly used and known precisely as rose diagram.

The collection of data has always interested scholars of biology and genetics; Ernst Haeckel and his genetic trees, from those that concern all living organisms such as Monophyletic Family Tree of Organisms of 1866, to the diagram that represents the evolution of man Family Tree of Man of 1879., until the Paleontological Tree of Vertebrates of the same year 1879 in which the evolution of different species is collected, can be considered a pioneer in this field.

Still innovative today, but dated 1885, Etienne-Jules Marey's La mèthode graphique offers a completely new visual way of communicating the timetabling of Paris-Lyon tram routes from the 1880s. Arrivals and departures are placed on the horizontal line, while the stations occupy the vertical axis, spaced out in proportion to their actual geographical distance. The lines that are thus created reflect the speed of the vehicle, greater speed defined by a greater gradient, and help in reading the points of interchange, moments of rest, identification of coincidences.

Another diagram still known today and that owes its name to a character, is the Sankey diagram, named after Captain Matthew Henry Phineas Riall

Sankey, an Irish engineer who first used them, in 1898, to represent the energy efficiency of a steam engine compared to a hypothetical same engine that had no energy loss.
With Otto Neurath, Austrian sociologist, economist and philosopher, the representation of information takes on a different character, moving from a system of lines and points to one based on pictograms. He is remembered for having created, together with the illustrator Gerd Arntz, the Isotype system (acronym of International System of Typographic Picture Education), in order to communicate information in a simple and visual way, without the use, or with a limited use, of written and spoken language, revolutionizing public signage and modern infographics [Fig. 4]. In the same way, but with a specific application to multivariate data and sociological characters, it is the contribution of Herman Chernoff, who is known for the system of faces of Chernoff, precisely.

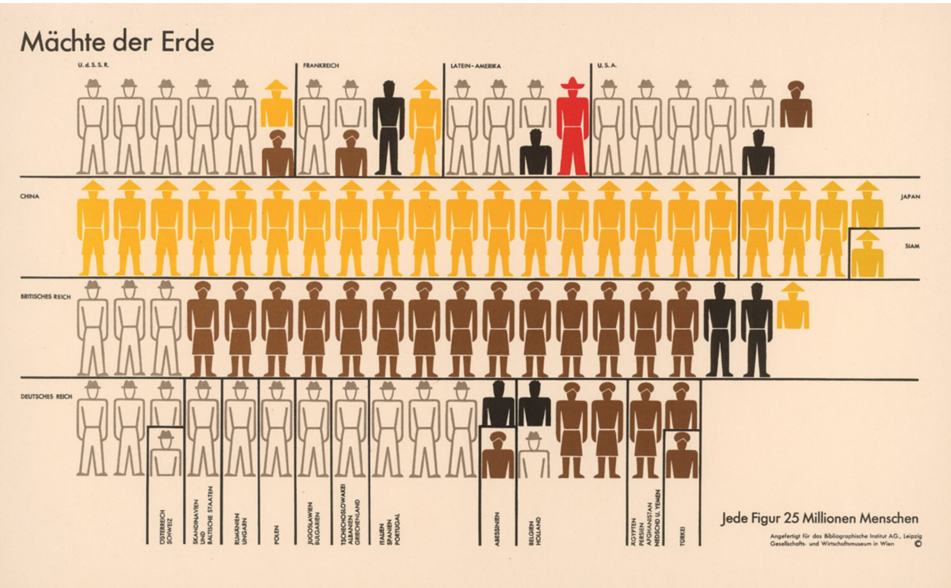


Fig. 4 Mächte der Erde (O. Neurath, 1835)

Finally, what is still considered a pivotal project for the discipline, is due to Harry Beck who in 1933 created and defined the map of underground transport in London inspired by the construction of electrical circuits, eliminating the precision of the spatial location for the benefit of the communication of flows and interchanges of transport lines [Fig. 5]. The project was so successful that it became the official representation of the London underground, a representation still used today not only in the city itself, but replicated throughout the world.

Pioneers of data visualisation such as William Playfair, John Snow, Florence Nightingale and Charles Joseph Minard were the first to exploit and encode information in the 18th and 19th centuries, beginning to see its potential; but modern supporters such as Edward Tufte, Ben Shneiderman, Jeffrey Heer Alberto Cairo and many others are responsible for the birth of a real discipline. Thanks to this renewed interest, in the last 30 years, a first wave of visualisation projects has taken control of the web and reached a wider audience, moving outside the academic environment and transforming the way in which novelties are shared. Giorgia Lupi, Stefanie Posavec, Stefaner Moritz, Valentina D'Efilippo, Jan Willem Tulp, Dominikus Baur, Nadieh Bremer, Lisa Charlotte Rost, Santiago Ortiz, Fernanda Vìègas, Martin Wattenberg, Paul Mijksenaar, Francesco Franchi, as well as Accurat, The Visual Agency, Density Design Lab, Stamen Design, Clever°Franke, Tulp Interactive, are just some of the names and studies that today are easy to associate to the world of data visualisation. New figures from different backgrounds, sometimes from the world of graphic design, sometimes from the world of interaction design, sometimes from the world of statistics or information technology, have transformed the way of seeing and perceiving the research and design of visualisations, shifting the debate to social networking platforms such as Twitter, transforming conferences into places of sharing and exchange, bringing newspaper readers closer to consulting infographics and to a different way of using newspaper articles. Today, we are witnessing more and more the emergence of new, innovative and interactive data-based platforms. The contributions submitted during the Visual Exhibition of the RSD7 conference provided an overview of the current ways of using data visualization applied to the investigation of complex systems, showing the great potential of the tool both in terms of analysis and communication phases. From the reconfiguration of places and urban spaces through new readings and interpretations, to the reorganization of companies through the management of complexity, to the systemic design of products and services, visualisation becomes a tool capable of conveying meanings, transforming data from simple elements to be visualised, to real components to design.


**Fig. 5** London Tube Map (H. Beck, 1933)

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# Visualizing complex systems

Chiara L. Remondino
Barbara Stabellini

Visualise: see tr. [visual der.]. - Make it visible. Build a visual image in the mind. However, today, a broader representation is given, including the graphical representation of data and concepts, from internal mental constructs to external artifacts to support decision making. Visualisations represent powerful cognitive tools that surround our daily lives (Bonsiepe, 2000) connecting two worlds, physical and digital, bringing the gap between them closer and closer, playing a crucial role in the exploration and communication of information. “A picture is worth a thousand words”.
Today we live in a world full of data and our daily lives depend to a large extent on our ability to process the information contained in them efficiently. However, technological advances have led to a situation where we collect far more data than we can understand, a phenomenon otherwise referred to as “information overload”. We therefore need to change our perspective so that visualisations are not simply defined by the technology they involve, but rather by the relationship with the purpose and context for which they are designed.

From a design point of view, visualisations represent the process that goes from data to knowledge (DIK continuum). In fact, they are able to collect data, information and knowledge (materials) and visualize them to create new knowledge (objective) (Masud et al., 2010). Furthermore, Wurman suggests that one of the main purposes of information representation is to help readers avoid the “black hole between data and knowledge” (Wurman, 1989); thanks to the relationship with context, unstructured information (reality and complexity) can be encoded into structured information and thus knowledge and insights for a more conscious decision making process based on data, a process based on a new model such as: DYKW (Data, Information, Knowledge, Wisdom) [Fig. 1].
Visualisation thus becomes a fundamental tool and medium for clarifying and simplifying information, favouring the exploration of complex phenomena, enabling the observer to have a profound understanding of the causes and effects of specific choices, comparing the effects in the most diverse situations, showing relational changes and distributing chaotic information in ordered and organised structures. From this scenario it is possible to deduce the importance and urgency of showing data, but above all of making them coherent and comprehensible, encouraging the eye to comparison and detail, avoiding distortions or gaps. Behind these abstract maps, there is the knowledge that it is not enough to choose a format, rather than a color, but instead you need to think about the message to be conveyed and the organization of variables and categories based on the goal you have set. Behind these abstract maps, one recognizes that the greatest value of an image is forcing us to notice something that we would not expect to see. Behind these abstract maps is the awareness that their intrinsic goal is to guide the observer in exploring and understanding the potential and

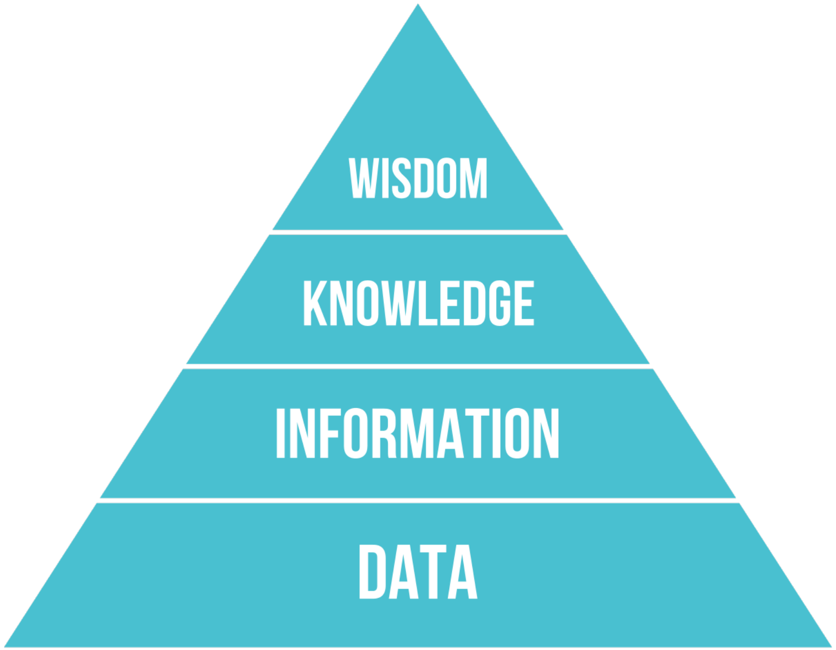


**Fig. 1** DYKW model (Data, Information, Knowledge, Wisdom).

characteristics of a territory (Corraini, 2017). Awareness acquired, moreover, by the possibility offered to the reader, also thanks to the application of the basic principles of interaction design, to undertake and intervene on the very construction of one's own interpretative path: a freedom of choice of reading paths, a possibility to build comparisons, historical causes, intuit subsequent evolutions (Colin & Troiano, 2014).
Aware of the possibilities offered by the tool, the implications and the possible and desirable effects on the actions and decisions of everyday life, there is now an urgent need for the participation of companies, organizations, administrations, the individual, as well as the community, a fundamental participation that becomes a lever for change in order to create original and innovative tools that can be integrated with traditional systems of mapping and analysis, less invasive tools and, at the same time, with faster turnaround times. There is a need for a new graphic alphabet, in a framework of functional rigor (Colin, 2014), to find the right code to give a visual order and visually synthesize the complexity, synthesizing this complexity to convey messages and qualitative narratives (Ciuccarelli, 2014).
We need a language with the ultimate goal of sharing knowledge, opening up the boundaries of communication in ways that until now have been unexplored.
Multidisciplinarity: this is one of the most strategic and successful approaches for all this to happen, an approach that actively involves different disciplines, from technical-scientific to statistical sectors, from the world of social sciences to urban planning, up to the inclusion of artistic sectors and more oriented to design, arriving at the expansion of the traditional definition of digital humanities.

**Inspirations and principles of information design**

"Information is the good that produces knowledge, the vehicle of a signal that can trigger a process. Knowledge is belief produced by information" (Dretske, 1981) states the philosopher F. Dretske in his book Knowledge and the Flow of Information. The last face of information design is represented by the phenomenon of big data. For this reason, the practice of visualizing information, data and so-called big data is becoming essential for their comprehension. This activity is fuelled by continuous technical, creative, procedural and taxonomic experimentations towards a constant re-elaboration and definition. In this regard, in 1987 McCormick, DeFanti and Brown defined visualization in the digital context as a computational method, a tool that "transforms the symbolic into the geometric, allowing researchers to observe their simulations and calculations. Visualization offers a method for seeing the invisible. It enriches the process of scientific discovery and promotes deep and unexpected visions. (McCormick et al., 1987)
Card in 1999 defines this practice as the use of computer-supported, interactive visual representations to amplify cognition;

cognition that takes on the meaning of acquisition and knowledge. He takes up, in his support, what Hamming wrote in 1973 about computational systems, adapting it to visualization, defining what will be an axiom for many in this field, that is, "the purpose of visualization is insight and not image" (Card, 1999).
Edward Tufte in his book The Visual Display of Quantitative information defines the three axioms of visual representation, stating that "a visualisation must be able to communicate complex ideas with clarity, precision and efficiency", and coining the term "chartjunk" or "junk tables" to identify backwards, all those works that overlap the objective of describing information, artistic and aesthetic ambitions, a thought clearly inherited from Bauhaus functionalism and influenced by the consideration of Adolf Loos "ornament is a crime", a thought destined to re-emerge periodically in history, defining a particular balance between the company system and the role of the designer.
There are also different authors who, based on their background, methodological approach and field of action, formulate and set new boundaries, contributing to the enrichment and specification of this domain. J. W. Tukey says "the greatest value of a graph is to force us to notice things we never expected to see", while Alberto Cairo says "any visualization is a model", a model hopefully distinguishable for truthfulness and clarity of information, for functionality as a guide to a correct interpretation of information, for depth of content, must then be enlightening ensuring an improvement in knowledge and finally pleasant from an aesthetic point of view (Cairo, 2016) because, as D. says, "the most important value of a graph is to force us to notice things that we never expected to see", while Alberto Cairo says "any visualization is a model", a model hopefully distinguishable for truthfulness and clarity of information, for functionality as a guide to a correct interpretation of information, for depth of content, must then be enlightening ensuring an improvement in knowledge and finally pleasant from an aesthetic point of view (Cairo, 2016) because, as D. A. Norman "aesthetic pleasantness is important because attractive and pleasant things help us to invest a little more effort in understanding how to use them" (Norman, 2004).
The brain finds it much easier to process information if it is presented visually than in words or numbers. The right hemisphere recognizes shapes and colors, while the left hemisphere processes information in the form of text or tables in a more analytical and sequential way. Reading the latter requires a considerable mental effort, as opposed to the visual ones that can be easily grasped in less time and in a more effective way. The brain thus identifies patterns, proportions, relations that would otherwise be difficult to manifest.
Accessible, intuitive, visual tools can make a difference by enabling people to understand complex systems and phenomena and find creative solutions, thus obviating what Robert N. Proctor

calls agnotology (Proctor & Schiebinger, 2008), i.e. the study of ignorance and doubt induced culturally by the absence of knowledge or even by the more contemporary problem of information overload characterized by the presence of more and more data, often inaccurate and therefore misleading.
Information visualizstion is becoming more than just a set of tools, technologies and techniques for understanding the meaning of data sets. It is emerging as a stand-alone medium. A guaranteed visual space, a clear and simple abstraction process to guide the observer to the discovery and exploration of physical space.
In this regard, the work Design for Information by Isabel Meirelles identifies the cognitive principles underlying the process of acquiring information, which can be summarized as follows (Meirelles, 2013):

— to remember information;
— to convey meanings;
— increase working memory;
— facilitate research;
— facilitate discovery;
— support perceptual inference;
— improve detection and recognition;
— provide real and theoretical models;
— provide an aid to data manipulation.

To enable a visualization to achieve these goals, there are several requirements and constraints implicit in its development that go beyond the mere creation of a reasonable and operationally functioning solution. As in most other fields related to design (architecture, product design, fashion,...), the visualization of information seeks to achieve a functional balance between aspects of utility, solidity and attractiveness, or in their original Latin form, utilitas, firmitas and venustas (Moere & Purchase, 2011).
The concept of "utility", in particular, corresponds to the classical notions of functionality, usability, utility and other quantitative performance measures. In visualisation evaluation studies, these aspects are generally defined in terms of effectiveness (the accuracy and completeness with which users perform specific tasks) and efficiency (the amount of resources spent in relation to the effectiveness criterion).
"Solidity" is about reliability and robustness. In the context of information visualization, and in accordance with the focus on visual form, robustness refers to the quality of the display presentation algorithm. In detail, it describes the characteristic that allows the correct functioning of the visualization, its connection to the dataset and the possibility to reproduce it easily or to improve it in case of need.
Finally, "attractiveness" refers to what is related to "aesthetics": the appeal or beauty of a given solution. In this context, it is important to underline that aesthetics is not limited exclusively to the visual form, but includes aspects such as originality, innovation, novelty or other more subjective factors that can understand the quality of the user experience.
It follows that the ability to visualize complex information, today, no longer

refers exclusively to the communication of quantitative information, but mainly concerns the world of visual narration of values and qualitative data (Scagnetti et al., 2007), no longer a purely strategic action at the level of marketing but a movement aimed at increasing the collective knowledge of the society in its complexity.

**Quantity and quality**

Starting from a system that sees data properly selected, organized, correlated and measured on a quantitative level as a fundamental input, the importance of a "naturally" qualitative output emerges; an output that finds an answer in the visual representation of the system itself. This change of perspective further amplifies the need and the urgency of redesigning the economic and business, personal and social, environmental and cultural systems for their components, always fuelling new design challenges capable of identifying unprecedented correlations between the variables at stake.

However, extracting the maximum potential from the data, aggregating them and correlating them to a specific territorial context, is not so simple. Most of the projects developed to date have the tendency to be mainly representations of a state of the art, not always useful to activate subsequent decision-making processes, thus limiting the discipline of design to a simple decoration. But it is thanks to design that, through processes and methods, styles and languages, it is able to create a real syntax, to be understood in a broad sense and not only linguistic, giving meaning to the information, but especially to the system chosen; a system made of visible elements, as well as invisible components, where even the absence of perceptible data, takes on a tangible value, like a "silence consent". In this way, "if we build or reconstruct that network of relationships, then the information begins to offer us an overall view of the world".

It is not difficult to imagine for the near future collaborative and completely transparent companies, administrations and companies able to provide their employees, customers, stakeholders and citizens with an all-round view of the surrounding reality. A quantum/qualitative vision that from a moral and ethical point of view develops a triple condition: availability, accessibility and accuracy, as part of a holistic strategy to support the management of the territory. A strategy that focuses on information as a product and service, a fundamental strategy in order to enable a collective knowledge of society. The system as a whole thus achieves a new balance capable of offering a frequent cross between wide-ranging cultural dynamics and pragmatic innovations.

However, it can be very difficult for non-experts to understand or make formal representations of analytical data. Mapping data in the right form, with the right tool requires technical, design, graphic and communication knowledge. Bad design can blur the real meaning of data, distorting reality

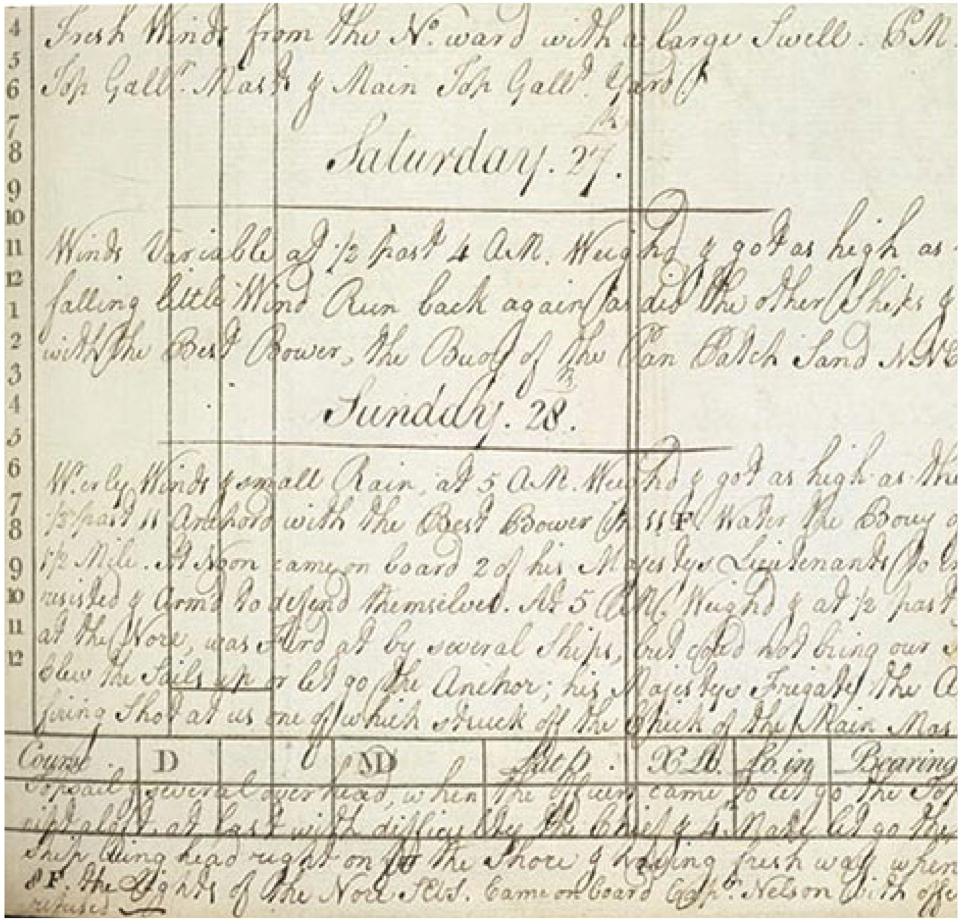
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**Fig. 2** Rochester Ship's Diary (1709)

unequivocally and causing obvious activities that are economically, socially and environmentally unsustainable. More visual tools, applications and processes that can be contextualized and contextualized can help to stimulate insights that can be interpreted in such a way as to trigger behavioral mechanisms of reaction. In this scenario, in the common sense, the data visualization aims at:

— to enable users to share a common language;

— to provide an overview of the state of the art at a strategic level;

— to trigger a more transparent mechanism between cities, research centres and organisations in general with a view to planning/participating.

Whether they are analog or digital, the best experimentations since ever are those carried out within a specific context. For this reason it is of fundamental importance for organizations as well as for citizens to keep track of all that the environment offers in the form of data and information. The environment is the context. The environment produces spatial, temporal, personal, collective data, but above all it relates them, contextualizes them, answering definitively one of the key questions of the visualisation "Compared to what?" (Tufte, 1983). Data thus becomes raw material, on the one hand enabling a continuous transformation, and on the other encouraging new projects, new visions that can be shared only if made visible.

Scientists, amateurs, national and international institutes have always been interested in understanding and forecasting weather conditions. Weather variations, mapped by professionals, individuals, sensors or other technologies, have become, have been, and are now, key material in the foresight of global climate change. In this process, sailors' observations have been the lifeblood for the development of the first oceanic and wind maps, as well as the diaries of the captains of the East India Companies' ships. It is 1709 when the ship Rochester sailed from Great Britain to China and its captain noted in detail in his diary drawings of ships, wildlife, native plants and particular places, recording their location, movements and climatic conditions [Fig. 2]. Today, the availability of real-time data allows scientists to complete precisely that work that began centuries ago, capturing the dynamic nature in our global system in interactive and dynamic maps; an example is the NASA project, which shows, through a clear and effective visualization, the trend of ocean currents between 2005 and 2007 detected through the use of satellites.

Another area that is strongly involved and interested in everything related to data visualization is that of healthcare, as an integral part of the continuous improvement of the well-being of society in its broadest sense. In this case, history shows us how sometimes visual representation can help, for example, to find causes and effects of diseases, or how the geographical distribution of infections

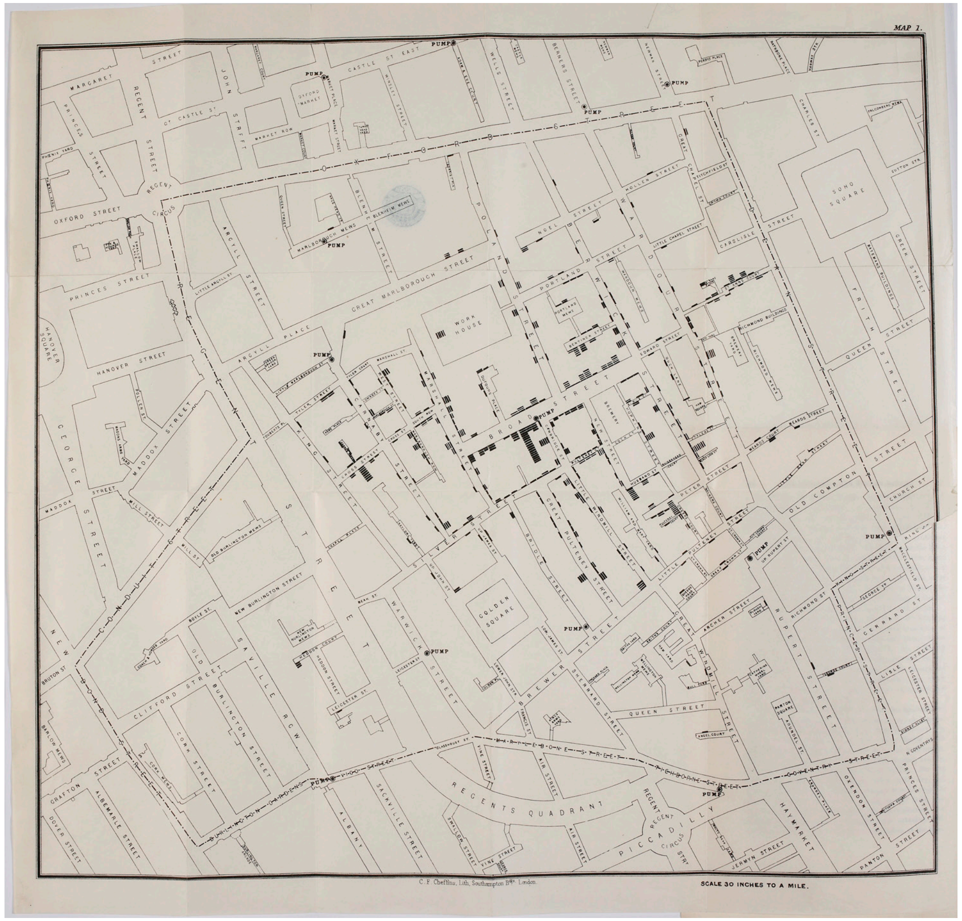



**Fig. 3** On the mode of communication of cholera (J. Snow, 1853)

allows to monitor their spread if not the identification of the local environmental trigger. Perhaps the greatest contribution in this scenario is that made by Dr. John Snow who, in 1853, mapped all the deaths caused by cholera, highlighting, in what can be called a "ghost map", the right location on the territory of the water pumps, officially demonstrating that the epidemic had not been spread by the Thames, but by the water contaminated by human waste passing through the city aqueducts and thanks to the mapping he was able to identify the distribution pump of contaminated water [Fig. 3].

Still today, the mapping of the dynamics of the health system is decidedly important, even more so if it is connected to other specific socio-demographic data to offer a clear and objective scenario of the different clinical situations in the world, from a global level to a more detailed and local one.

Maps and cartography in general have always been closely linked to the world of mobility research, and not only with regard to the display of routes or directional infographic signs. The analysis and visualization of digital traces, whether personal or collective, are an aid to a continuous and renewed reading of society. The pioneering ORION (On-Road Integrated Optimization and Navigation) initiative carried out by UPS dates back to 1980 and, through appropriate sensors, UPS began to monitor all its vehicles, recording their speed, direction, braking times and other performance [Fig. 4]. The fundamental part of this vision was that from the very beginning, all the information collected was not only used to monitor daily internal performance, but also to redesign routes, optimise fuel consumption and reduce carbon emissions into the environment. Energy consumption, if we consider the environment as the context, is in fact one of the hottest topics today. The increasing availability of energy data allows people to determine how they use it by defining their impact on the environment, also linking this information with other data sets such as public transport, technology, production.

GPS, wi-fi observations, geo-referenced content, social networks, smartphones in general, the digital revolution, the ubiquity of the tools for mapping daily dynamics, define a concept of data that goes far beyond the simple indication of number. Today, data represents real life, a snapshot of the world, at a precise moment in a precise place, in effect a photograph. The reading of this "shot" obviously changes according to the visual form assumed, but it is only the context that will completely change the perspective. The interpretation of the dynamics between individuals, companies and territory in a continuous and dynamic pro-active and retroactive mechanism is the key to enabling new development policies. Identifying recurring patterns or altering factors allows the understanding of two distinct but complementary phenomena: attractiveness and pulsation (Prophet, 2016). The first derives fundamentally from the spatial distribution of users and the density of their digital interactions


Fig. 4 ORION System (UPS, 2013)

and social activities; the second refers more specifically to the attractiveness over time considering also the variations due to reactions triggered by events and disturbing or enabling events specific to the context. Graphically representing the dynamism of these phenomena becomes strategic for all those activities related to the urban system, tourism, economic, but also activities related to the world of mobility and the energy sector. To graphically represent the dynamism of these phenomena means to bring out decompositions, groupings by similarities, differences or possible comparisons between all the elements at stake.
Companies should therefore embrace complexity, because complexity is the hallmark of our time. The contemporaneity of the inevitable change dictated by the digital revolution, is causing the equally inevitable common approach on the part of companies to always and only use technology as a single answer, without spending enough time in the pragmatic definition of real problems, real needs or possible opportunities of the information assets in their possession. Opportunities dictated by all the possible hybridizations between technology and the humanities, between science and design, with the original aim of taking the conversation to a higher level.

**Research and exhibition**

This work collects the contributions exposed during the RSD7 conference in the framework of the exhibition "Visualizing complex systems" [Pics. at the end of the chapter]. These contributions come from the most diverse university faculties and cover an international panorama that goes from the United States and Canada to India.
The criteria that guided the selection of contributions were as follows:
— the role of visualisation in investigation, communication or project development;
— the role of communication visualisation in complex systems;
— functionality of the visualization with respect to the exposed topic;
— clarity and efficiency.
Contributions, from data and process visualisation to giga-mapping, from visual representation of part-whole relationships to visual tools for decision making, can be categorised in the following macro-areas:
— experimentation and methods;
— education;
— healthcare;
— city;
— territory.

Experimentation and methods

Many researches have already tried to identify methods to better represent complexity, researches that have involved different disciplines and for different purposes too.
Whether they are taxonomies or modes of representation useful to complete a process, they all find in the graphic representation and visualization of the collected data a strong point to enable a higher understanding of the phenomenon investigated.
There are four contributions collected in this section. They range from research

and definition of 16 visual models to represent complexity, to visual strategies to improve the usability of existing decision-making tools, from experiments through the use of chord diagrams representing the relationships between different stakeholders, to the identification of a way to describe almost anatomically a system.

Education

"We are a visual and symbolic species" (Cairo, 2012), says Alberto Cairo. Everything that our senses perceive and capture is transformed in our minds into simple and easily manageable representations or symbols, verbal and textual symbols, mental images and visual schemes. The affirmation of Cairo therefore focuses on the need to enable knowledge and understanding through the use of visual forms, graphics, diagrams, underlining how these are much more effective than lists of data, statistical formulas, algorithms and the now almost obsolete reports.

In this context, education finds a wide space for action, having the possibility of visually translating information that would be difficult to understand or memorize.

The contributions presented and categorized under this label show just how it is possible to transfer complex meanings using visual forms that very often make use of languages and playful tools to better support.

From lessons learned about the effects of one's choices through role-playing, to unconventional platforms for communicating environmental data, to more in-depth investigations into the future of education itself and the discipline of design, visualization becomes a versatile tool for all users.

Healthcare

As already pointed out, the health sector has a large amount of data to the point that visualisation tools can only become fundamental for their understanding or communication.

Three contributions have addressed this issue, and in each of them the world of representation takes on a different role. In fact, we move from the use of maps and diagrams to highlight the difference and disparity between the management and services offered by the traditional health sector compared with the possibilities of e-health, to maps with higher degrees of detail to analysis of the entire Indian health system, without forgetting the possibility of communication to convey important messages such as those of complexity in the system of organ donation.

City

The city has always fascinated research from many points of view; the exploration and narration of the dynamics that are established and develop in it are certainly one of the main sources of inspiration. Knowing its movements, understanding its flows, analyzing its metabolism, becomes fundamental to design on it in a coherent and effective way.

Two contributions specifically investigate visualization for these purposes, contributions that use forms of mapping and abstraction with the aim of highlighting the relational potentials of the city and the spaces available in it.

Territory

Sometimes synonymous with context, environment. The detailed analysis of a territory is able to highlight specific phenomena and not, relate different environments and compare sectors. Conscious, exploratory, informative, projectual, the visualizations that place the territory at the center may have very different purposes, but all reflect sections that become easier to understand.

The contributions belonging to this category are mainly conceptual and infographic maps, graphs of specific case studies for regions or sectors of investigation that underline the importance of knowledge of the context in order to achieve sustainable design.

Today, we are faced with environmental, social and economic challenges that can be better understood and faced with greater security only by starting to act in a collaborative perspective, observing what surrounds us in a broader and more conscious way, starting, therefore, from the territory itself.


CHANGEMAKER PEDAGOGY
PANARCHY'S CATALYST
Fig. 1 The introduction of Panarchy's catalyst/ THE CHANGEMAKER PEDAGOGY
URISHING
FRAMEWORK
3. STAGE: THREE
DE-INSTITUTIONALIZE TO
RE-INSTITUTIONALIZE
2. STAGE: TWO
INCUBATING THE
'THE PURPOSE DRIVEN HUMAN'
THE CIRCULAR ECONOMY
INDUSTRY 4.0

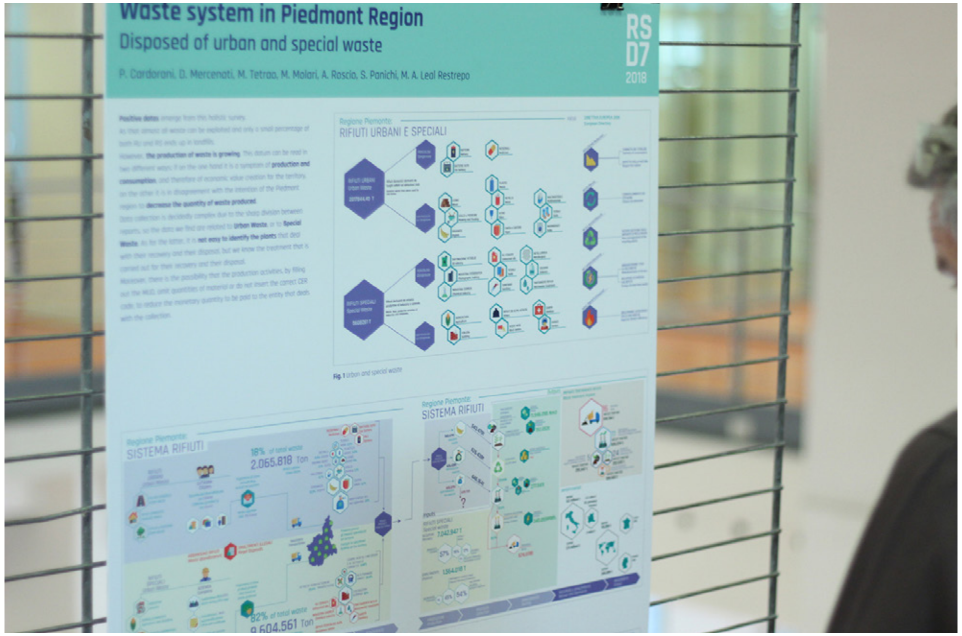

Stakeholder Relationships Mapping
RSD7
2018


What is design?
What is the problem?
Who is involved?
How do we take action?


Q. Yang
2018
Environment
Population
Health Care


Interstellar
"To Boldly Go Where No One Has Gone Before"
RSD7
2018
100
75
50


Designing Designers
A critical look at design education
T. Campbell, A. Lutterman
What is design?
What is the problem?
Who is involved?
DESIGN SCHOOLS
EDUCATIONAL INSTITUTES
INDUSTRY
GOVERNMENT
THE PUBLIC


Waste system in Piedmont Region
Disposed of urban and special waste
P. Cordorani, D. Mercenati, M. Tetrao, M. Molari, A. Roscio, S. Panichi, M. A. Leal Restrepo
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A case study on Access to Electricity
Decentralized People-Centric Energy Model for India
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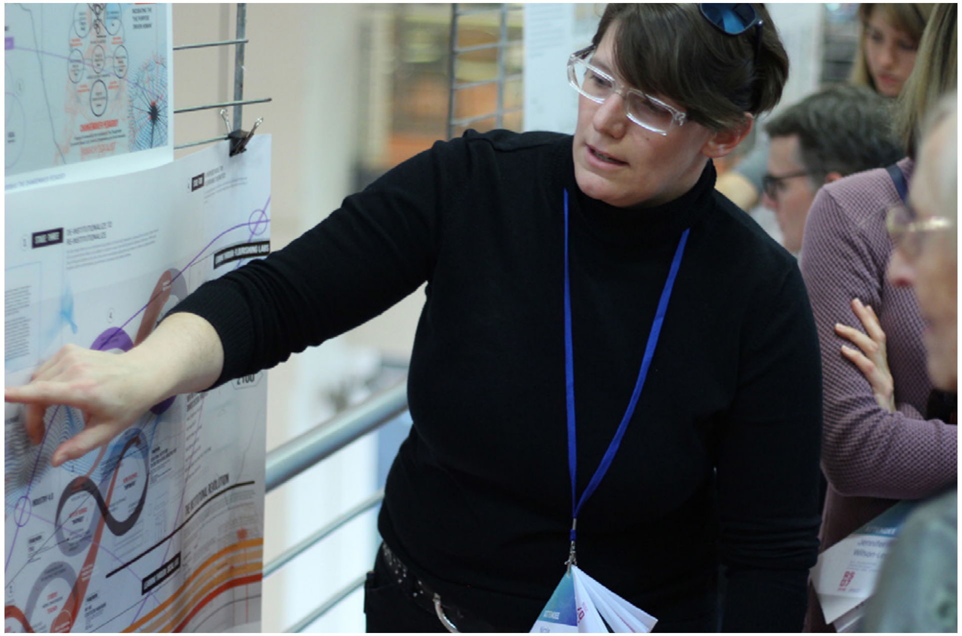

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RSD7 2018

# EXPERIMENTATION & METHODS

# The Visual Representation of Complexity

## Definitions, examples & learning points

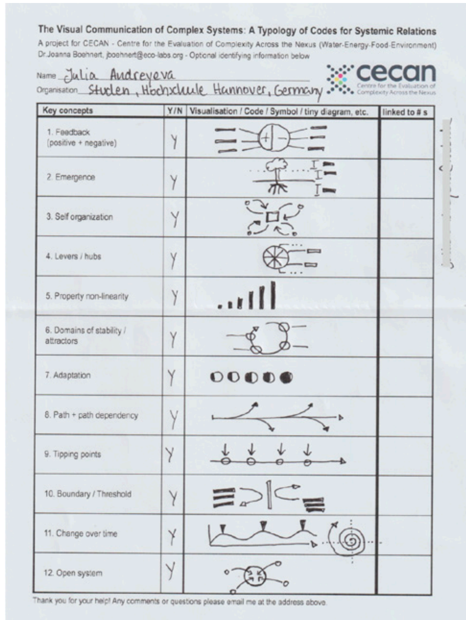
Author: **J. Boehnert**

University / Organization: **EcoLabs, UK**

Keywords: **Complexity, Key Characteristics, Visual Language**

Sustainability practitioners have long relied on images to display relationships in complex adaptive systems on various scales and across different domains. These images facilitate communication, learning, collaboration and evaluation as they contribute to shared understanding of systemic processes. This research addresses the need for images that are widely understood across different fields and sectors for researchers, policy makers, design practitioners and evaluators with varying degrees of familiarity with the complexity sciences. The research identifies, defines and illustrates 16 key features of complex systems and contributes to an evolving visual language of complexity. Ultimately the work supports learning as a basis for informed decision-making at CECAN (Centre for the Evaluation of Complexity Across the Nexus) and other communities engaged with the analysis of complex problems.

A research process was designed to identify sixteen key characteristics of complexity and to inform the development of new images and descriptions. In order to gather ideas from academics, sustainability practitioners and designers with expertise in the complexity sciences, systems mapping and design, I collected 50 surveys at The Environment, Economy, Democracy: Flourishing Together RSD6 (Relating Systems Thinking and Design) conference in Oslo (October 2017) and ran two participatory workshop in London (November and December 2017). The images, definitions, examples and learning points were developed with this research process. The text below was written with Alex Penn, Pete Barbrook-Johnson, Martha Bicket and Dione Hills. Many thanks to RSD6 organisers and all who contributed images and ideas in the surveys and workshops.



The Visual Communication of Complex Systems: A Typology of Codes for Systemic Relations
A project for CECAN - Centre for the Evaluation of Complexity Across the Nexus (Water-Energy-Food-Environment)
Dr.Joanna Boehnert, jboehnert@eco-labs.org - Optional identifying information below

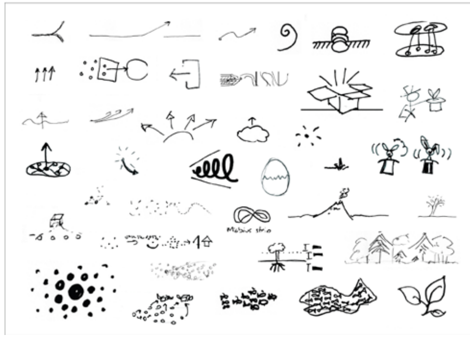
Name Julia Andreyeva
Organisation Studen, Hochschule Hannover, Germany

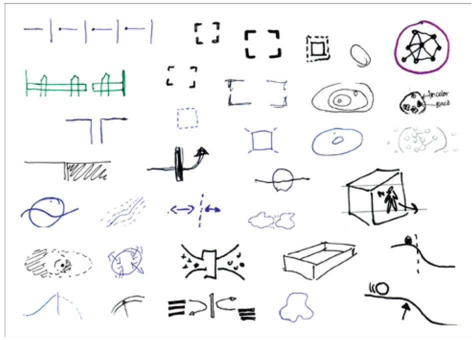
cecan Centre for the Evaluation of Complexity Across the Nexus

| Key concepts | Y/N | Visualisation / Code / Symbol / tiny diagram, etc. | linked to # s |
|---|---|---|---|
| 1. Feedback (positive + negative) | Y | | |
| 2. Emergence | Y | | |
| 3. Self organization | Y | | |
| 4. Levers / hubs | Y | | |
| 5. Property non-linearity | Y | | |
| 6. Domains of stability / attractors | Y | | |
| 7. Adaptation | Y | | |
| 8. Path + path dependency | Y | | |
| 9. Tipping points | Y | | |
| 10. Boundary / Threshold | Y | | |
| 11. Change over time | Y | | |
| 12. Open system | Y | | |

Thank you for your help! Any comments or questions please email me at the address above.

**Fig. 1** Survey Sample





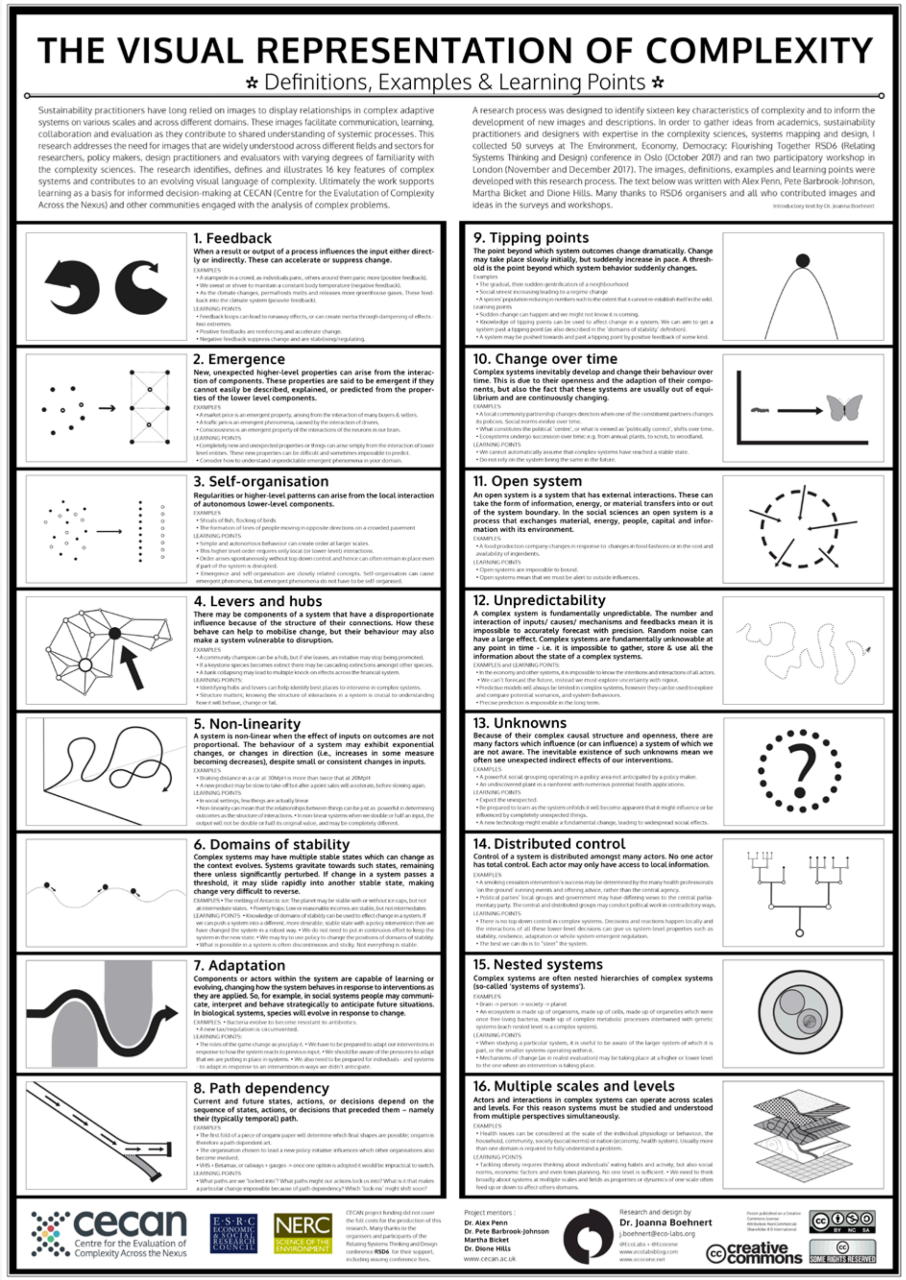



Fig. 2 Feedback, collection of survey samples
Fig. 3 Emergence, collection of survey samples
Fig. 4 Boundary / threshold, collection of survey samples

Fig. 5 The visual representation of complexity, J. Boehnert, 2018

# Visual explanation of Quality Function Deployment

## Strategies to improve the QFD decision-making tool's usability

Authors: **S. Imbesi, G. A. Giacobone**

University / Organization: **University of Ferrara, Italy**

Keywords: **Quality Function Deployment, Multidisciplinary Team, Design Research, User Centered Design, Graphic Design**

The Quality Function Deployment, also known as QFD, was born in Japan around 1965 as a tool to obtain measurable parameters related to design quality, basing on needs and requirements expressed by the users.
The inputs of this tool are the measurable characteristics or attributes of the product or service that is going to be designed, and the needs expressed by the costumer in his own language. These parameters are inserted in a matrix called House of Quality that, using a graphic approach, allows the multidisciplinary team to assign a mark to the degree of correlation. The QFD is usually used in business contexts by multidisciplinary teams that, after being subjected to significant training, for a defined period meet and work together to compile the tool.
The authors have been using the QFD in several design research projects with the aim of bringing innovation using a user centered design approach, including researchers of different fields and professionals working in the markets related to the products or services that were going to be designed. It was noticed

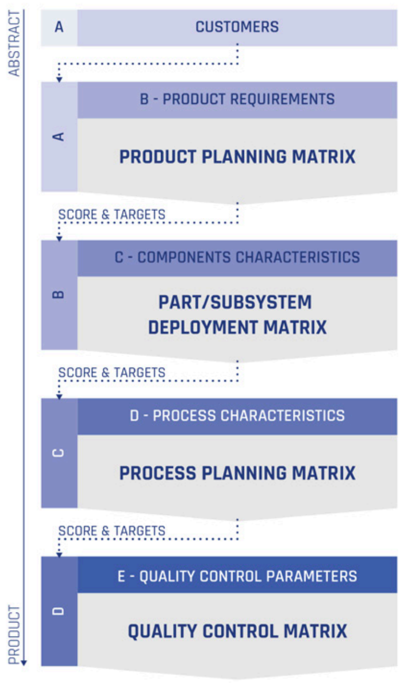



Fig. 1 QFD planning structure

INTERACTIONS

9 = Strong
3= Medium
1= Weak
0= No relations

| | ABS. RELEVANCE OF NEEDS | % RELEVANCE OF NEEDS | 1. PROCUT SPECIFICATION | 2. PROCUT SPECIFICATION | 3. PROCUT SPECIFICATION | 4. PROCUT SPECIFICATION | 5. PROCUT SPECIFICATION | 6. PROCUT SPECIFICATION | 7. PROCUT SPECIFICATION | 8. PROCUT SPECIFICATION | 9. PROCUT SPECIFICATION | 10. PROCUT SPECIFICATION | 1. COMPETITOR | 2. COMPETITOR | 3. COMPETITOR | 4. COMPETITOR | 5. COMPETITOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. COSTUMER NEED | 4 | 6% | 0 | 9 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 3 | 2 | 1 | 3 | 3 | 3 |
| 2. COSTUMER NEED | 1 | 1% | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 2 | 1 | 1 | 2 | 3 |
| 3. COSTUMER NEED | 5 | 7% | 0 | 3 | 3 | 0 | 1 | 3 | 1 | 3 | 3 | 1 | 5 | 3 | 4 | 2 | 4 |
| 4. COSTUMER NEED | 3 | 4% | 0 | 3 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 1 | 2 | 1 | 1 | 3 | 4 |
| 5. COSTUMER NEED | 3 | 4% | 0 | 3 | 0 | 9 | 0 | 3 | 0 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 4 |
| 6. COSTUMER NEED | 2 | 3% | 9 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 2 |
| 7. COSTUMER NEED | 1 | 1% | 0 | 3 | 3 | 1 | 1 | 3 | 1 | 3 | 3 | 1 | 1 | 2 | 2 | 3 | 1 |
| 8. COSTUMER NEED | 2 | 3% | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 2 | 3 | 3 | 3 |
| 9. COSTUMER NEED | 4 | 6% | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 4 | 5 |
| 10. COSTUMER NEED | 5 | 7% | 0 | 9 | 0 | 0 | 0 | 9 | 0 | 1 | 0 | 1 | 3 | 2 | 3 | 4 | 5 |
| ABSOLUTE TECHNICAL IMPORTANCE | | | 65 | 280 | 188 | 142 | 68 | 216 | 72 | 164 | 129 | 87 | | | | | |
| % TECHNICAL IMPORTANCE | | | 5% | 20% | 13% | 10% | 5% | 15% | 5% | 12% | 9% | 6% | | | | | |

Fig. 2 Aspect of the traditional QFD matrix

that some problems occurred using QFD in contexts where people had not been subjected to adequate training, and where they did not have the opportunity to meet regularly in person, but most of the time they met virtually online.
In this poster the authors suggest some reflections on how graphic solutions could be applied to the QFD, to make this tool's easier to be used and applied by a multidisciplinary team that never met before and have never used it, with no time to be trained.
The possible graphic strategies will aim to increase the tool's usability to people with different backgrounds that are using the QFD for the first time, to make it accessible and effective in its results. The support of graphic design is very important to make the process more intuitive and less discouraging, to open the use of the tool to persons that are not specific technicians and to share obtained results to the team in a most intuitive way.


**Fig. 3** House of Quality's sections: every parts of the matrix corrisponds to a stage of the QFD process. For every stage there are some critical issues that could be overcame using graphic design solutions

# Comparative Stakeholder Relationships Mapping

## Using radial convergence to map relationships + prototype change

Author: **K. Peter**

University / Organization: **OCAD University and Royal Bank of Canada**

Keywords: **Stakeholder Relationships, Role Play, Radial Convergence Mapping, Policy Research, System-Level Change, Narrative, Growth, Economy**

This visualization came out of a larger research study that looked at alternative narratives on the future of economic growth. Motivated to understand why the current economic system appears to be failing us, and what a human-centered approach might bring to the challenge, the study investigated both current and alternative narratives on economic growth and how a participatory approach to reframing might enable transition to a more desirable alternative. Within the context of the larger study, role play was used to enlist diverse inputs of both expert and non-expert stakeholders.

**ACTIVITY**: Using an alternative narrative developed in the first phase of the study, twelve stakeholders were engaged in the second phase for a simulated discussion addressing the question of "How might we get to a more inclusive economy?". The activity was guided by prompts derived from Roman Krznaric's "Rough guide to how change happens" (2007) covering the desired change, who is involved, what strategies might be taken, what contexts they might play out within and pathways or processes that might be needed to bring about the change.

**OUTCOME**: A key outcome was that narratives in combination with role play can be used as both representatives of the change desired as well as probes for change, and that through simulated enactment of an alternative narrative stakeholders in the system might themselves begin to enact the change in the world. Further, strategies generated in the role play were intended to encourage policy influencers and policy makers to adopt and evolve a richer and more participatory set of policy research and development tools. Among the strategies was the recommendation to engender a prototyping mindset across government, including the introduction and use of narrative probes.

**ANALYSIS**: Radial convergence maps were created to first anticipate the nature of relationships within the role play—notably the alliances and tensions that might form—then to analyze and understand stakeholder interactions within each of the two groups and comparatively across the groups.


**Fig. 1** Role play participant shown in "character" across two groups

From the visual analysis emerged a list of potential stakeholders to involve in future engagements (simulated or actual), an awareness of advantaged and disadvantaged stakeholders, and potential and non-obvious partnerships that could be fostered within the larger system.

**Stakeholders to involve in future engagements (simulated and actual), specifically**: Youth, seniors, enterprise board members, global advisors, libertarians and Indigenous Peoples.

**Advantaged and disadvantaged stakeholders, notably**: Government, startups and effective storytellers are seen as advantaged, and immigrants and youth are among those considered disadvantaged.

**Potential and non-obvious partnerships, for example**: Media and wellbeing advocates, enterprise and startups, immigrants and startups.

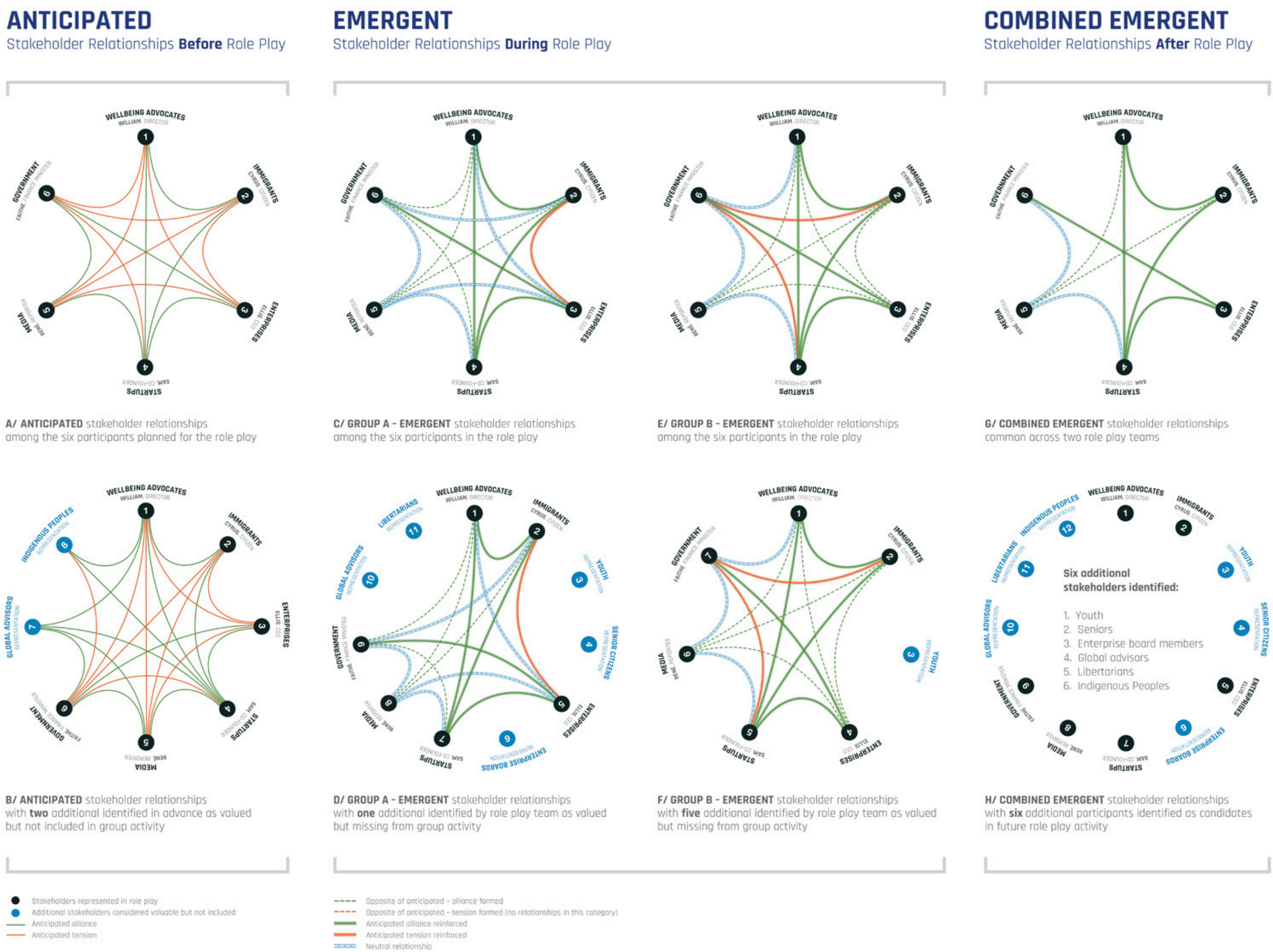



**Fig. 2** Analysis of stakeholder relationship using radial convergence mapping before, during and after a comparative role play activity

# Anatomy of Systems

## A tool for ethnography of infrastructures

Authors: **A. Nogueira, C. Teixeira, W. Ashton**

University / Organization: **Institute of Design, USA**

Keywords: **Anatomy Of Infrastructures, Ethnography Of Infrastructures, System's Visualization, Multi-Systems Integration**

**BACKGROUND**

Designers are known for their abilities to create interventions (products, services infrastructures and systems) with product-technology features capable of promoting new experiences among actors. While these interventions are often oriented towards impacting social systems, they embed new affordances into the socio-ecological context, and generate new interactions not only among humans, but also between humans and non-humans' actors. As the field increasingly engages in complex socio-ecological challenges, new methodologies are required to incorporate considerations of the dynamic, non-linear interactions among actors shaping these challenges. We explored novel approaches to ethnography and prototyping of infrastructures in order to (1) uncover the logics shaping these interactions, and (2) iterate interventions to increase the fitness in socio-ecological systems. We assumed design practices as iterative processes in which participants continuously gathered information about context through prototyping.

**THE TOOL**

This tool supports actors in understanding the interconnectivity between them. It situates the goals of the system in the center, representing the societal level, and the features of the system in the outlier circle, representing the product-technology level. Features are followed by affordances, representing product-service systems, and impacts within socio-technical systems. This correlation is helpful for designers to understand not only multi-level integration but also how features, the interactions among actors afforded by them, the impacts these interactions generate, and the overall alignment between the features and the intended goals can be integrated into new systems interventions. Each zone (or level of the system) should be read separately given its own dimensions. While there is no single path for utilizing this tool, here is one suggestion, following the logic of:
Goals <-> Impacts <-> Affordances <-> Features

**STEP 1**: List the overall goals of the system, and situate them in the center of the diagram.

**STEP 2**: Identify few indicators of impacts supporting the achievement of the goal. These should be represented as variables impacting the dynamics of the system. Situate them in the next zone, and connect these indicators with the goals.

**STEP 3**: Identify features of the system supporting impacts, and position them in the outside circle. These should be actors, products, and services that interact in the system of interest.

**STEP 4**: Connect the impacts with the features through the actionable properties each one of the features embeds into the system.
You might use color coding for separating the different levels and elements.

Ultimately, this activity should surface multi-level interactions, and how different types of resources are flowing between the levels of the system. Validate your representation with others.

## CONTEXT OF APPLICATION

We applied some tools of this new methodology in 'The Future of Farmers Market' project, a partnership between IIT-Institute of Design, a graduate design school in Chicago, and the Plant Chicago, a non-profit organization located on the south side of Chicago with a mission to cultivate local circular economies through education, research, and incubation. Plant Chicago recently began working to develop collective activities with co-located businesses at The Plant, an industrial facility on the south side of Chicago that serves as a community building space for local food and beverage businesses. The project focused on multi-systems integration as a strategy for developing circular economies, and considered farmers' markets as critical paths for advancing transitions in the local context. By applying new tools, participants uncovered four main challenges among farmers' markets: data application, access to best practices, materials & nutrient management, and rules & regulations. Once these patterns were situated within the system's anatomy, participants were able agree on four actionable properties that market managers should intervene to advance local circular economy practices in Chicago: collaboration, education, facilitation, coordination.

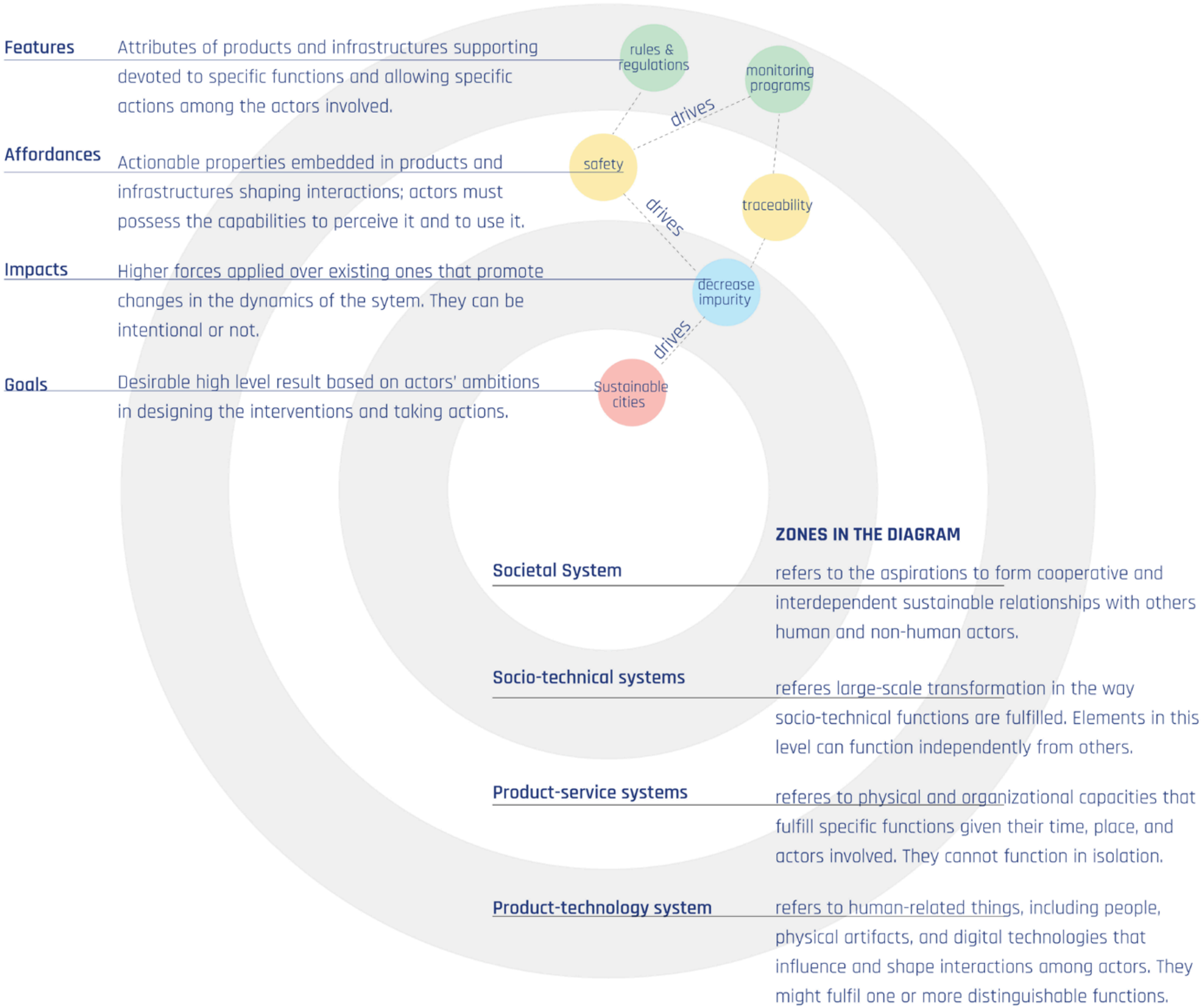



Fig. 1 Anatomy of System

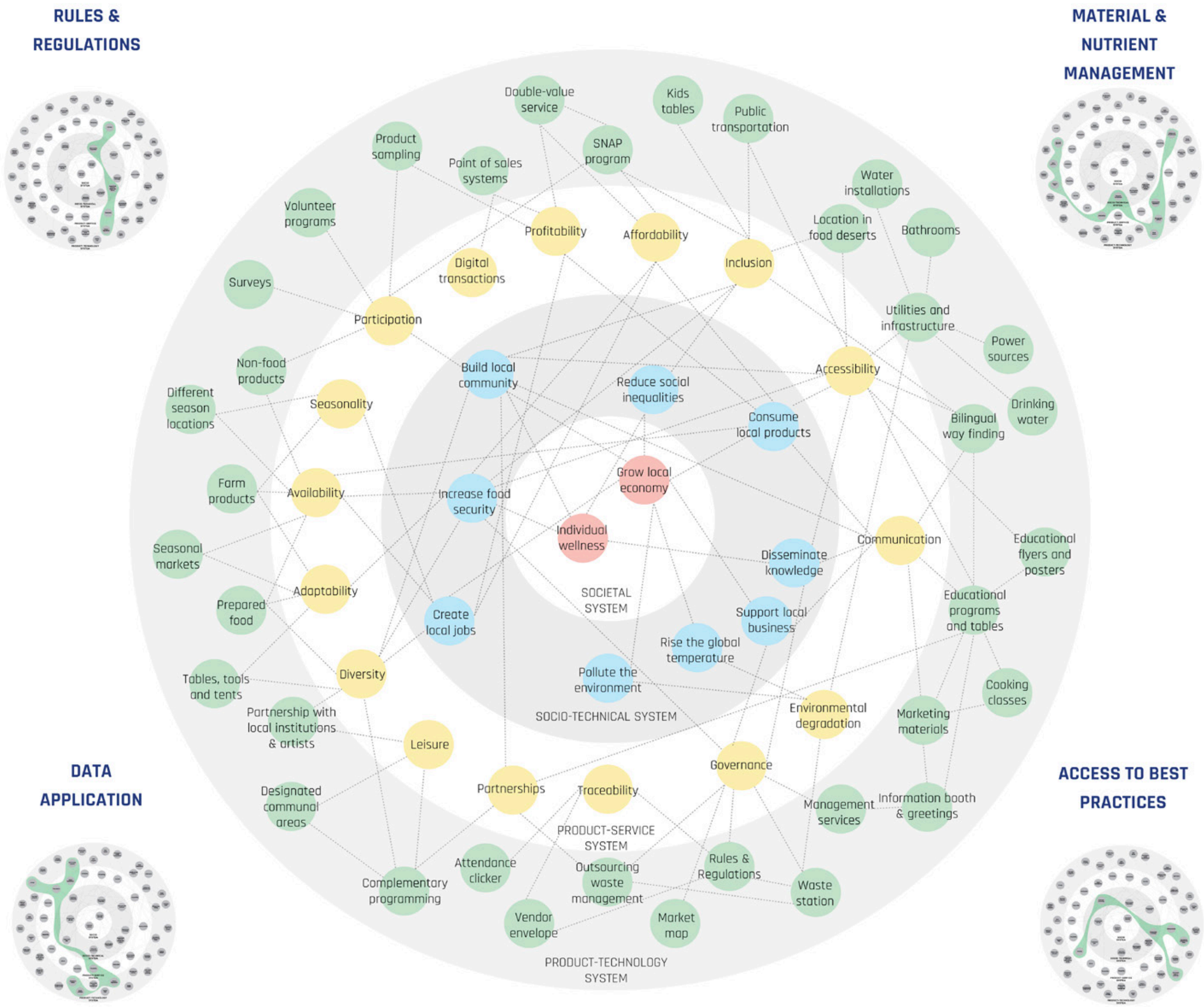



**Fig. 2** Anatomy of Farmers Market in Chicago, USA

RSD7 2018

# EDUCATION

# Interstellar

"To boldly go where no one has gone before"

Authors: **A. Oliveira, I. Cortes, L. Shand, N. Matharu**

University / Organization: **OCAD University, Canada**

Keywords: **Synthesis Map, Space Travel, Mars, Extraterrestrial Colonization, Interstellar, Planetary**

## A game of coopetition

The intrinsic human need to explore, discover, and conquer new frontiers saturates every domain, from sports to science. By far the most daunting of these domains, whether material, physiological, or intellectual, is interstellar space. Although still at least 100 years away from viable commercial space travel to Mars, the entities with the means to drive this pursuit remain vigilant despite popular wisdom. It is a pursuit that requires a non-zero-sum game, a Systems Thinking perspective of global cooperation and mutual gain. Technology, policy, and social advancements born out of space travel may provide the answers to some of Earth's most pressing problems. The challenge has been to inspire the vast majority of people to look upwards again after decades of fixation on the current world condition. Media and entertainment play significant roles in influencing attitudes and world views, and games in particular can offer ways to explore complex multidimensional ideas in simple and fun ways. By combining gaming and systems concepts, Interstellar, explores the social and ethical plateaus that challenge our evolution toward a unified space-going species through a compelling multiplayer board game. By balancing the causal, and contradictory, relationships between military, civilian, commercial and scientific interests, the game lets players explore the dynamics between cooperation vs competition, and their effects on advancing civilization into Space.

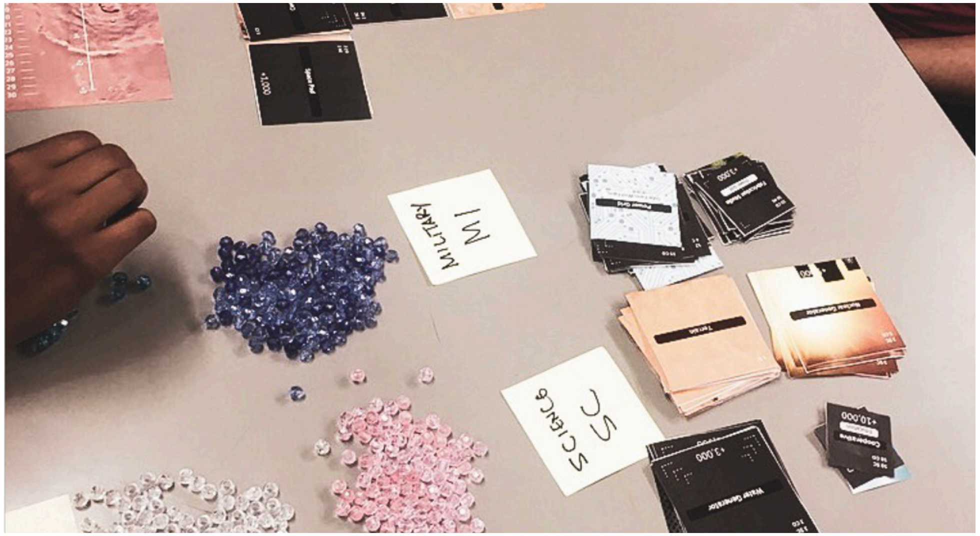



**Fig. 1** Play-testing a prototype of the board game designed to interactively explore the concepts in the sythesis map

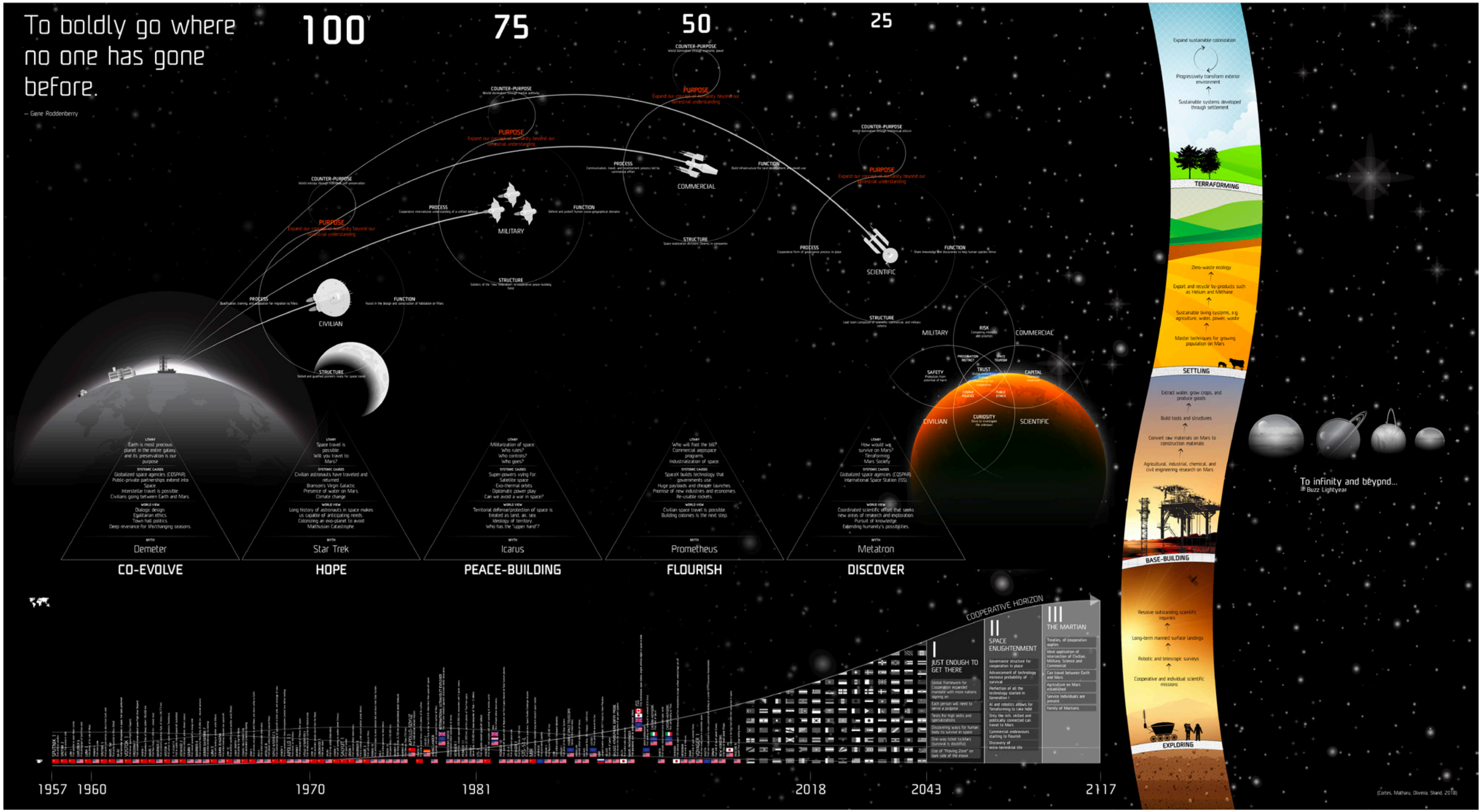



Fig. 2 Our 100 year journey to Mars requires "coopetition" and trust—it is a social challenge rather than a technological one

# Clear

## Air Quality Data as a tool for enabling learning and community action

Authors: **T. L de Aguiar Freitas**

University / Organization: **The Oslo School of Architecture and Design**

Keywords: **Service Design, Systemic Design, Environmental Data, Air Quality, Education**

Clear is an exploration of how Service and Systems Oriented Design can be used in the public sector to generate awareness and trigger action regarding environmental topics.

Miljødirektoratet, the environment directorate of Norway, has the mandate to spread knowledge about air quality data with the general population with the aim of reducing harm and changing habits. At the moment, there is a consortium of government bodies that gathers data through several measuring stations scattered around the country. This data is mostly used for scientific purpose.

The problem is that this data has little contextualization to people's routines, or even worse: it contradicts their whole life choices – moving to the suburbs, having kids, owning a car, etc. This generates a cognitive bias against environmental sound actions and measures (Oslo aims to be car free in it's city centre, for instance). To make matters worse, air pollution has many causes and sometimes individuals power to act is diminished, asking for stronger policy.

This contradiction asked for a different approach. Instead of trying to change deeply rooted habits, the project targeted children from 8th to 10th grades. The proposal is called 'Up & Around': an educational platform composed of a series of activities that are assigned by teachers and performed by students using two dedicated iPad apps. These activities aim to teach children all there is to know

**Fig. 1** The service's main touchpoints are pre-made activities for teachers and iPad apps for designing study programs and following students

about Air Quality and to engage them in action in their communities, so they can spread knowledge to parents and even local authorities.

'Up & Around' is also great for teachers: content is based on national curriculum and they can evaluate their student's work continuously from the app, making it a great tool for teaching.

The ultimate goal of the project is to create the next generation of air quality advocates and introduce the topic of local politics in middle school environment, in order to facilitate for radical changes that will be demanded in the coming years.

In the development of the project, most of the tools of the Systems Oriented Design playbook were used: stablishing a Rich Design Space, utilizing Gigamaps as a means to generate common understanding of a problématique, as well as several methods for systemic impact evaluation of proposed design solutions. User insight and prototyping were an integral part of the whole design processes.

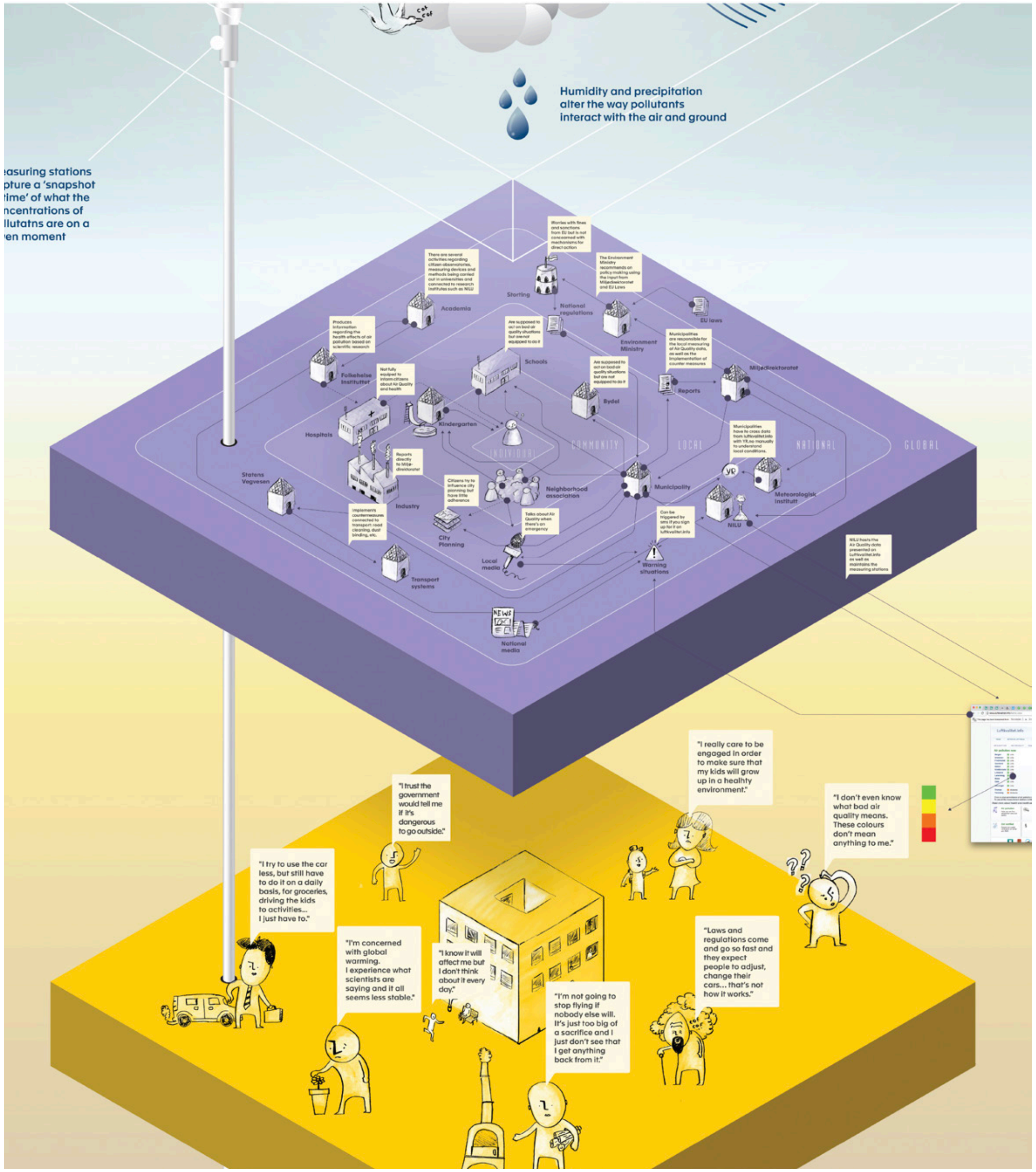



**Fig. 2** Close-up of the Gigamap developed during the insight phase of the project. The map layers environmental, social, individual and geotechnical data

# Flourishing Cybernetics

## A Biomimetics Post-Secondary Futures Narratives

Authors: **N. Abuseif, N. Norris, J. Wilson-Lee**

University / Organization: **OCAD University, Canada**

Keywords: **Transdisciplinary Learning, Changemaking, Higher Education, Flourishing Economies**

"Education based solely on past models will fail, whereas education that learns from the past, based on navigating through uncertainty, and built on cooperation, can lead us to create a world we want to live in and pass on to generations to come. The future needs people who are able to synthesize and contextualize information, keep an open mind to continuous change and emergence and look for, and see, a bigger, much bigger picture. Specialist expertise is still essential, but should be linked with other specialist expertise to generate a more comprehensive understanding of the expanding complexity of the emerging world." (Hodgson, Tony, 2014)

Imagine a world where purpose-driven humans shift our economic and bureaucratic systems using a life-long empathy driven 'changemaker' pedagogy. The following systemic map is an optimistic narrative based upon a '3 horizon economies' model where we examine how might post-secondary institutions transform to meet the needs of future social innovators, communities and industries. In the map, as we reach the 3rd horizon of a Flourishing Economy, we visualize through panarchy, Changemakers informing the design of systems inspired by Dr. John Ehrenfeld's Sustainable Satisfaction Delivery Systems (SSDS) ideology. (Ehrenfeld, 2001). Our narrative concludes with an imagined heuristics model to uncover the way in which we will co-evolve and flourish with autonomous technologies conceptualized as "Flourishing Cybernetics."

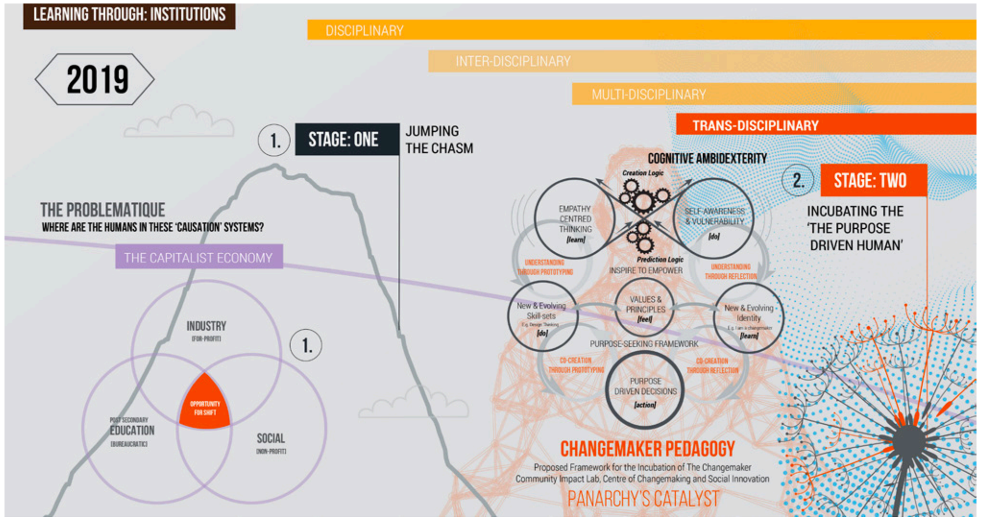



**Fig. 1** The Introduction of Panarchy's catalyst/ THE CHANGEMAKER PEDAGOGY

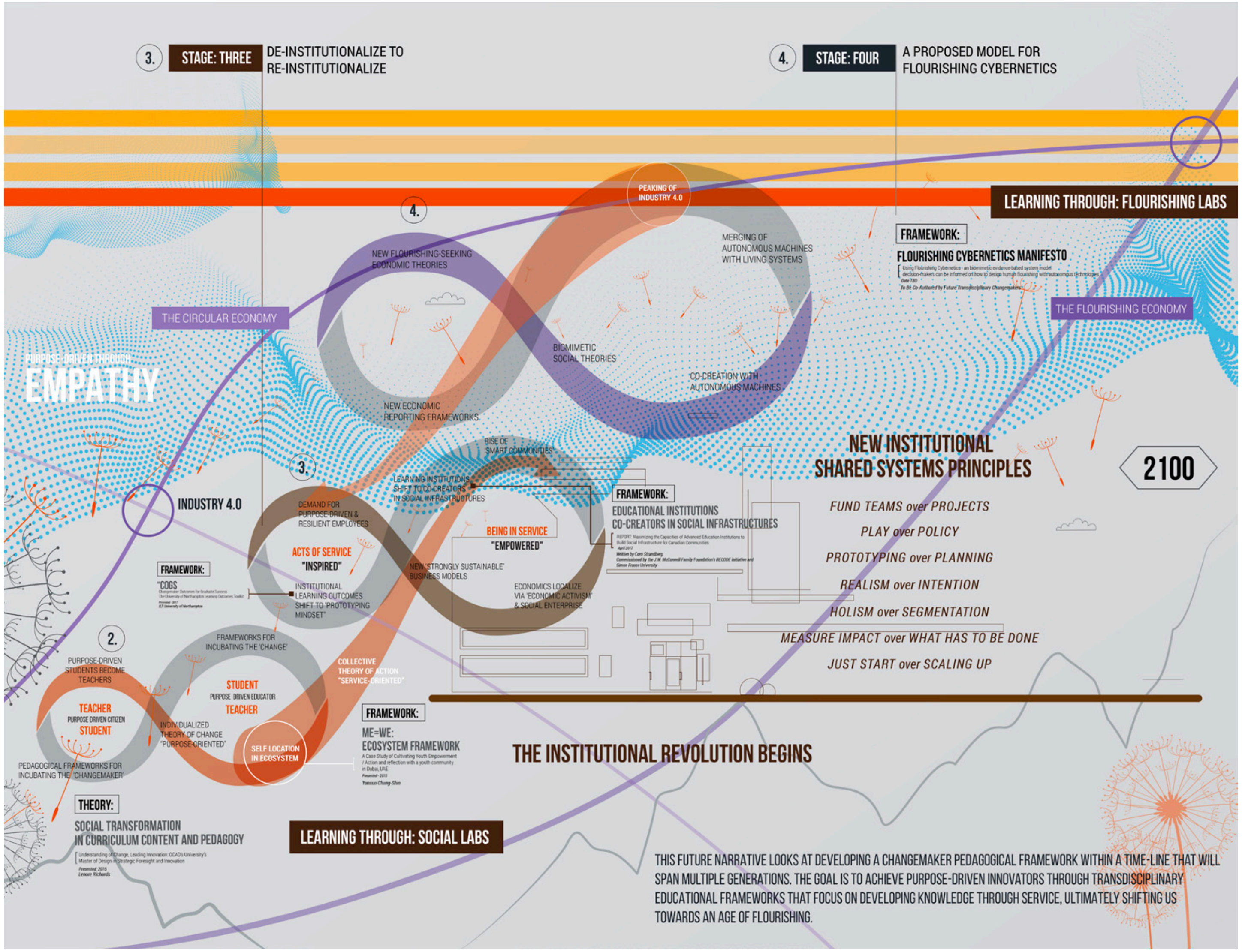



**Fig. 2** How the adaptive cycles socio-economic systems nest into a panarchy, creating a theory of how purpose-driven individuals might shift us towards flourishing

# Designing Designers

## A Critical look at design education

Authors: **T. Campbell, A. Lutterman**

University / Organization: **OCAD University, Canada**

Keywords: **Design Education, Causal Layered Analysis, Ontological Design, Transition**

Design has enormous influence on the world at all scales; it mediates our daily experiences and shapes our ways of life.
We all "design" to some degree, but professional designers are in a unique position to influence our social practices, our environment, and our experiences of the world. The ways in which professional designers practice is commonly formed through tertiary design education (i.e. at a university or similar).
Living in a time of global ecological and social crises when design could be leveraged to transition to alternative futures, we take a critical look at design education, asking how we might navigate toward sustainable and equitable design practices through a preferred design education landscape.

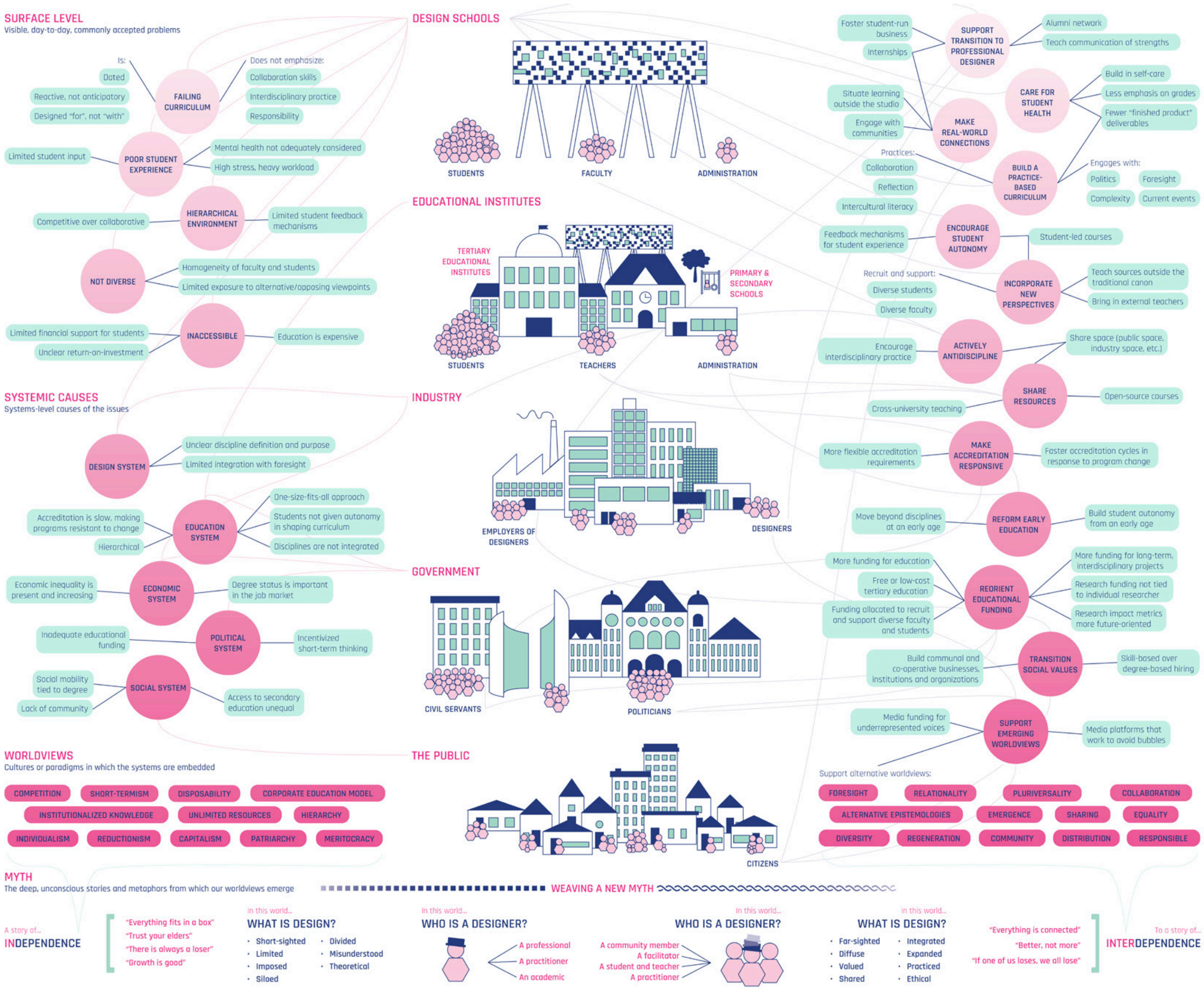
**What is design?**
Design goes far beyond its popular understanding, ranging from physical products to the natural environment. The deeper layers of design encompass the layers found above them.

**What is the problem?**
Critiques of the current design education landscape have been mapped using Causal-Layered Analysis (CLA). The four layers of CLA get deeper to understand a problem from its surface-level manifestations to its deepest, unconscious roots.

**Who is involved?**
Surface-level problems may be located within design schools, while deeper issues are located within increasingly diffused spaces. We have identified key actors within each problem space and the interventions they have power to act upon.

**How do we take action?**
Below are a list of possible points of intervention for transforming design education toward a preferred future from surface to system, drawing directly from the critiques mapped using CLA.

**A final word...**
It is important to discuss and address the surface-level problems within design education, but lasting change will require an exploration of their deep, systemic causes. A preferred future for design education involves working to not only better the education itself, but to build a better world.



SURFACE LEVEL
Visible, day-to-day, commonly accepted problems
Is:
Dated
Reactive, not anticipatory
Designed "for", not "with"
FAILING CURRICULUM
Does not emphasize:
Collaboration skills
Interdisciplinary practice
Responsibility
Limited student input
POOR STUDENT EXPERIENCE
Mental health not adequately considered
High stress, heavy workload
Competitive over collaborative
HIERARCHICAL ENVIRONMENT
Limited student feedback mechanisms
NOT DIVERSE
Homogeneity of faculty and students
Limited exposure to alternative/opposing viewpoints
Limited financial support for students
Unclear return-on-investment
INACCESSIBLE
Education is expensive
SYSTEMIC CAUSES
Systems-level causes of the issues
DESIGN SYSTEM
Unclear discipline definition and purpose
Limited integration with foresight
Accreditation is slow, making programs resistant to change
Hierarchical
EDUCATION SYSTEM
One-size-fits-all approach
Students not given autonomy in shaping curriculum
Disciplines are not integrated
Economic inequality is present and increasing
ECONOMIC SYSTEM
Degree status is important in the job market
Inadequate educational funding
POLITICAL SYSTEM
Incentivized short-term thinking
Social mobility tied to degree
Lack of community
SOCIAL SYSTEM
Access to secondary education unequal
WORLDVIEWS
Cultures or paradigms in which the systems are embedded
COMPETITION
SHORT-TERMISM
DISPOSABILITY
CORPORATE EDUCATION MODEL
INSTITUTIONALIZED KNOWLEDGE
UNLIMITED RESOURCES
HIERARCHY
INDIVIDUALISM
REDUCTIONISM
CAPITALISM
PATRIARCHY
MERITOCRACY
MYTH
The deep, unconscious stories and metaphors from which our worldviews emerge
DESIGN SCHOOLS
STUDENTS
FACULTY
ADMINISTRATION
EDUCATIONAL INSTITUTES
TERTIARY EDUCATIONAL INSTITUTES
PRIMARY & SECONDARY SCHOOLS
STUDENTS
TEACHERS
ADMINISTRATION
INDUSTRY
EMPLOYERS OF DESIGNERS
DESIGNERS
GOVERNMENT
CIVIL SERVANTS
POLITICIANS
THE PUBLIC
CITIZENS
WEAVING A NEW MYTH
Foster student-run business
Internships
SUPPORT TRANSITION TO PROFESSIONAL DESIGNER
Alumni network
Teach communication of strengths
CARE FOR STUDENT HEALTH
Build in self-care
Less emphasis on grades
Fewer "finished product" deliverables
Situate learning outside the studio
Engage with communities
MAKE REAL-WORLD CONNECTIONS
Practices:
Collaboration
Reflection
Intercultural literacy
BUILD A PRACTICE-BASED CURRICULUM
Engages with:
Politics
Foresight
Complexity
Current events
Feedback mechanisms for student experience
ENCOURAGE STUDENT AUTONOMY
Student-led courses
Recruit and support:
Diverse students
Diverse faculty
INCORPORATE NEW PERSPECTIVES
Teach sources outside the traditional canon
Bring in external teachers
Encourage interdisciplinary practice
ACTIVELY ANTIDISCIPLINE
Share space (public space, industry space, etc.)
Cross-university teaching
SHARE RESOURCES
Open-source courses
More flexible accreditation requirements
MAKE ACCREDITATION RESPONSIVE
Foster accreditation cycles in response to program change
Move beyond disciplines at an early age
REFORM EARLY EDUCATION
Build student autonomy from an early age
More funding for education
Free or low-cost tertiary education
Funding allocated to recruit and support diverse faculty and students
REORIENT EDUCATIONAL FUNDING
More funding for long-term, interdisciplinary projects
Research funding not tied to individual researcher
Research impact metrics more future-oriented
Build communal and co-operative businesses, institutions and organizations
TRANSITION SOCIAL VALUES
Skill-based over degree-based hiring
Media funding for underrepresented voices
SUPPORT EMERGING WORLDVIEWS
Media platforms that work to avoid bubbles
Support alternative worldviews:
FORESIGHT
RELATIONALITY
PLURIVERSALITY
COLLABORATION
ALTERNATIVE EPISTEMOLOGIES
EMERGENCE
SHARING
EQUALITY
DIVERSITY
REGENERATION
COMMUNITY
DISTRIBUTION
RESPONSIBLE
A story of...
INDEPENDENCE
"Everything fits in a box"
"Trust your elders"
"There is always a loser"
"Growth is good"
In this world...
WHAT IS DESIGN?
Short-sighted
Limited
Imposed
Siloed
Divided
Misunderstood
Theoretical
In this world...
WHO IS A DESIGNER?
A professional
A practitioner
An academic
In this world...
WHO IS A DESIGNER?
A community member
A facilitator
A student and teacher
A practitioner
In this world...
WHAT IS DESIGN?
Far-sighted
Diffuse
Valued
Shared
Integrated
Expanded
Practiced
Ethical
"Everything is connected"
"Better, not more"
"If one of us loses, we all lose"
To a story of...
INTERDEPENDENCE

RSD7 2018

# CITY

# Open Interactive Mapping

## Exploring, abstracting, deciding in the relational city

Author: **A. Stamatopoulou**

University / Organization:
**School of Architecture, National Technical University of Athens, Greece**

Keywords: **Mapping Methodology, Open Mapping, Relational City, Decision-Making Processes, Immaterial Networks of the City, Intersubjectivity, Design Logics**

Spatio-temporal territories are constantly changing complex systems composed of heterogeneous content: material and immaterial elements, as these interactions are being generated, combined and experienced by diverse subjects in a specific context. Open Interactive Mapping is the visualisation of an under-construction methodology of mapping-and-designing the city, through this point of view. The methodology approaches the city as constituted by signifying objects-subjects' interactions, which can reveal its component relations among heterogeneous parameters. In dialogue with questions on how city's multiplicity can be mapped and how such a mapping might contribute to designing-intervening processes, intention of the methodology is to function as a tool capable of revealing and at the same time abstracting city's complexity, contributing to decision-making and management processes in a territory. The methodology the methodology is composed of three levels of actions (fig.1 in blue colour): the gathering of data (diverse mappings); the search of translation parameters among the mappings; applications and experiments that test the methodology in specific case-studies. The organisation and the capacities of data management are being performed through the Open Interactive Map (OIM) that is being presented in this poster. The general aim of the OIM is to be capable of organising and managing city's com- plexity as this emerges from multiple mappings and their relations. The OIM is a system of a data base of multiple mappings in their original form, a table and a map (fig.1 in green colour). The horizontal axis of the table integrates references to all the different mappings and the vertical the properties/ (translation) parameters list as organised in categories. On the map the different references to physical locations are noted. The data-base, the table and the map are interconnected through many options of selections. For instance, selections on the table can activate networks of locations on the map, enabling multiple decompositions and recompositions of the city beyond the physical ones. Selections on the map can indicate properties attributed to locations. Combinations - sequences of selections in a logic of back-and-forth actions, based on specific scenarios and intentions can guide and support a decision-making process while feeding the perspective of design logics that take nothing fore-granted.

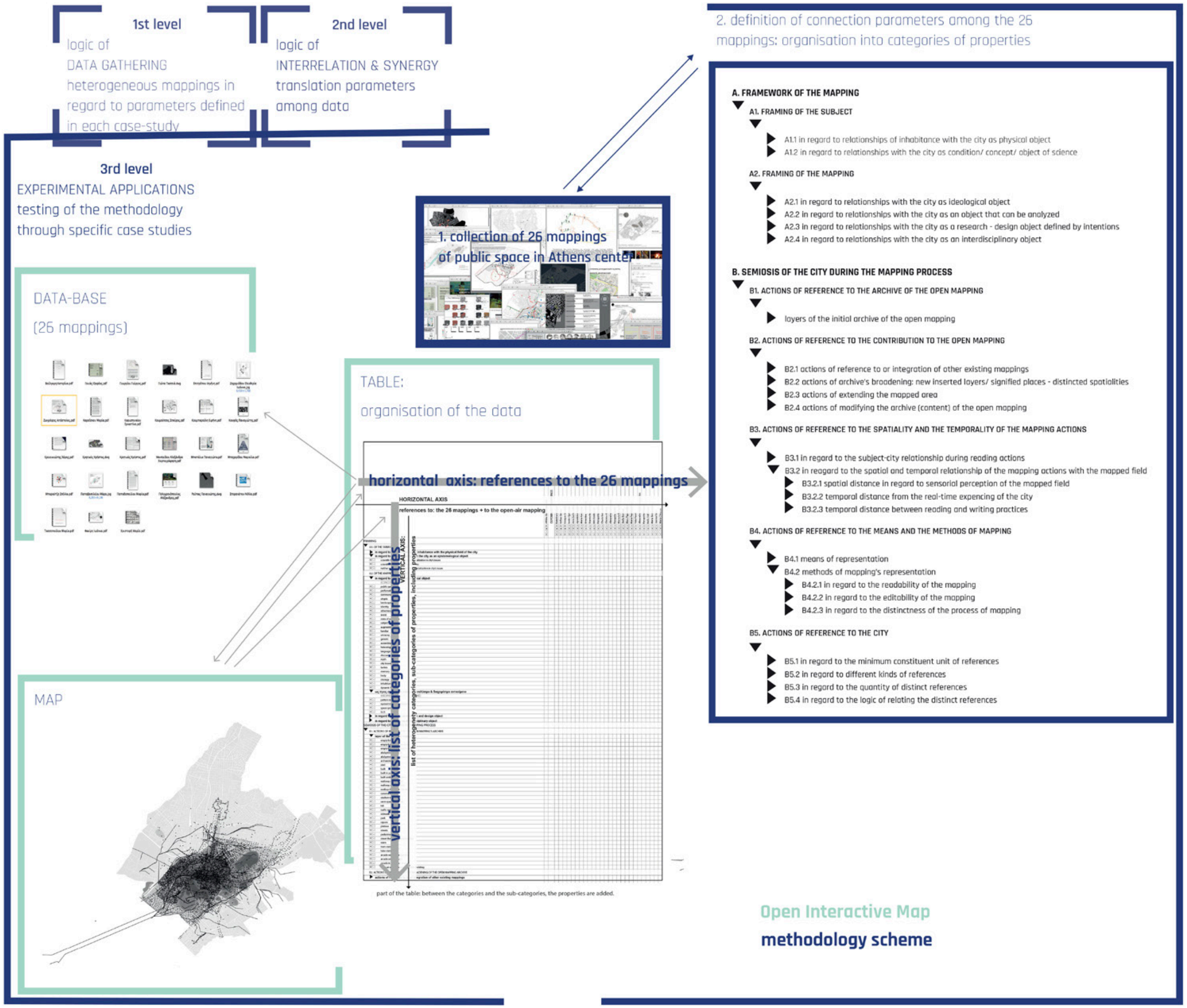



**Fig. 1** Scheme of the Open Interactive Map as embeded in the methodology of mapping-and-designing the relational city

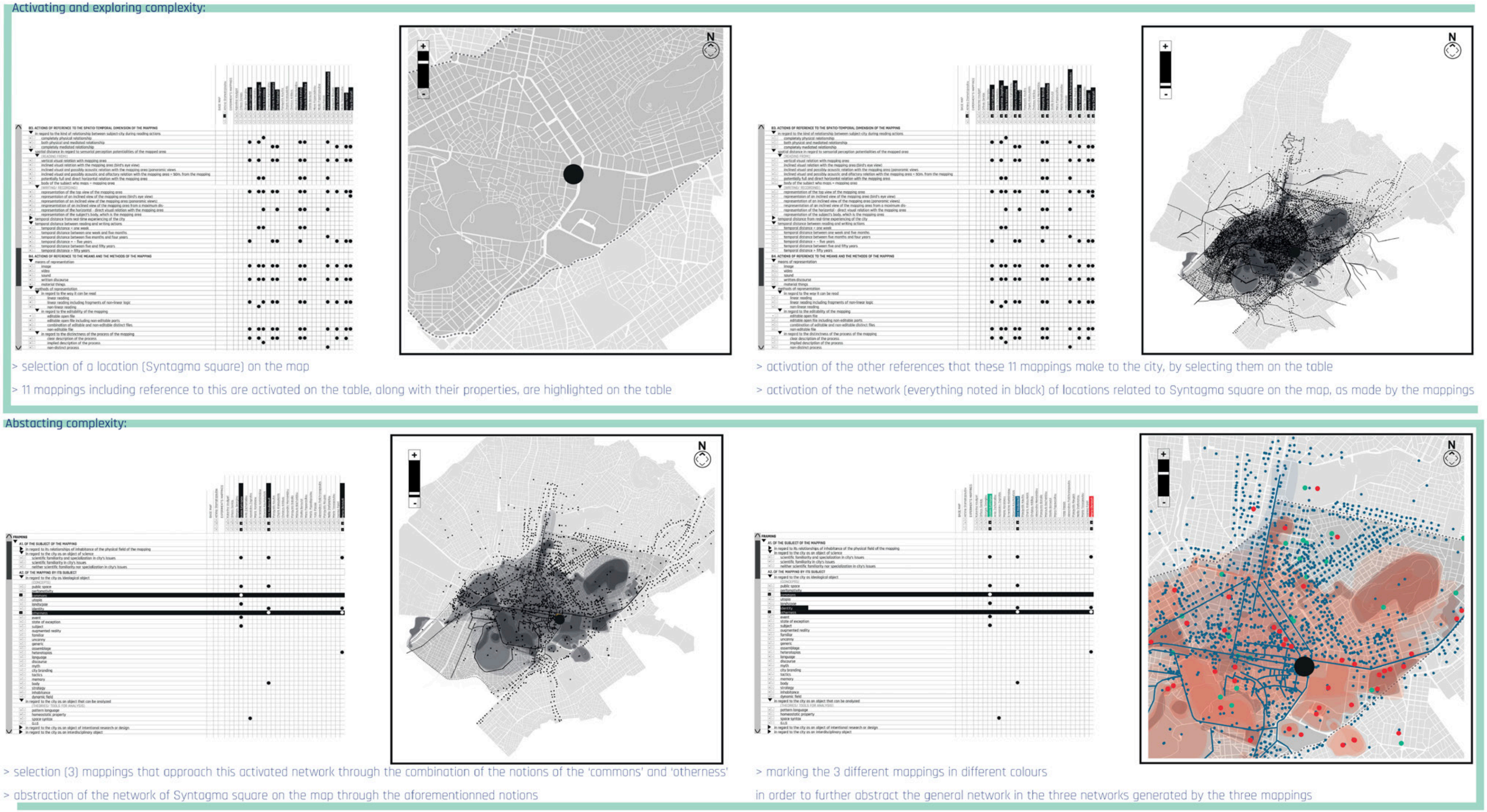



**Fig. 2** Samples of activating (above frames) and abstracting (below frames) complexity of a location (Syntagma square) as this emerges from the 26 mappings of an experimental testing application

# HECATE: The Affective City

## Mapping the city's spaces of possibilities

Authors: **Y. Passia, P. Roupas, D. Skomvoulis**

University / Organization: **National Technical University of Athens_School of Architecture, Greece**

Keywords: **Apparatus, Machine, Connectionist City Scape, Affordances, Communications, Hekate**

**INTRO: space of possibilities**
The project theorizes the city as a multiplicity, a structure of spaces of possibilities while at the same time trying to establish a liaison between the city's properties, tendencies and capacities. While space is generally perceived - within complexity theory and dynamic systems theory - as a changing field of dense interactions that occur in a range of spatial and temporal scales, we are unable to perceive it or describe it in these terms. In this framework, Hecate is the city's apparatus; an urban "mining" system able to decipher, map, connect, or navigate itself through the superimposed layers of information within an urban territory. It is an interactive city scape, a complementary organizational system to the actual city. It is visualized as a network of richly interconnected nodes of varying intensities, each representing information flows between the system and the city.

**MAPPING: an informative mining system**
In order to push the boundaries further we have to surpass the appearance of the existing form of the city as a constructed landscape of forms, built upon percepts that are fundamentally immanent and insurmountable. The complexity of information act as an obstacle to the acquisition of personal cognition and knowledge. By mapping a landscape of points of interaction we have developed a mining system which extracts information from contemporary urban landscapes without theorizing a single viewpoint as a vantage point. Any geolocated point within the urban sphere becomes vantage point independently from our a priori imposed symbolic values. Using algorithmic procedures in order to construct a simplified ontogenic model we seek to represent the correlations through an apparatus which has the capacity to translate any information in a qualitative tension. That is the main reason why any information Hecate depicts is organized based on the number of points per surface and the proximity of these points. That means that each semantic layer of the city is translated in geo referenced intensities. The main aim of this procedure is to complement in a quasi-virtual apparatus the site specific symbolic content through the qualitative compression of information. The concept of abstraction as a site specific operation is crucial because of its immanent capacity of compressing different informational layers in a single entity that preserves the invariant traits while it preserves its capacity to diversify the informational layers into local instantiations. These characteristics made the procedure a method for the organization of information, the simplification of the representation, the diversification of thought processes and the increasing possibilities of the formation of new territories of space interaction.

**MATERIALITY: manifestation of virtuality**
Performing a recurring two-fold process - collect information and distribute it in the city - it creates a virtual network of nodes that interact and finally form a "living" organism attached to the public areas of urban territory. This network reinstates the areas of intensities within the urban context through the local

instantiations of the structure which has previously interacted with the global information system of the city in order to form itself. Each node interacts with the user, makes local decisions and forms an autonomous architectural structure in order to reveal the space of intensities according to the user. This “informative spatial object” consisting of a network of nodes interconnected via an exoskeleton in the exact coordinates that will reveal the tendencies inherent in the urban fabric, has its own spatial formation while the ability to interconnect with other nodes, reveals its immanent capacity for mutation.


**Fig. 1** Mapping intensities of urban territories

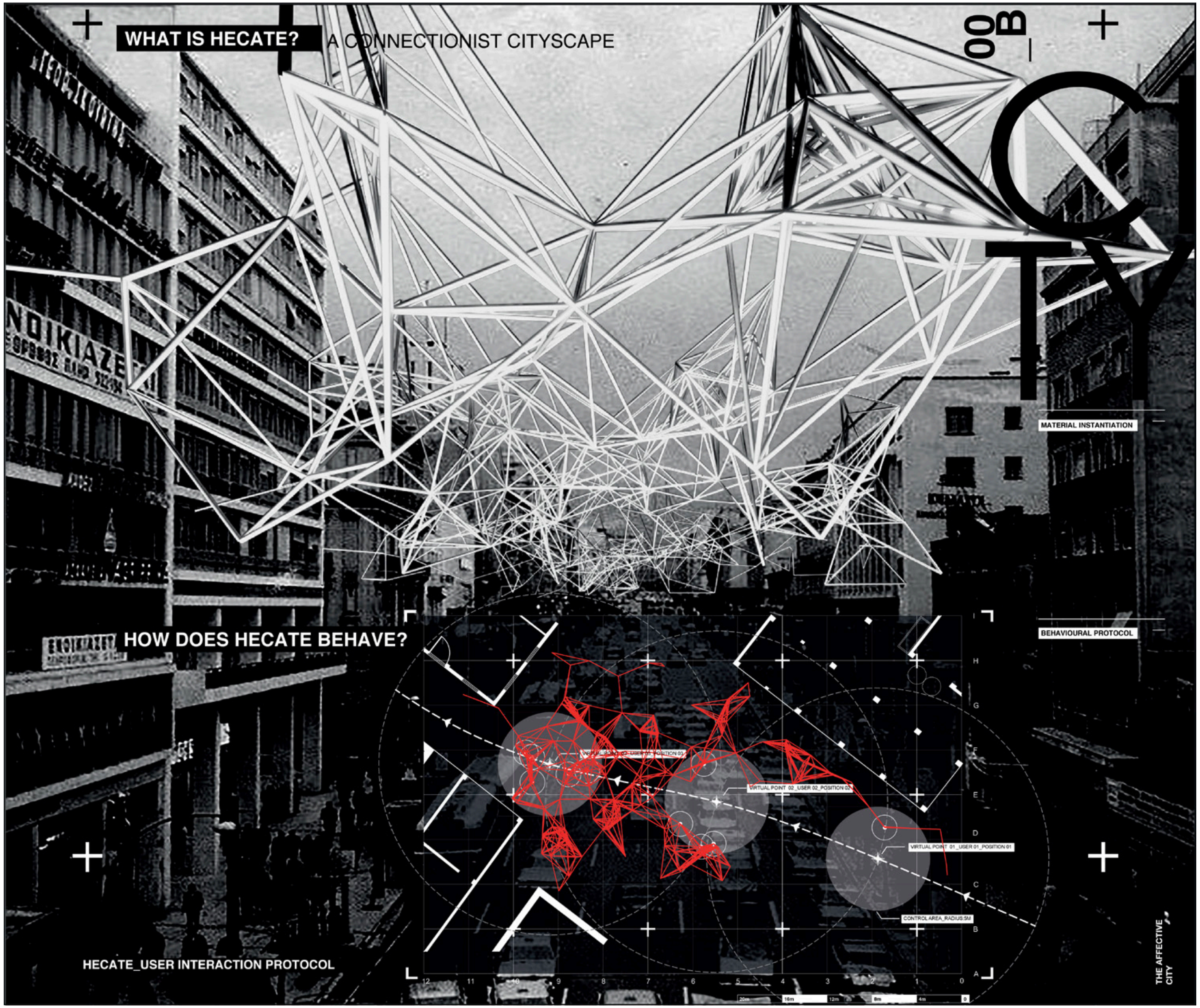



Fig. 2 Informative spatial cityscape

RSD7 2018

# HEALTHCARE

# eHealth: Better Health Care Through Technology

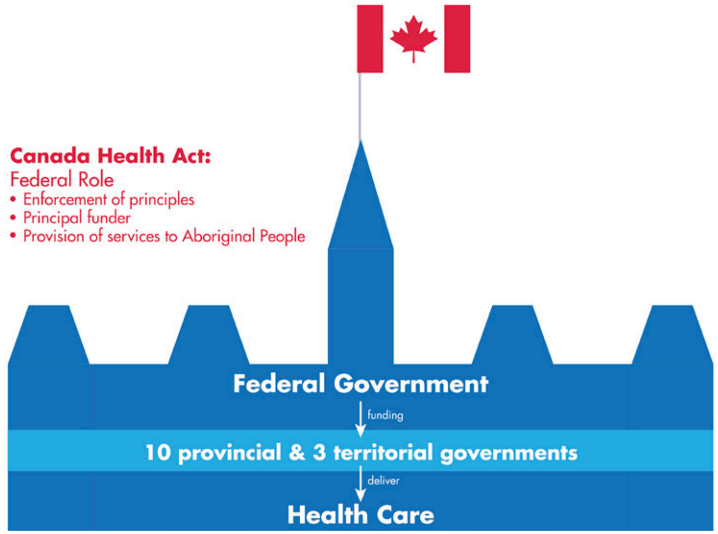
## Chronic Disease Management

Authors: **Q. Yang**

University / Organization:
**Ontario College of Art and Design University (OCADU)**

Keywords: **eHealth, Health Care, Gigamapping, Systems Oriented Design, Federalism, Visualization, Chronic Disease Management**

Our journey into the Canadian health care system may be a top-down approach, starting with macro policies and regulations. However, for most of us, we relate our personal experiences of our interactions with the health care system to our impressions of the overall system. Starting from this personal perspective, we begin our journey with James, a retired 65-year old man with symptoms suggestive of chronic obstructive pulmonary disease (COPD). James needs to consult with his family doctor to get a diagnosis and treatment for his health problems. James has limited mobility and depends on his daughter, Hedy, to help him get to medical appointments. Starting from this personal situation, I will proceed to describe a shift from a problem-solving focus to a paradigm shift of constructivism where the definition of the problem is less clear and where complexity precludes a linear search for solutions and where there is no optimal solution. I will use a systems oriented design approach to explore the complexity of the issues involved in this seemingly straightforward matter. I will be using a gigamap to visually display the complexity. "Gigamapping is super extensive mapping across multiple layers and scales with the goal of investigating relations between seemingly separate categories, hence providing boundary critiques on the conception and framing of systems (Sevaldson, 2012)." Canadian federalism pose unique challenge and opportunities in health care delivery that are more apparent what visually displayed.



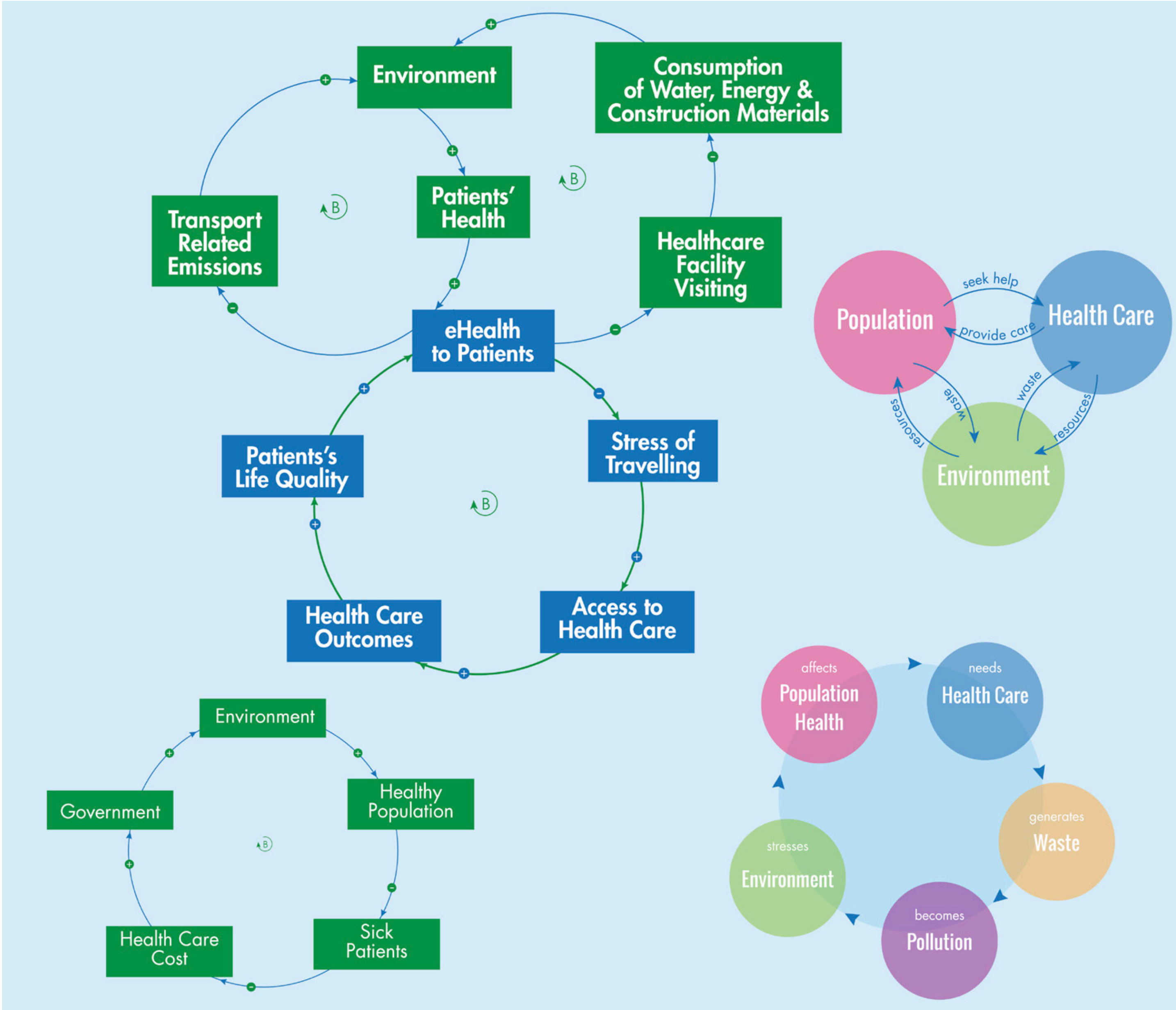



Fig. 1 Relationship of Population Health, Environment, Health Care and Government Role

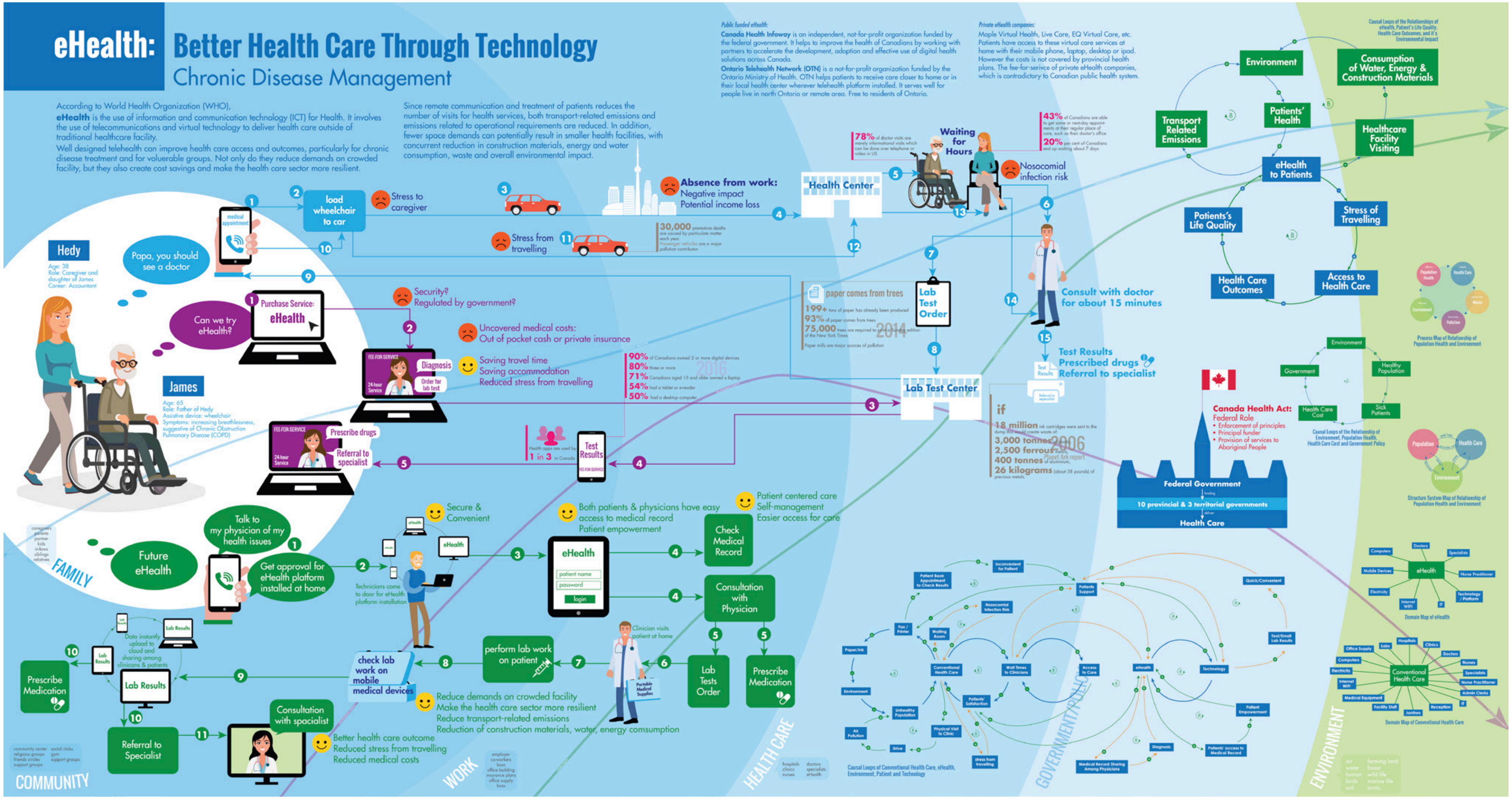



Fig. 2 Comparison of eHealth and Traditional Health Care

# Designing for Comprehensive Healthcare

A ground zero study and system synthesis from India

Authors: **M. Laroia, S. Gupta**

University / Organization: **School of International Biodesign, India**

Keywords: **Healthcare system, Patient care, Giga-map, Information synthesis, Indian context**

The Indian healthcare system is a convoluted web of interplaying elements, a rare occurrence, where the public and private sector coexist, interact and function simultaneously to deliver healthcare services. Considering, the public and private health systems as sub-systems of the whole, it was observed that solutions don't easily penetrate into or traverse through these sectors. Moreover, the causality of the problems in the system remains largely misunderstood, leading to piled up unmet needs. These are wicked problems as they bleed into one another making designing for health in India, challenging.

The adoption of System Thinking methodologies like cluster mapping, user-experience graphs and feedback loops, emerged as effective tools for information handling and synthesis. The Giga map, drawn thereafter, compares the state proposed structure of the system with its abysmal ground realities along with outlining the patients' experiences while navigating this system.

The public and private system were observed as a whole and their comparative analysis was quintessential in deciphering unforeseen relationships, making the system study unique to our context. Their disparateness led to the emergence of a unique and inspiring interplay for discovering unmet needs. It is in this context that the study conducted holds relevance and lays the ground for dialogue and discovering the 'sweet spot of intervention.'

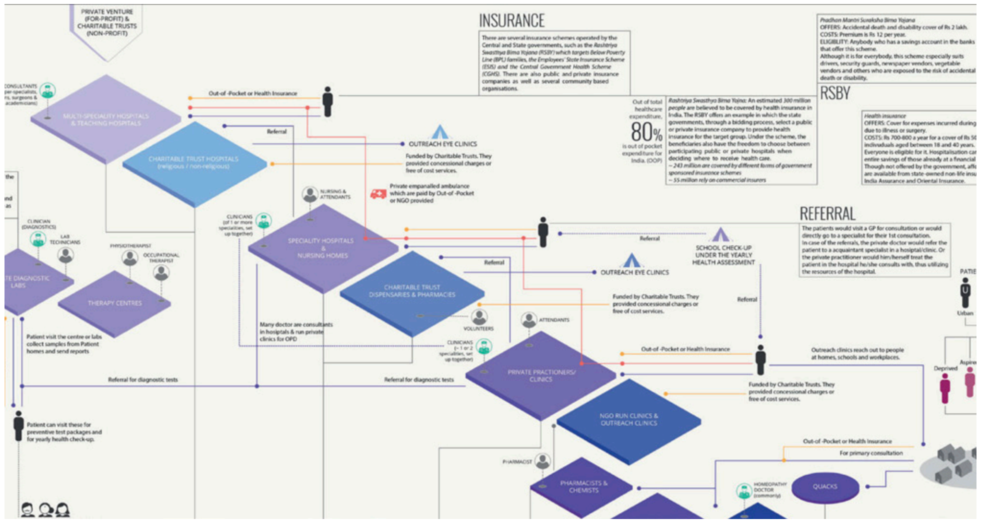



**Fig. 1** The private healthcare system of India with the various points of patient entry, their interactions and methods of healthcare delivery

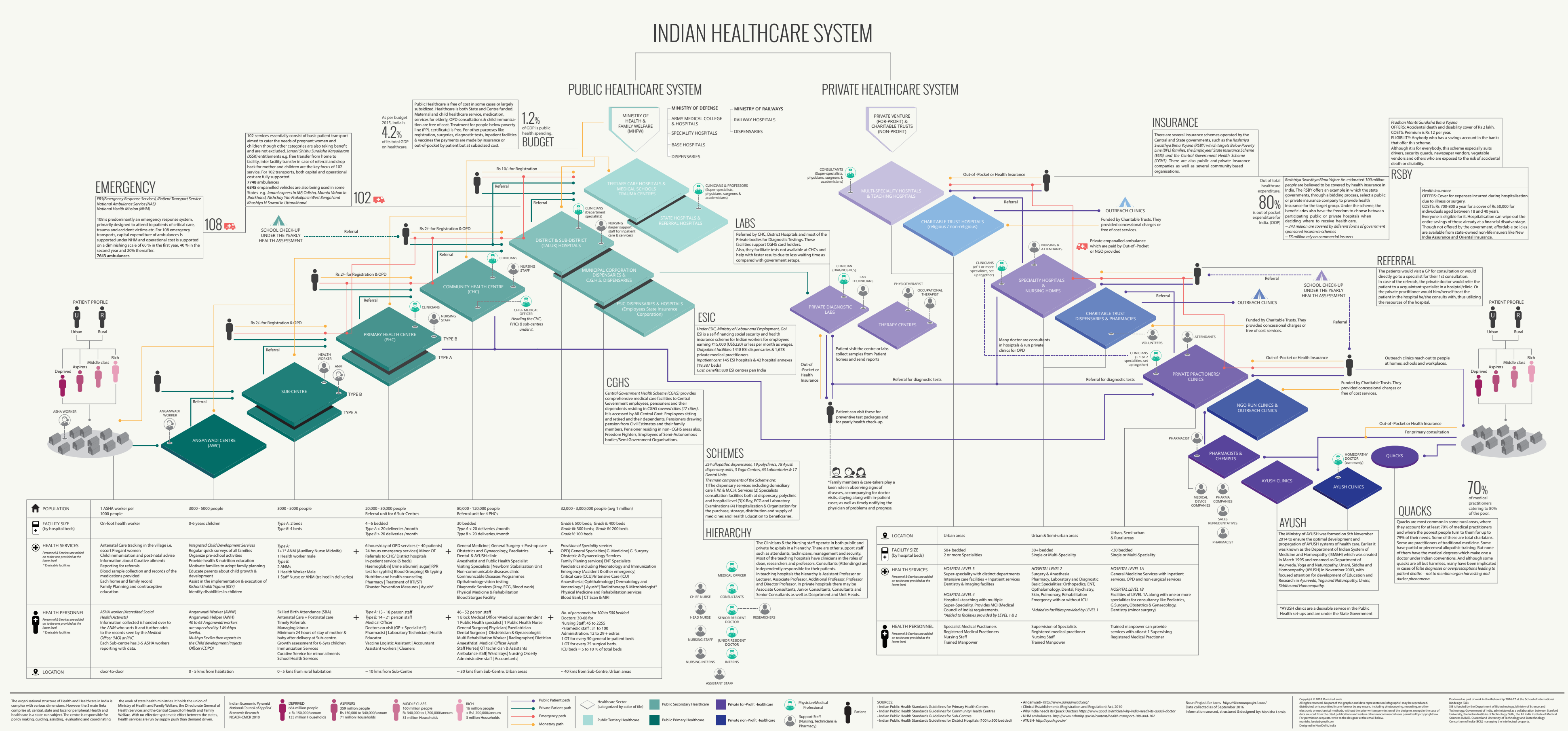



**Fig. 2** Hierarchical pyramid of the Indian Healthcare System, showing the Public (in green) and Private (in purple) systems. The patient pathway is highlighted at different levels along with flow of funds, healthcare schemes, resource distribution and the various stakeholders of the system

# A Systems views of Organ Donation

## Exploring complexity within the Canadian organ donation system

Authors: **L. Capobianco, M. McGovern**

University / Organization: **OCAD University, Canada**

Keywords: **Systems Thinking, Organ Donation, System Design**

The successful transplantation of organs from one individual to another is one of the largest medical advances in modern medicine. The organ transplantation of one deceased individuals organs and tissues can improve the quality of life of up to ten persons lives (Lee, Midodizi, & Gourishankar al., 2010). However, amongst this 96%, only 54% were on the donor registry list (Lee, et al., 2010). This statistic highlights the complexity of the current Canadian organ transplant/ registry system, and suggests the opportunity for systems thinking to reimagine the current system structure. Organ donation is further complicated by the provincial and territorial differences in how this process is managed. Each province and territory in Canada has their own system in place for how organ registration and donation will take place. The current model highlight the lack of an overarching national database that collects information on national donor demographics. As well, those who do not support organ donation often cite common misunderstandings surrounding organ procurement such as: lack of respect of the body by medical team, and inability to have desired funeral services, as primary reasons for their choice not to be donors (Morgan, et al., 2008). The unique universal healthcare system in Canada places the nation in a favorable position to implement nationwide change in terms of organ donation (Lee, et al., 2016). The system map created highlights the potential opportunities to improve organ donation and registration by examining global leaders like Spain, the differences between provinces and territories in procurement strategies, policies and educational programs curated to encourage and inform users on donorship, and how this information may be amalgamated to reimagine the future of organ donation and registration within Ontario.

References:

Lee, E., Midodizi, W., Gourishankar, S. (2010). Attitudes and opinions on organ donation: an opportunity to educate in a Canadian city. Clin Transpantation, 24(1), E223-E229

Morgan, S.E., Harrison, T.R., Walid, A.A., Long, S.E., & Stephenson, M. (2008). In their own words: the reasons why people will (not) sign on organ donor card. Health Communication, 23(1), 23-33

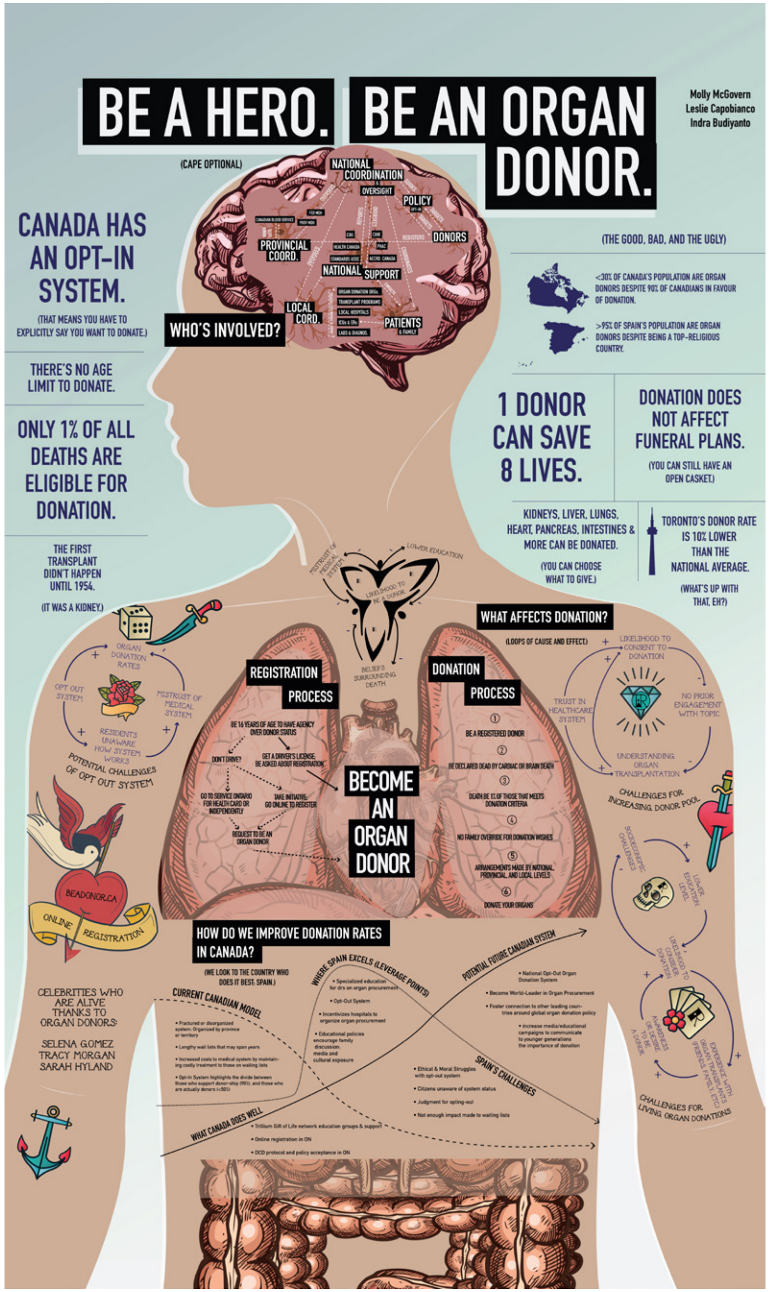



Fig. 1 A Systems views of Organ Donations

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# TERRITORY

# A case study on Access to Electricity

## Decentralized People-Centric Energy Model for India

Authors: **M. Laroia, P. Arun Kumar, M. Minz, B. Khateeb, P. Nahar**

University / Organization: **National Institute of Design, Ahmedabad, India**

Keywords: **Giga-mapping, Visual tools, Access to Electricity, Decentralized System, Data visualization**

Most of the developing world still lives in darkness. In India alone, 400 million people have irregular or no access to electricity. The system is ever evolving and dependent on numerous interplaying factors varying from macro ones like government policies to micro ones like electricity theft and over-consumption due to lifestyle practices.

The India-specific research incorporated a megatrend study, outlining the contributing factors, product-service life-cycles, analysing electricity usage and interacting with stakeholders. Extensive mapping revealed underlying patterns like the complex network of flows, threats, opportunities, feedback loops and latent links that add to the delicacy of the system. 'Personas' served as instrumental nodes in understanding user-behaviour, user-needs and the demand for context-specific solutions that must work coherently within the system.

The developed Giga-map was used to analyse a case of a Decentralised Electricity System, with a vision for 2040. Respecting the variability, multiple solutions were designed for energy equity. The Giga-map served as a tool to provide a safe playing area to test new ideas and debate opportunities, creating grounds for deliberation. The reader can choose an Avatar, trace the lifecycle of electricity and fit ones-self into different contexts to foresee solutions and plan for effective execution. The proposed people-centric system could serve as a resource for communities to plan better policies with a holistic understanding of the system, empowering people and making electricity accessible.

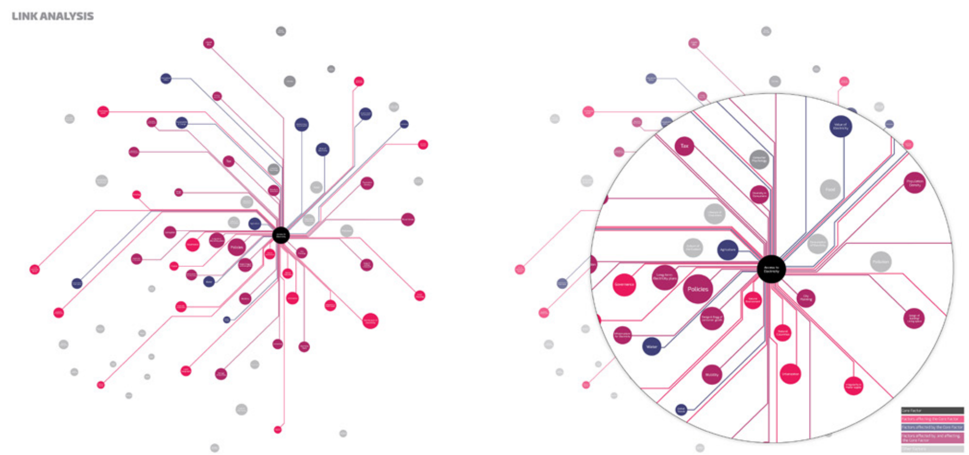


**Fig. 1** Cluster mapping of the Indian's electricity system showing the interdependency amongst various factors based on their impact on each other

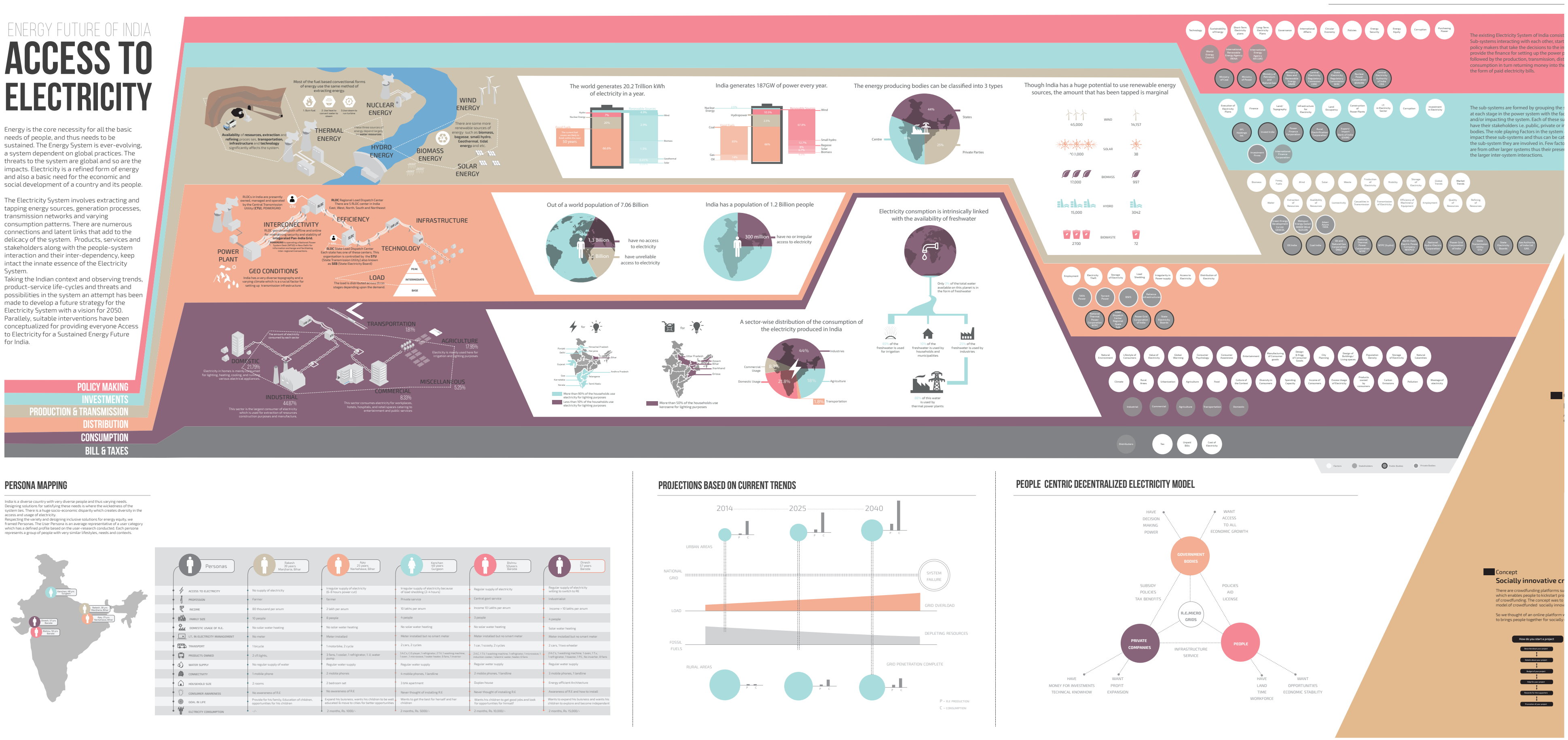


**Fig. 2** The sub-systems of the Electricity system i.e. Production, Distribution and Consumption and associated factors, stakeholders and data

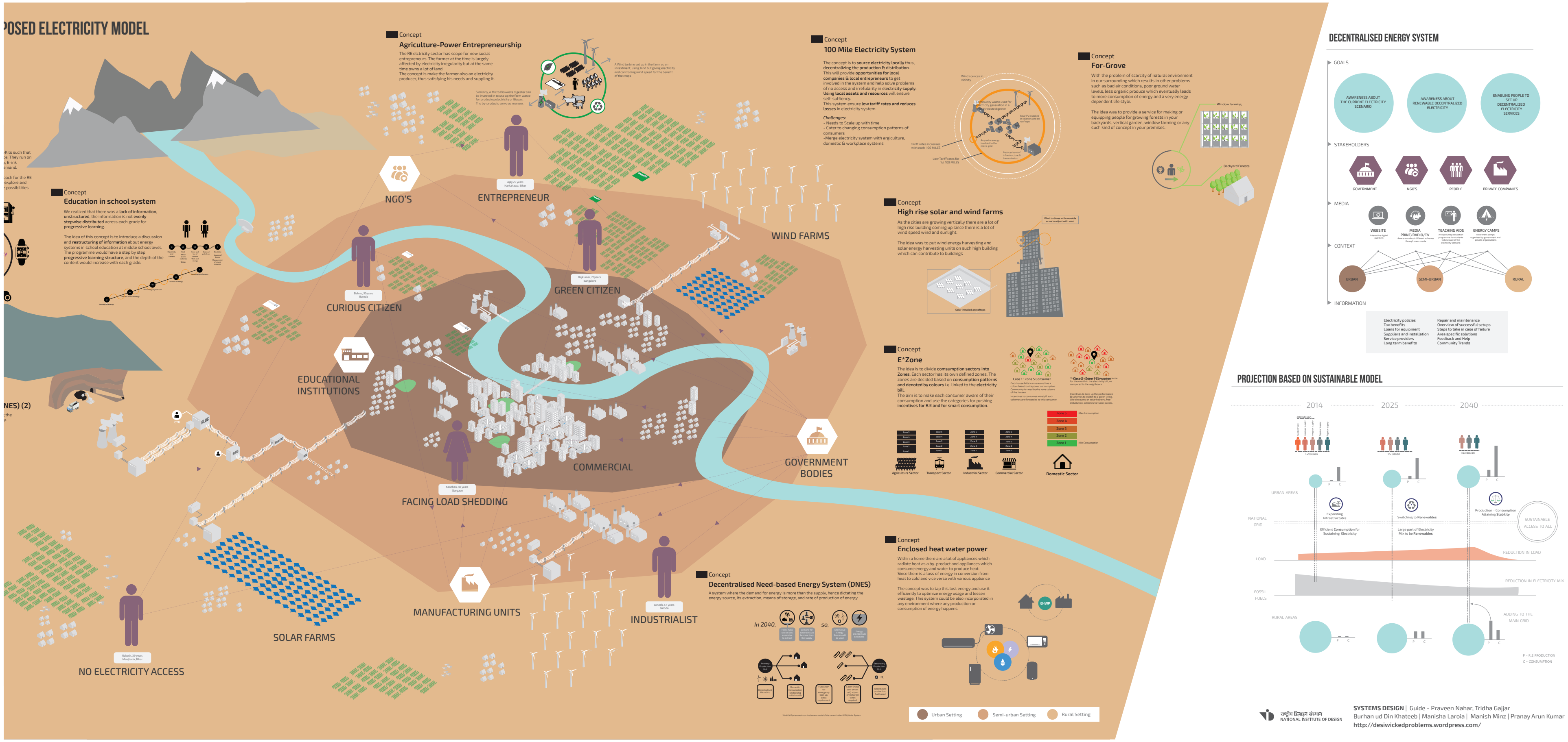


**Fig. 3** The proposed Decentralized People-centric energy model proposed for India with a vision of 2040 showing diverse personas, varying solutions and different deployments contexts.

# Design for the Taste-Makers

System oriented innovation for improving life of salt pan labourers

Authors: **A. Kumar, P. Wagle, P. Bandakar**

University / Organization: **National Institute of Design, India**

Keywords: **Social Innovation, Migration, Empowerment, Community based Design, Wicked problems, Co-Creation, Unorganized Sector, Systemic Design**

The Indian social construct is a complex structure comprising of various social, cultural, societal, regional and political elements that are interconnected to each other. The social construct which was primarily occupation based is still effective in certain areas and occupations of India. One of these occupations is of salt pan labourer. Food being one of the most important basic necessities for survival, there needs no second thought to understand the importance of Salt. Just like other food industries, salt manufacturing industry too is moving towards complete automation with minimal human intervention. But considering the population involved in manual salt manufacturing and the sole dependency of them on this job for livelihood, social innovation was necessary to improve their inhuman living condition. This paper gives and understanding of the grassroot reality in the salt manufacturing areas which was build using systemic design thinking. The approach enabled to look at the problem faced by the Salt Pan labourers from a micro and meta level using design tools like Co-creation workshops, Participatory activity, Shadowing, Day in life, and primary research methods like laddering method etc.

The Insights received after the researches were mapped against their effect at micra and meta level. Systemic design thinking approach enabled in selecting the final ideas that could contribute significantly in the existing system. 5 different levels of solutions were proposed after the exercise to improve the living condition of the salt pan labourer. The final outcomes at micro level were new product interventions, activities for NGO's working in the area for development of children and designing Co-creation workshops for NGO's to bring about an inclusive design solution for solving the future problems. The solutions proposed at macro level were a new self-sustainable or an assistive social business model which would involve all the stakeholders to work together in uplifting the living condition of everyone involved in the business of manual salt manufacturing. A policy level intervention was also part of the final outcome, which was proposed understanding the magnitude of effect a small policy could make in the system.

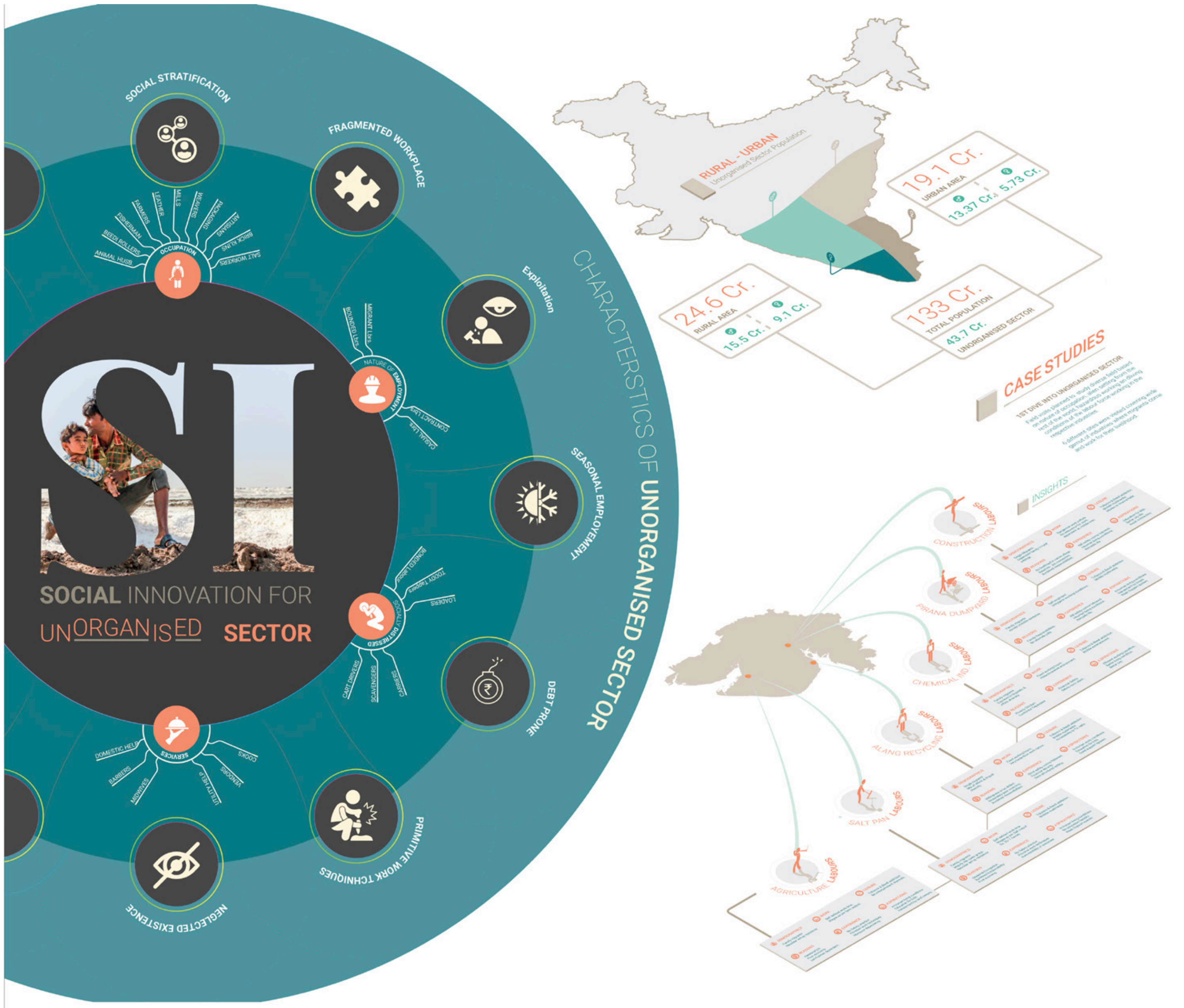


Fig. 1 Unorganised sector overview and Indian scenario with case studies

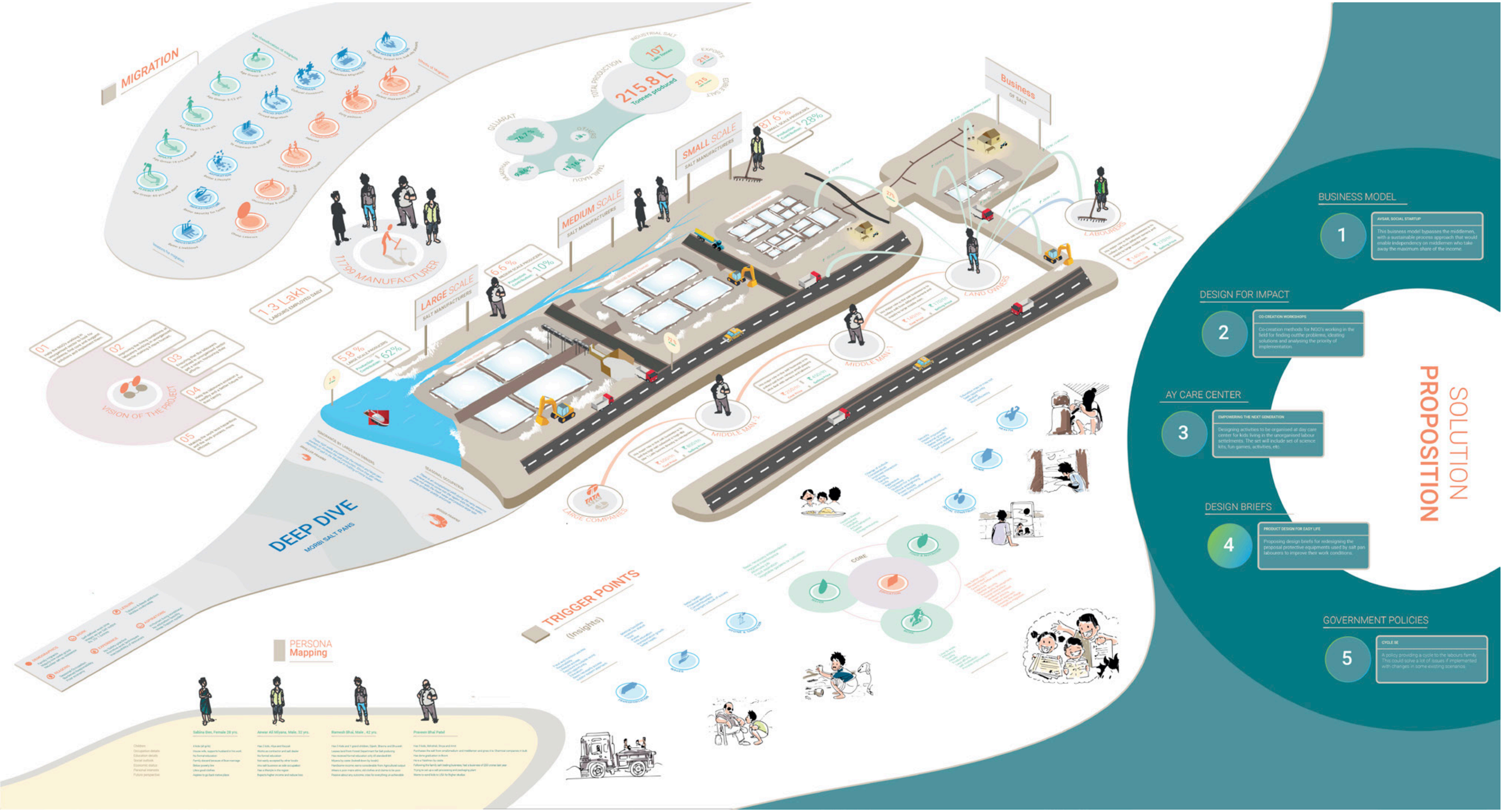


**Fig. 2** Giga Map representation for the systemic level meta to micro view of the Salt Pan Labours with solution propositions

# Waste system in Piedmont Region

## Disposed of urban and special waste

Authors: **P. Cardorani, D. Mercenati, M. Tetrao, M. Molari, A. Roscio, S. Panichi, M. A. Leal Restrepo, A. Pallaro, C. Giraldo Nohra, C. Battistoni, S. Barbero**

University / Organization:
**Politecnico di Torino, Italy**

Keywords: **Waste system, Piedmont Region, Urban Waste, Special Waste, Import export, Waste trend in Piedmont Region**

Positive data emerge from this holistic survey.
As that almost all waste can be exploited and only a small percentage of both RU and RS ends up in landfills.
However, the production of waste is growing. This datum can be read in two different ways: if on the one hand it is a symptom of production and consumption, and therefore of economic value creation for the territory, on the other it is in disagreement with the intention of the Piedmont region to decrease the quantity of waste produced.
Data collection is decidedly complex due to the sharp division between reports, so the data we find are related to Urban Waste, or to Special Waste. As for the latter, it is not easy to identify the plants that deal with their recovery and their disposal, but we know the treatment that is carried out for their recovery and their disposal.
Moreover, there is the possibility that the production activities, by filling out the MUD, omit quantities of material or do not insert the correct CER code, to reduce the monetary quantity to be paid to the entity that deals with the collection.

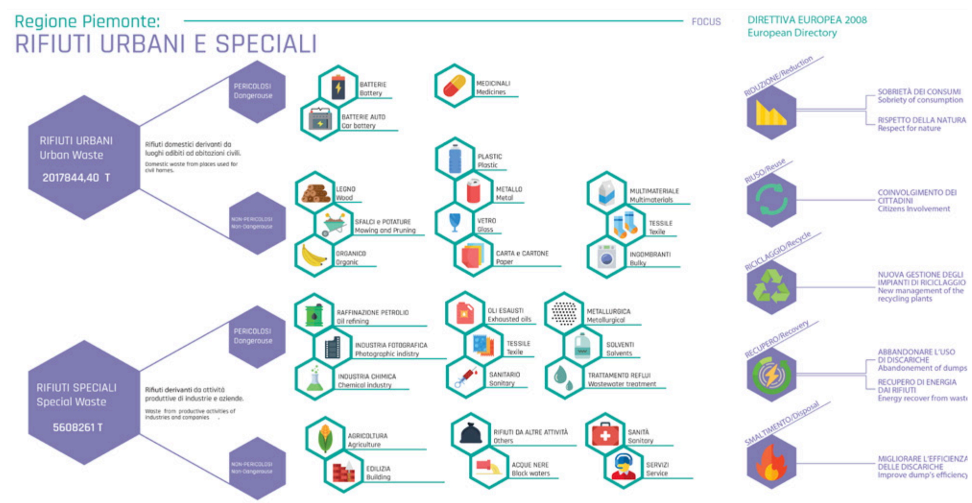


**Fig. 1** Urban and special waste

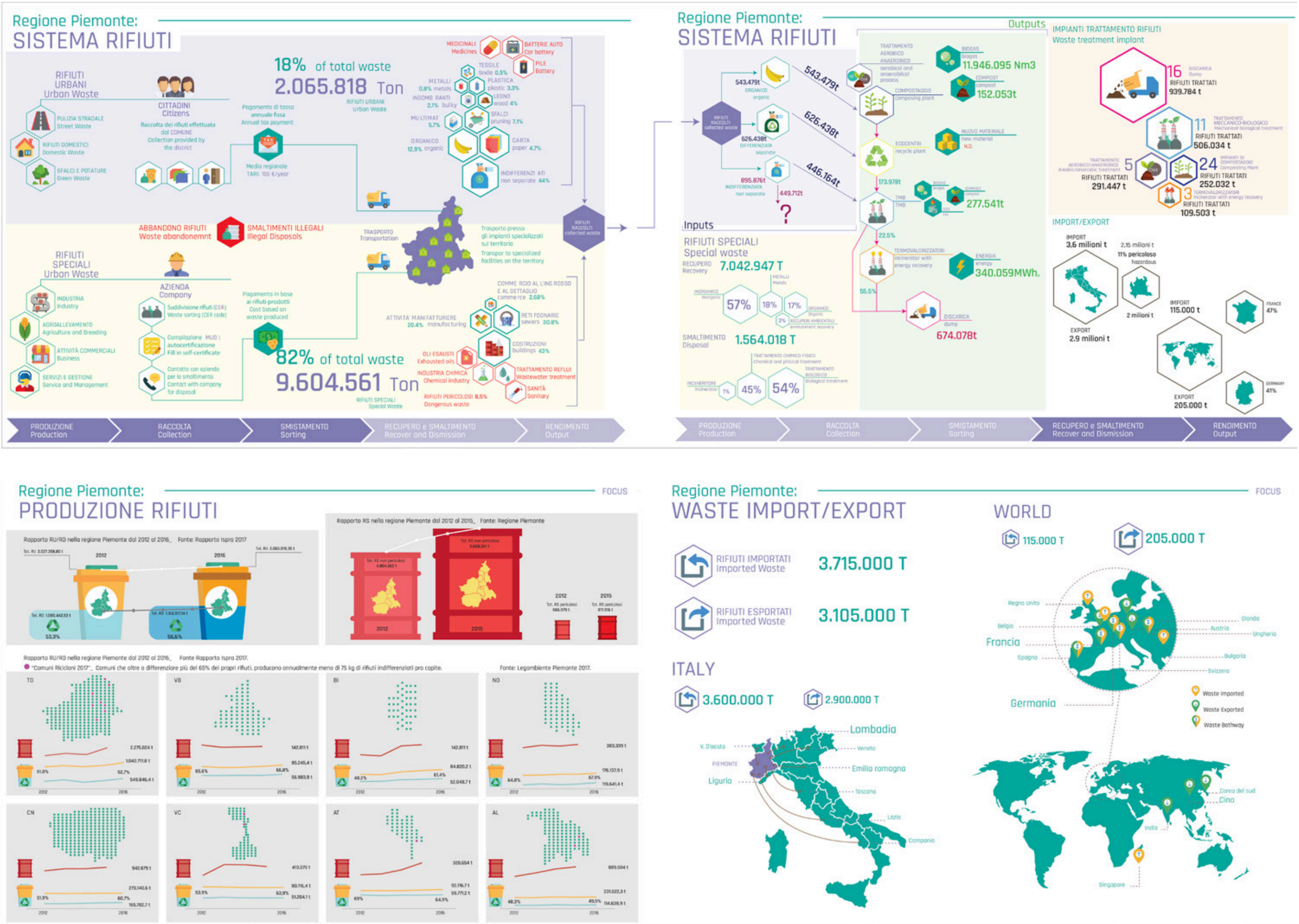


**Fig. 2** Analysis waste disposal.
Waste analysis by province and import/ export management

# Rice sector
System and new opportunities

Authors: **A. Aulisio, E. V. Bruno, L. Tong, C. Battistoni, S. Barbero**

University / Organization:
**Politecnico di Torino, Italy**

Keywords: **Systemic Design, Systemic Thinking, Industrial Process, Rice Tranformation**

This analysis, performed in Piedmont region (Italy), shows in detail the process of rice transformation and the characteristics of every outputs. There are many opportunities for the realization of a project that involves several players in the analyzed area (Vercelli - Italy), because the "waste" produced during the processing of rice reaches high percentages (about 40%) compared to the total raw material entering the supply chain.
The analysis focuses on a company that already implements some good practices, for example a network contract that involves farmers and entrepreneurs, in order to carry on the Vercelli rice tradition, but with a vision to the future. This contract also allows for a well-organized control of the rice supply chain, from cultivation to final products.
Currently, the outputs deriving from this transformation are resold and reused, but not exploited, as they are outputs very rich in nutrients and chemical-physical characteristics exploitable for uses in sectors where they would acquire greater value (bioplastics, green building, food etc...). These are therefore quality outputs and as such they need a process designed in order to continue to accumulate value.
The research underlines all the possible uses and opportunities that the supply chain can offer, giving rise to both economic and environmental benefits and increasing the connections in the territory in what can be defined as a systemic vision.

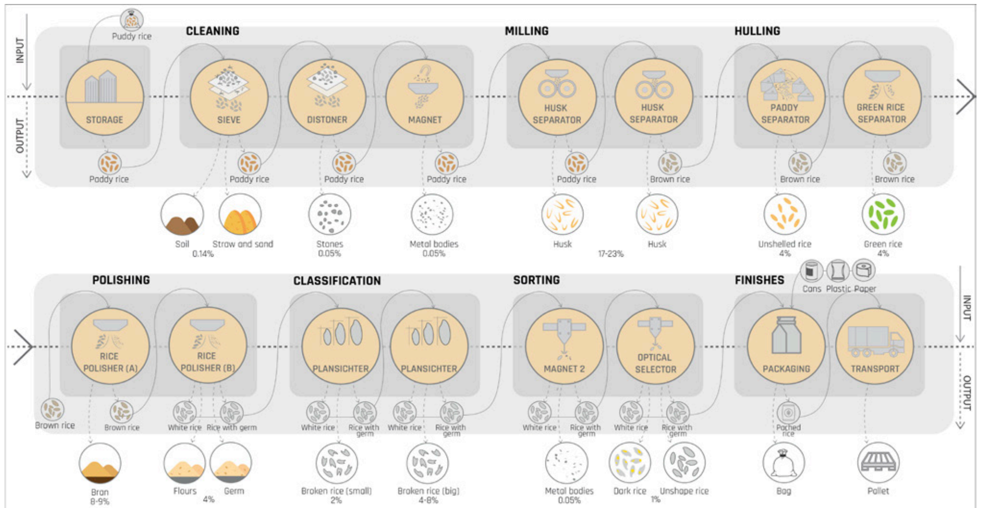


**Fig. 1** Transformation of puddy rice and production of outputs

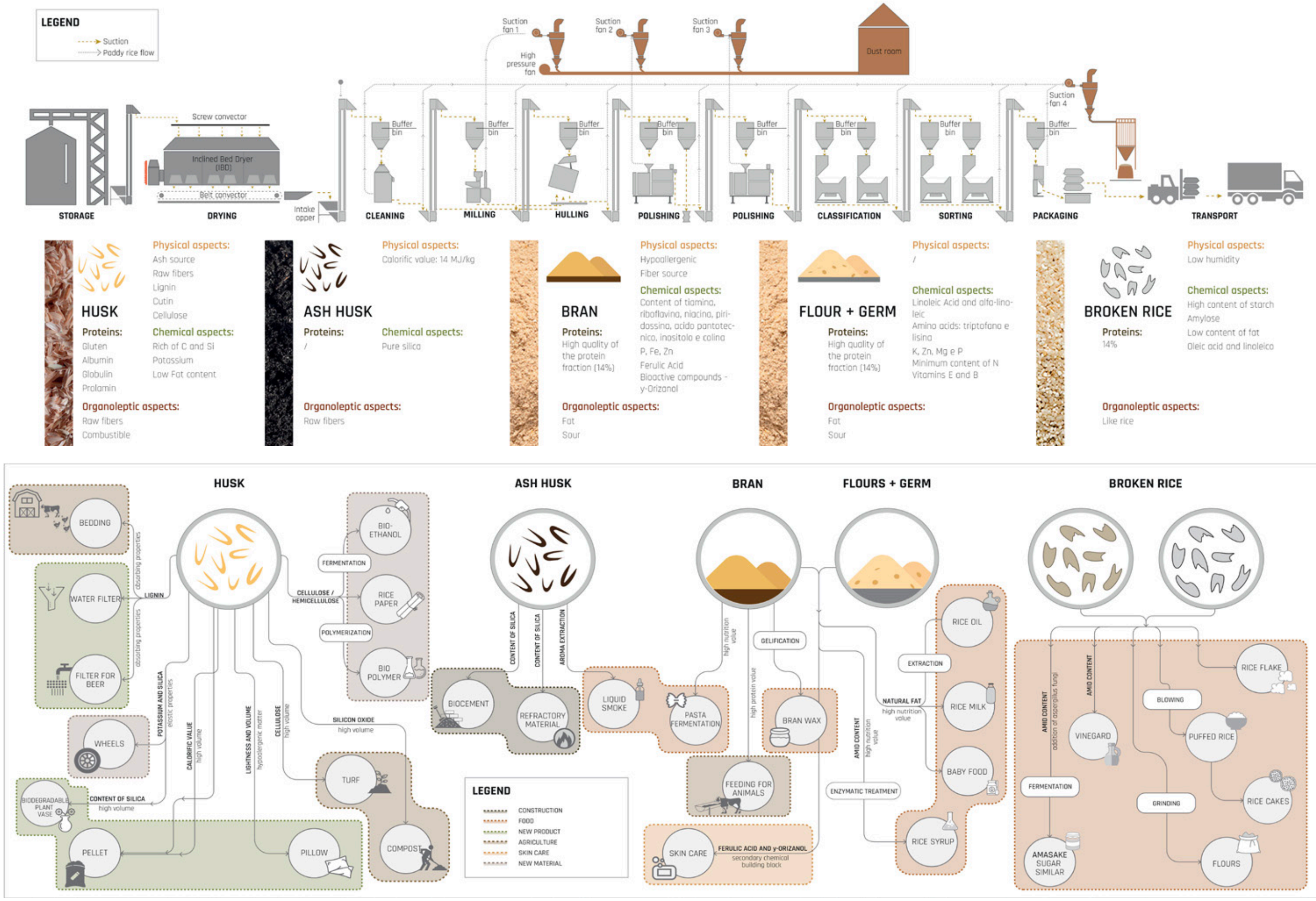


**Fig. 2** Supply chain and properties of each outputs.
Opportunities of each outputs

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