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Mapping disciplinary mobility for tackling complex problems

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Abstract: This working paper aims to explore the value of spatial metaphors and collective mapping as a conceptual and methodological framework to facilitate the understanding of cross-disciplinary interactions within heterogeneous working groups tackling complex problems. This kind of problems requires the formulation of systems-oriented approaches that are not always easy to communicate or assimilate while working with a team with mixed knowledge backgrounds and expertise, so there is an opportunity space to improve the way groups comprehend their problems' level of complexity and the nature of their own profiles, workflows and processes. Spatial metaphors and collective mapping can serve as a common ground for teams to represent those interactions. This paper presents the results of several workshop-led activities held with multidisciplinary teams utilizing a systems-oriented set of tools supported on visual thinking and spatial metaphors such as nationality, territory and mobility.

Keywords: *complex problems, cross-disciplinarity, knowmadism, systemic design, collective mapping*

1. Introduction

According to Midgley (2003), the way we understand problems cannot be separated from the way they are intervened and investigated. Complexity does not show explicit boundaries or divisions and its structure does not always match with the disciplinary approaches that we have crafted through the different levels of human knowledge. Therefore, since observers are also part of the system they are trying to frame, systemic intervention processes should be designed taking under consideration the nature and configuration of the actants that are looking to create changes within the system.

Mostly in academic and professional interventions, disciplines work as strategic points of departure where agency is self-regulated by the actants shared interests and the methods and processes that are better known for them, either individually or collectively. This kind of organization leads to the classification and distribution of tasks in a workflow, which implicitly defines the division of labor and the departmentalization of knowledge

However, our contemporary world keeps asking us to solve highly complex issues that cannot be addressed only by isolated specialists but require collective approaches that integrate diverse kinds of knowledge, such as systems thinking. The need for this kind of approaches is also a consequence of the increasing effects of information decentralization, the ambiguity on academic legitimization systems, the disciplinary flexibilization of expertise areas, and the lack of manageability of knowledge in terms of possession (Quaggiotto, 2008).

In order to understand the complexity of knowledge exchange processes that a team requires while addressing equally complex issues, this paper explores diverse possibilities to represent and communicate cross-disciplinary interactions among team members, specifically regarding to human beings with a formal disciplinary background and expertise.

2. Working groups and self-organization processes

Francis Heylighen (2013) considers that collaboration in human working groups depends on the degree of coordination achieved during self-organization processes, when individual agency and strategies are aligned to a range of collective objectives. When agency is not obstructed but complemented by each agent's action, the kind of collaboration is called synergy. Thus, coordination is "the structuring of actions in time and (social) space so as to minimize friction and maximize synergy between these actions" (Ibid., p. 123).

One of the main problems in self-organization processes of human working groups is the fact that individuals' interventions respond to a shared framework of paradigms, interests, specialized language, methods and ideologies that were historically built through disciplinary practices. Discordances between disciplinary practices and the group's collective objectives result into a lower coordination degree.

2.1. How coordination works

Heylighen describes four elemental mechanisms that ensure coordination within a group and constitute a complex branched network of mutually dependent processes [Figure 1]:

- **Alignment:** The orientation of multiple agents' actions towards a shared direction or objective in order to generate a low friction degree among agents and strategies. The loss of alignment can be a consequence of the agents' dispersion or segmentation over the working space.
- **Division of labor:** The development of different tasks according to the compatibility and complementarity of each agent's capabilities.
- **Workflow:** Coordination of activities that have place one after another in a sequence of actions. Its realization depends on the agents' availability and capacity (in terms of how diverse and reciprocal their capabilities are).
- **Aggregation:** Simultaneous collection of all the agents' contributions in order to synthesize them towards a coherent final product or outcome.
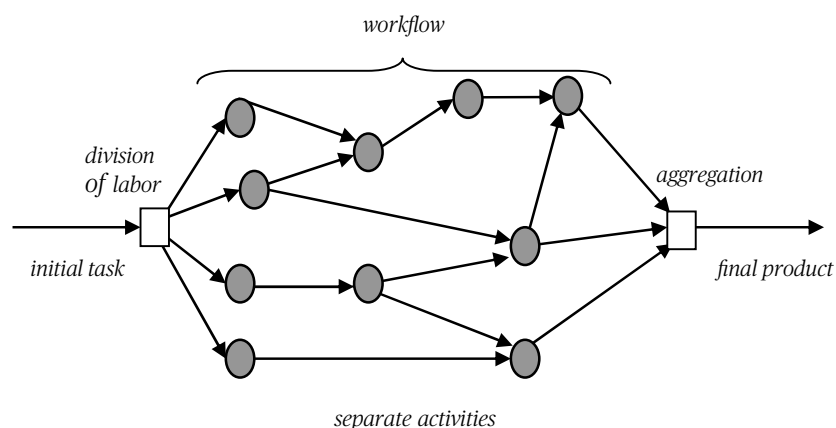

Figure 1. Coordination in which an initial task is split up in separate activities performed by different agents (division of labor), which are followed by other activities (workflow), and whose results are assembled into a final product (aggregation). Grey circles represent individual agents performing activities. Arrows represent the "flow" of work from one agent to the next. (Heylighen, 2013)

Heylighen points out that problem solving requires intelligence (either it is individual of collective, according to agents' distribution over the working space). Collective intelligence is only achieved by the integration of diverse agents with different forms of expertise (knowledge, information and skills) and it represents by itself a cognitive coordination problem that could be analyzed by evaluating Surowiecki's requirements for a group to exhibit collective intelligence (2005), which are:

- **Diversity:** In terms of the knowledge and expertise possessed by each agent.
- **Independence:** In order to avoid influence or premature alignment.
- **Decentralization:** Information gathering and processing in a parallel and collective way.
- **Aggregation:** Discussion mechanisms and collective decision-making processes.

2.2. Disciplinary orientation according to complexity

According to Heylighen's perspective on coordination, we could say that academic disciplines play a key role for collaborative processes as they set the ground for the division of labor and the decentralization of tasks through the segmentation of different activities. We can see results of this segmentation not only in academic production, but also in how knowledge has been traditionally managed in business around the world. However, it is well known from knowledge economy (Gibbons et al., 2010) that, even though the Mode 1 production of knowledge (monodisciplinarity) has brought highly specialized outcomes for industrial and social development, the Mode 2 (multi/inter/transdisciplinarity) is valued by its potential to resolve complex and uncertain problems, mostly due its need of enabling a more open, iterative and heterogenous process of knowledge production.

In an attempt to understand the sequence of actions performed by heterogenous working groups where there is a high influence from the agents' disciplinary backgrounds, cross-disciplinary interaction has been schematized in many different ways as a coordination process which interactions complexify according to the nature of the addressed issue [See Figure 2] and the number of involved agents (Carbone & Crowder, 2011; Godemann, 2008; González-Castillo, 2016; Mumuni, Kaliannan, & O'Reilly, 2016). However, this kind of theoretical approaches result highly complicated to comprehend or replicate for non-scientific practitioners, thus they fail as a hands-on framework for groups to evaluate or design their cross-disciplinary interactions.
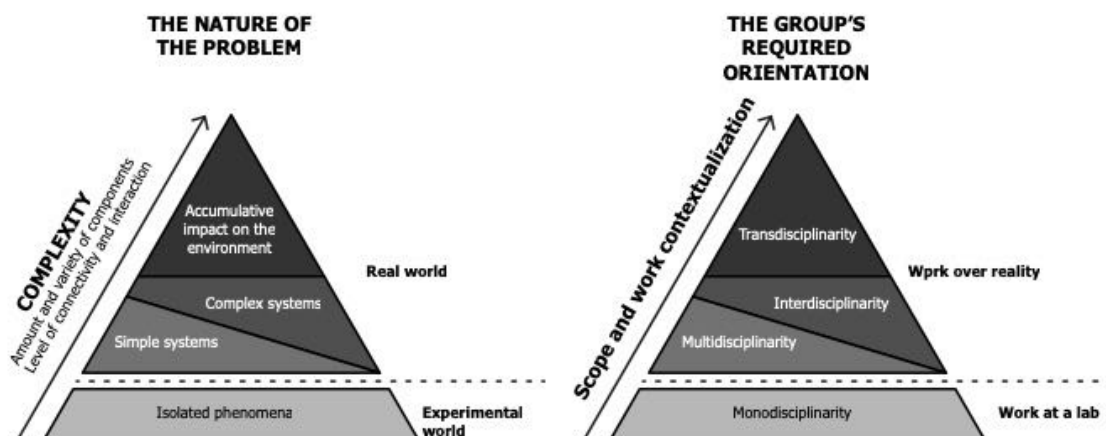

Figure 2. Adaptation of situations/problems and disciplinary orientations pyramids. (González-Castillo, 2015)

Since, as argued above, agents addressing complex issues are inherent parts of the systems they are working with, a systemic design approach might be useful to bridge the gap between problem framing and self-organizing processes such as team building and group coordination. This would mean helping teams understand themselves before (or while) understanding their problems. Joi Ito claims "we need a paradigm shift that allow us to understand, design and deploy interventions in complex systems, (a paradigm that requires) a post-disciplinary approach; a new "participant design" process in which the participants in the system are the designers" (2018, p. 31).

3. Disciplinary mobility

With a constructivist point of view over knowledge, Oliva-Figueroa, Koch-Ewertz, and Quintero-Tapia (2014) offer an interesting approach to understand migratory processes among diverse disciplinary areas within the academic realm. In this context, the usage of the term "disciplinary mobility" was planned to serve as an evaluation metric to measure quantitative regularities referring to processes of displacement and disciplinary interactivity among students of different careers according to the totality of undergraduate and graduate students of academic institutions. Even though they do not deepen into the conceptual construction of this term, it still serves as a rich concept to link with other conceptualizations such as "knowmads"[1], an term inspired by Peter Drucker's concept of "knowledge workers" and coined by John Moravec to refer to an emerging class of borderless workers who apply what they know into new contexts to create value within different organizational and social configurations, regardless their former disciplinary backgrounds (Moravec, 2013; Moravec & van den Hoff, 2015).

There seems to be a tendency to utilize concepts such as "mobility" or "nomadism" as a metaphorical way to represent contemporary dynamics of interactivity in terms of identity, consumption and production of information (Gaggiotti, et al. 2015) —which actually makes sense, considering the possible meanings that those concepts would imply if looked by a systemic point of view—. Metaphor is an essential linguistic resource to understand and represent a concept in terms of another (Lakoff & Johnson, 2008) and has been constantly used as a cognitive tool to explain how humans experience the world, translating complex phenomena to "a much more human scale" (Fauconnier & Turner, 2008) in order to enable a higher sense of understanding of a situation.

Following the metaphor of "disciplinary mobility" as the possibility of moving across different fields of knowledge, I would like to propose an extent to the concept so it can be understood as the capacity of agents to flow across institutionalized systems of knowledge, oriented by their interests of agency, and regulated by diverse exchange dynamics that enable their organization and linkage with other agents through the consumption, production, and application of knowledge.

This metaphor made even more sense for me while reading Neri Oxman's "Age of Entanglement" (2016), where she states the following:

> "But how can we become constant travelers within a border-free, and lingo-legible 'intellectual Pangea?' How can we traverse a cerebral supercontinent, where the analog of world citizenship governs our identity as thinking—and creating—beings? How can we navigate an atlas that is charted not for four hats, but for one pair of shoes, and with which we can—including some luck and a quantum leap-of-faith—inhabit multiple places at once? Can a scientist invent better solutions than an engineer? Is an artist's mindset really all that different from a scientist's? Are they simply two ways of operating in the world that are

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[1] Also described by the author as a combination of "knowledge nomad" and "mad for knowledge".

complementary and intertwined? Or, when practicing art, is perhaps what truly counts less the art form and more one's (way of) being? Ultimately: is there a way to understand the culture of making which transcends a two-dimensional Euclidean geometry—four plots to match four hats—to a more holistic, integrative and globe-like approach?"

In the same article, Oxman presents the "Krebs Cycle of Creativity (KCC)" [Figure 3], based on Rich Gold's four hats of creativity matrix (2007) [Figure 4]. This diagram works as a framework to identify the flows of human creativity across four disciplinary dimensions (Art, Science, Design and Engineering). As a speculative map, the KCC is intentionally abstract and can be understood as a clock, a microscope, a compass and a gyroscope.
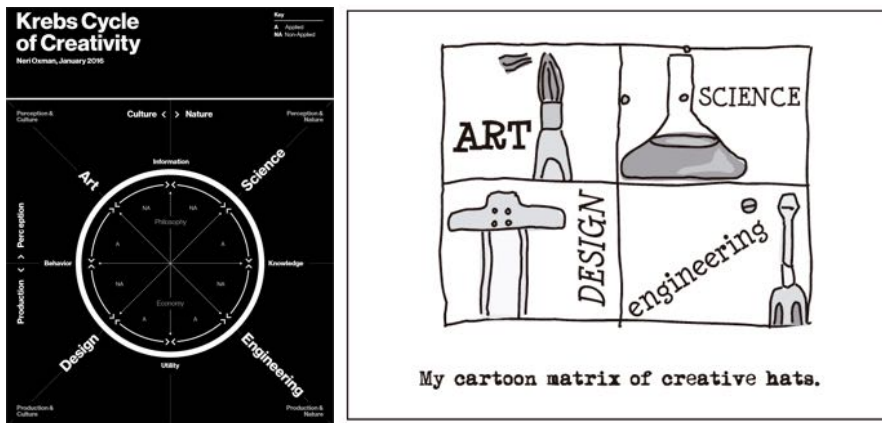

Figure 3 (left). Krebs Cycle of Creativity (Oxman, 2016)
Figure 4 (right). Four hats of creativity matrix (Gold, 2007)

Based on the above, as part of a thesis dissertation for the undergraduate program of Graphic Communication Design at Universidad Autónoma Metropolitana (UAM) in Mexico, a team of product and graphic designers were challenged in 2017 to develop innovative theoretical and methodological approaches that enabled "disciplinary mobility" for working groups using systemic design as foundation, since it was a possibility space (Sevaldson, 2017) to create intersections between systems thinking and practice (regarding self-organization processes for working groups and complex problems framing), design thinking (as a mode of reflection and process implementation) and design practice (as a preferred outcome supported by visual thinking and communication design).

4. The Knowmap Workshop

The main outcome of this research-through-design project was the experience design and facilitation of several workshops under the name of "Knowmap[2]". The workshops gathered a diverse range of participants from different disciplines that organized themselves in teams in order to use a set of

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[2] Clearly inspired by the term "knowmad" but referring in this case to the act of mapping knowledge interactions as the workshop's main activity.

tools and techniques particularly designed to reflect on how disciplines shape the way we approach to complex problems and how we interact with other agents while working in a group. The workshop helped participants making those interactions explicit through visual thinking and interactive dynamics that used spatial metaphors to understand the journey of collaboration (e.g. their disciplinary profiles were depicted as nationalities and knowledge areas as territories of action). Both tools and techniques were inspired by diverse strategic and systemic design methods that such as management and planning applications of Gigamaps (Sevaldson, 2018) and multiplans approaches on collective mapping (Ares & Risler, 2016). These techniques were oriented to identify Heylighen's mechanisms of coordination within each team (alignment, division of labor, workflow and aggregation) utilizing Oxman's KCC as a framework (disciplinary dimensions and flows) and Moravec's concept of "knowmadism" to describe each participant's disciplinary mobility (e.g. we framed their disciplinary specialization and willingness to collaborate referring to them as a traveler's profile; i.e. a local, a tourist or a knowmad). The usage of the migration metaphor helped participants understand the flexibility of their knowledge and expertise and how it was perceived by others in terms of identity and practice.

4.1. Disciplinary interaction as rite of passage

In previous research (Marines, 2015a, 2015b), cross-disciplinary interaction was proposed to be understood as a rite of passage (van Gennep, 1909) that represented the changes of an individual's way of being/working through the experimentation and collaboration with other academic and professional disciplines (from monodisciplinarity to inter/multi/transdisciplinarity). Rites of passage where used as a way to understand these processes since they served as a micro-sociological approach to study small groups and were also compatible with several soft systems approaches. As van Gennep's rites of passage, the Knowmap Workshop was facilitated through three separated stages: Separation, Margin and Aggregation. Each stage provided theoretical and practical approaches to systems thinking and disciplinary collaboration to enable the full understanding of each tool and technique.

Figure 5. Tools designed for the three different stages of the "Knowmap Workshop" (from left to right: Separation - Disciplinary passport, Margin - Disciplinary canvas, and Aggregation - KnowMAP canvas)

4.1.1. Separation (Disciplinary Passport)

The workshop begins with an ice-breaker activity inspired on the moment when a migrant arrives to a new country and interacts with an immigration officer. This activity introduces participants to the metaphor of a voyage that is constantly reinforced during the workshop in order to enable the conversation about how disciplinary specialization shapes our identity and the way we think, understand and respond to our complex world.

4.1.2. Margin (Disciplinary Canvas)

This phase is designed to help participants to move forward from a monodisciplinary to a cross-disciplinary way of thinking and understanding of their problems.

The activity starts with filling a "Disciplinary canvas", a tool created to develop hypotheses around a random complex problem that is built collaboratively, in order to enable a horizontal conversation about the participants' thoughts and perspectives about different problematic scenarios.

4.1.3. Aggregation (KnowMAP Canvas)

During this very last phase, the workshop participants build a self-organized team to map their own-crafted complex problem through the usage of the KnowMAP Canvas (a mapping tool based on the layers of Neri Oxman's KCC.

At the end of this activity, teams develop their own version of a KnowMAP journey, a Gigamap variant that helps visualizing their interactions with spatial metaphors, identifying buildings (disciplines), paths (workflows), roadblocks (conflicts) and vehicles (time-based strategies).
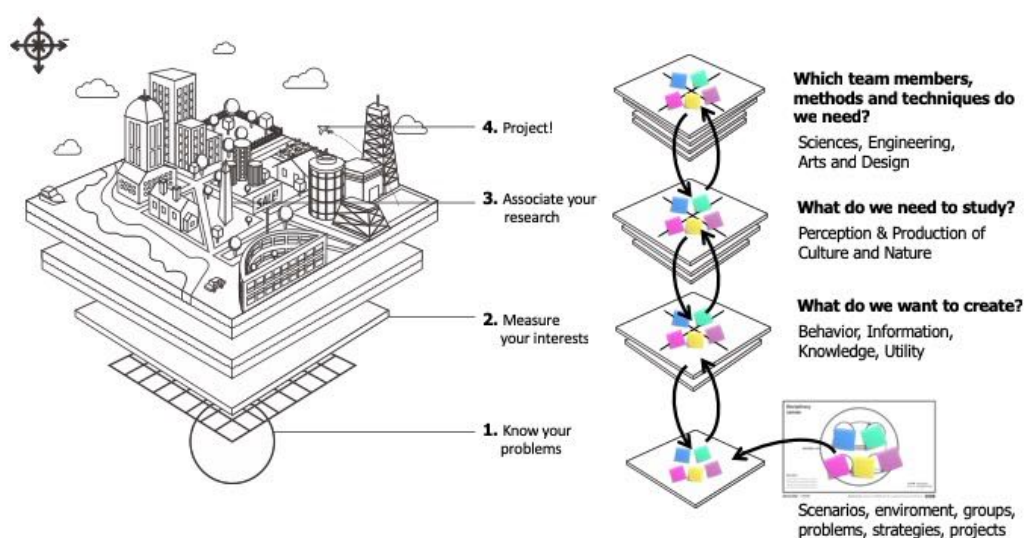

Figure 6. Visualization of the Knowmap Canvas techcnique, during the last workshop stage when all the tools are integrated into a single Gigamap.

5. Learnings and next steps

5.1. Foucault's disciplinary power

It is relevant to acknowledge that another theoretical inspiration for the workshop design was Michel Foucault's philosophical understanding of disciplines. Bolaños (2010) argues that many philosophers of science ignore the fact that the concept of scientific discipline is not a epistemological or political neutral term, highlighting Foucault's approach to the term "discipline" that was framed as a discursive form of knowledge production and regulation, but also as a set of techniques to achieve individuals standardization and control over their behavior (Foucault, 1990). Foucault argued that "disciplinary power" aimed to distribute and organize individual forces in order to increase their economic strength at the same time as their political force was reduced.

Foucault utilized several spatial metaphors to represent this kind of domination over individual behavior, such as field, position, region, and territory. He strongly believed that spatial metaphors served to explain the dynamics of disciplinary power and made explicit the relations between power and knowledge. This is why strategic thinking (highly related to war and military strategy) is usually communicated through spatial metaphors, since they are a hint of a combative thinking that uses geographic vocabulary in order to represent the use of knowledge as a political element.

Exploring the relations between the concepts of space, knowledge and power as understood by Michel Foucault, helped participants to reflect on the way academic disciplines have been historically and culturally constructed, in the same way that the idea of nations was created to regulate individuals with the distribution and classification of space and identity. This happens as well with human knowledge and the way institutions created frontiers to separate and reproduce modes of knowledge production. This phenomenon has direct impact in the way human agents assimilate these modes as a way of being and doing.

5.2. Visualizing complex disciplinary interactions

This exploratory research on systemic design and disciplinary interaction served to test the value of utilizing spatial metaphors as a shared vocabulary while mapping complex relations between disciplines and agents. Workshop results proved that visual and systems thinking tools can facilitate the understanding of those interactions through a rhetoric process that visualizes strategic flows, interests, barriers and leverage points. There was also good feedback regarding how the workshop includes the observer (individual and collective) as a part of the system and starts mapping their profiles before mapping the problems.

From Plato's allegory of the cave to Foucault's disciplinary space and Oxman's KCC, humans have made use of diverse spatial metaphors to refer to knowledge perception, construction and appropriation. This subject seems to be relevant for future reflections on how the concept of space serves as a linguistic vehicle to facilitate systems-oriented approaches.

5.3. Future applications

The set of tools and techniques developed for the Knowmap Workshop will be constantly iterated and improved during future sessions. However, they can already serve as a reference for systemic design practitioners. The workshop contents still require to be tested in more practical applications in order to create evaluation metrics and turn them into an integrated toolkit.

In recent sessions, the workshop techniques have been replicated for several projects related to organizational innovation and team building. The tools have been perceived as useful for teams that aim to diagnose and improve their collaborative processes and knowledge exchange. "Disciplinary mobility" extended concept also made sense for participants as a way to describe their professional and academic future orientations. The concept will be explored to discover other applications for career design and professional evaluation for human productivity.

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