Titre : Participatory design tools and systemic methods for multimodal air-rail systems

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Summary

This thesis offers research into multidisciplinary design methods based on the issue of mobility and respect for planetary limits. In terms of methods, we propose to explore a new combination of 1) participatory design methods, to contextualize design, and 2) systemic design methods, to take into account the complexity of the problems to be addressed. We propose that this exploration take shape around an important case study for sustainable mobility, that of multimodal transport, with a particular focus on air and rail transport for medium- and long-distance travel. This case study is particularly relevant to the subject of this thesis (participative systemic design), as it involves taking a passenger-centric problem and considering the problem of multimodal mobility in a multidimensional way. The aim of this thesis is thus to develop an innovative approach to multimodal transport that is both systemic and participatory.

Scientific Objectives scientifiques, state of the art.

The starting point for this research project, which aims to design tools and methods for both systemic and participatory design, is to be found in work in progress at the three laboratories concerned. The subject of the thesis proposes a novel combination of two classes of design methods: systemic design, the basis of Laetitia Bornes' thesis work at ENAC and ISAE-SUPAERO [4, 5], and participatory design, the subject of scientific publications at ENAC [18, 19, 20], ISAE-SUPAERO [6] and UTT [1].

L. Bornes' thesis extends the methods of systems design, originally intended for organizational designers, to the design of interactive systems. Systems design is a new field of interdisciplinary research that combines complex thinking (system thinking and critical systems thinking [14]) with design thinking [7]. It develops methods and tools for tackling complex, multi-scale problems at social and socio-technical levels [27]. Today, it is increasingly recognized that the design of IT tools requires systems thinking [10, 24]. Indeed, if we want to go beyond the direct carbon impact of the technical resources mobilized, it is necessary to determine and anticipate possible indirect effects, such as rebound effects or structural effects, which need to be understood by integrating several scales: temporal, spatial, organizational or social. This consideration, which must be taken into account from the earliest stages of system design, is in our view all the more important for tools used by air transport users and stakeholders, as they potentially impact the activity itself. The field of systems design [15, 29] is particularly relevant to answering these questions. While systemic designers are mainly interested in the levels of organizations and social systems, the approach initiated at ENAC and ISAE-SUPAERO with Laetitia Bornes' thesis proposes to adapt systemic design to the design of interactive systems with tools accessible to designers. A modeling tool has been developed to identify leverage variables and propose alternative design options [5].

However, the tool and approach proposed in L. Bornes' thesis are not applicable to participatory design activities with end-users. Participatory design is an approach whose principle is to integrate end-users in all phases of a design process, from field surveys to tool

evaluation, including ideation and prototyping. This collaborative, multi-disciplinary approach enables systems design work to be better contextualized [3]: its aim is to reduce design errors, accelerate convergence towards relevant solutions, and integrate optimizations arising from the concrete use of tools [19, 26, 2], thus enabling the development of systems that better meet needs [6]. It was born some thirty years ago [26], and has developed extensively in the fields of HMI, organizations and systems of systems. It is currently taught in some engineering programs [11] or international HMI masters programs [21], and is the subject of publications in numerous conferences (notably the PDC Participatory Design Conference, see for example [19]). This approach is applied at ENAC to numerous HMI research projects, as well as to student projects in the HMI master's program co-organized with IRIT.

But participatory design does not, as a rule, include the systemic dimension (exceptions can be found cf. [6]). Extending the methods and tools proposed in Laetitia Bornes' thesis to the participatory approach requires methodological work, as well as the design and development of tools. The direction proposed for this new thesis, in order to make systemic dimensions perceptible to the user during a workshop, is to design a methodology and tools to integrate consideration of indirect effects with potential users of mobility tools. In terms of methods, various means exist to enable participants to project into the future, based in particular on design fictions [23, 8] but also on systematic innovation methods such as C-K [13], which shares the same choices of iterative and collaborative design processes as participatory design. Regarding tools, particularly for systemic prototyping to be deployed in participatory workshops (see Burnell 2018 [8] or Brazier et al. 2018 [6] for a primer on this approach), our proposal is to explore low-fidelity simulations as well as immersive techniques [28], such as projection techniques enabling user immersion within multi-scale visualizations (see Simeone et al [28] for an example of the use of this type of technique but without the participatory dimension).

Case study.

Many studies have been carried out on multimodal transport with a view to sustainability [9, 22]. However, although this is a multi-dimensional problem, most of its dimensions are treated separately [22]. We are thinking, for example, of research dimensions such as: passenger behavior analysis (e.g. [16, 17]), multimodal operations design (e.g. [9]), economic analyses of transport company offers (e.g. [30]), multimodal infrastructure design (e.g. [22, 25]), multimodal vehicle design (e.g. [12]).

What the subject brings to the use case is a dual approach:
1) a passenger-centric approach, including but not limited to technology, and explicitly based on travel needs, which the participatory methodology will help to better define, and
2) a systemic approach, which, by integrating the different dimensions, will enable potential users and designers to better integrate the complexity of the design space.
The case study will thus provide an opportunity to prototype tools for multimodality, based on a better-dimensioned analysis.

Expected contributions.

The thesis will provide the following deliverables:
1) for transport multimodality:
- a systemic analysis focusing on multimodal needs and issues
- design principles for multimodal systems
- prototype tools for multimodal users and stakeholders
2) for systemic participatory design :

- a global methodology describing the activities, methods and tools to be implemented in a participatory systemic design process
- prototype design tools adapted to support the participatory workshops associated with this methodology

Provisional working schedule

Year 1:
- state of the art :
    - o methodological: participatory design, systemic design
    - o technical: mixed reality tools
    - o case study: multimodal transportation
- field surveys on practices with a systemic effect
    - o collaborative workshops on systemic analysis of situations (cf SDT: systemic design toolkit)
    - o start of workshops focused on the case study
    - o study of the need for projection elements based on the analyses carried out previously, and initial ideation workshops on projection elements.

Year 2:
- design and finalization of case studies
- publication of surveys and case studies with implications for the design of projection elements
- participatory design of mixed-reality projection elements
- development of these tools
- use in participatory prototyping workshops on case studies

Year 3:
- evaluation and reiteration of the design, development of a global methodology
- publication of tools
- proposal of a toolkit for systemic participatory prototyping
- dissertation writing

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Formation et spécificités souhaitées

Designer/Ingénieur avec des connaissances et expériences en design Systémique. Connaissance en développement informatique avec souhait de découvrir de nouveaux langages.