UNCERTAINTY IN URBAN SYSTEM DESIGN

A scenario-based method applied to mobility in Paris and Cairo

Anthropolis Chair Seminar | 11 January 2023

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AGENDA

01 **Introduction**

02 **Urban system scenarios**

03 **Future urbanites**

04 **Discussion + conclusion**

05 **References + publications**

START   SOURCES   ANNEX

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01 Introduction

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GREATER PARIS

GREATER CAIRO

Supervisors

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Thesis Supervisor
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Hosts

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AUC

Mohamed Hegazy
TfC

Abdelrahman Melegy
TfC

Funding

START   SOURCES   ANNEX

WHY URBAN MOBILITY (UM)?

Mostly urbanised planet

Key emission contributor

Arteries of urban life

HOW CAN WE IMPACT UM?

Urban & spatial planning

Behavioural changes

Product/service design

WHAT IS SUSTAINABLE UM?

Low- to net-zero emissions

Distributed accessibility

Enabling efficient mobility

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HUMAN CENTERED MOBILITY CentraleSupélec

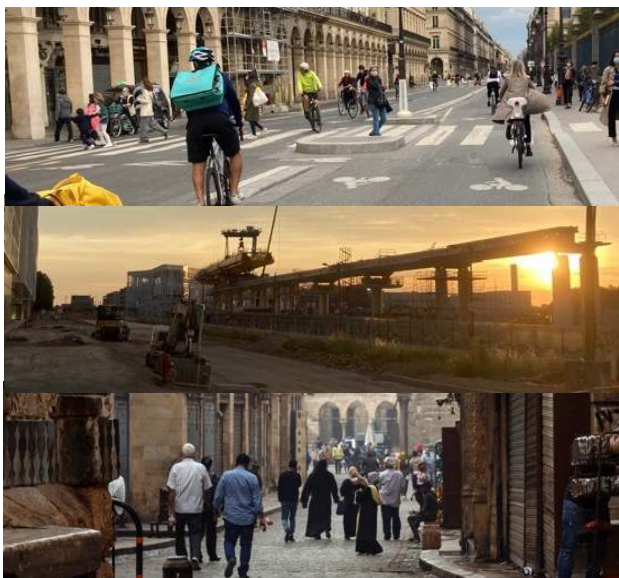## ENVIRONMENT

SOCIO-SPATIAL JUSTICE

ECONOMY

OVERALL OBJECTIVE

UN Sustainable Development Goal 11.2: By 2030, provide access to **safe**, **affordable**, **accessible** and **sustainable** transport systems **for all**, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, **women, children, persons with disabilities and older persons** (UN, 2015)
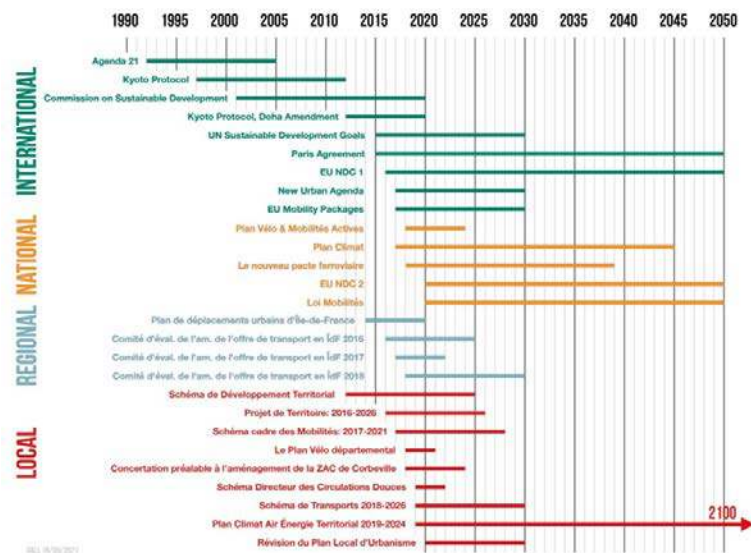
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LOCAL DIVERSITY

Various local contexts
(climate, culture, practices) with
diverse **needs + conditions**

FUTURE UNCERTAINTY

Long-term processes
(idea-to-market or lifetime) with
unexpected developments

RESOURCE-CONSTRAINTS

Complex system design require
extensive data. Foresight
require a lot of **time + money.**

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To design is to devise courses of action aimed at **changing existing situations** into **preferred ones.**

— Herbert Simon

To do that, we need...

...a) an understanding of the current and preferred state

> Model of current and future system

...b) a way to design the link between the two (or more) states

> Method for designing system

RESEARCH GAPS

GAP A | Local urban mobility futures have not been modelled in a way that allows a systemic and holistic perspective on their transitions towards alternative states.

GAP B | There is a lack of methods to work with diverse future urbanites across qualitative and quantitative design methods in urban system design.

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To do that, we need...

...a) an understanding of the current and preferred state

> Model of current and future system

...b) a way to design the link between the two (or more) states

> Method for designing system

RESEARCH QUESTIONS

How can we support design processes of people-centred, place-based urban mobility solutions in contexts of uncertainty?

QUESTION A | How can we model local urban mobility futures in a systemic and holistic manner to permit designing transitions towards alternative states?

QUESTION B | How can we work with diverse future urbanites across qualitative and quantitative design methods in urban system design?
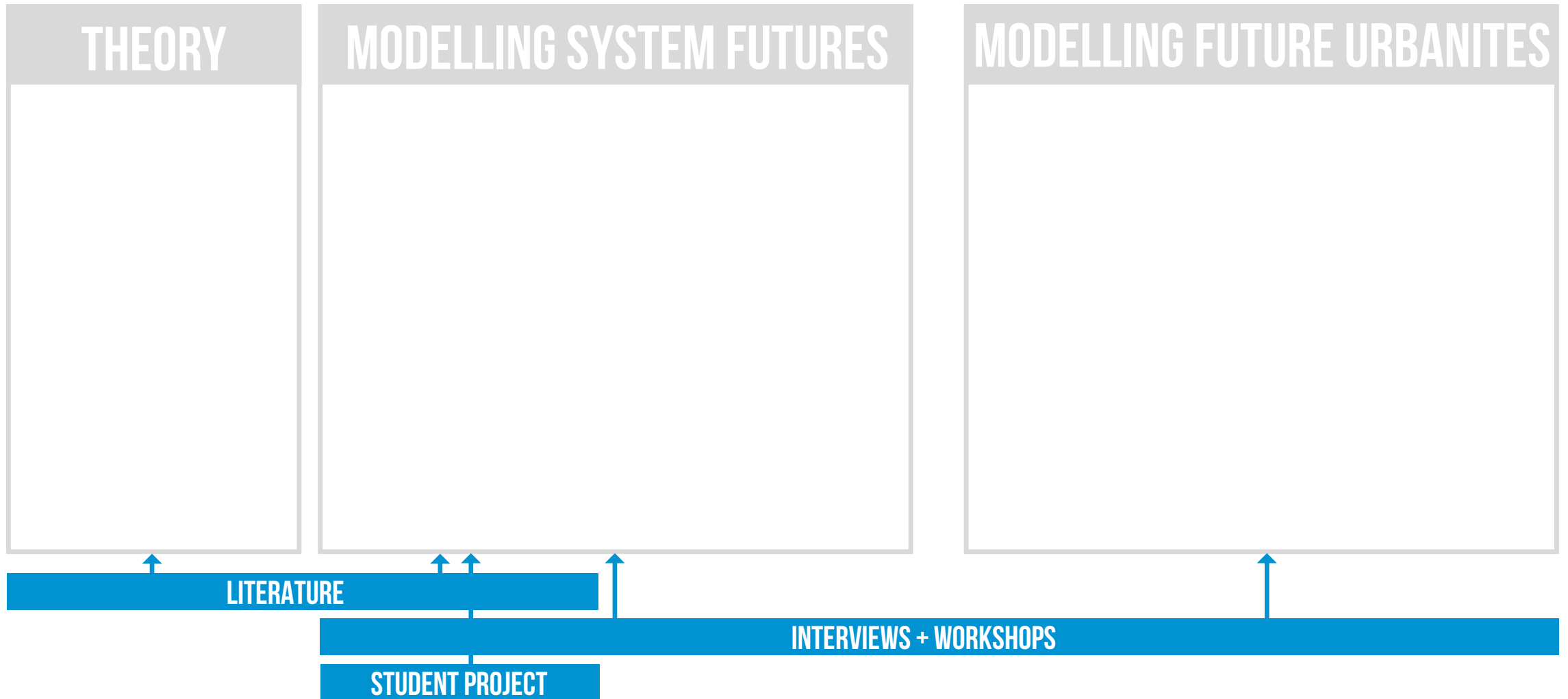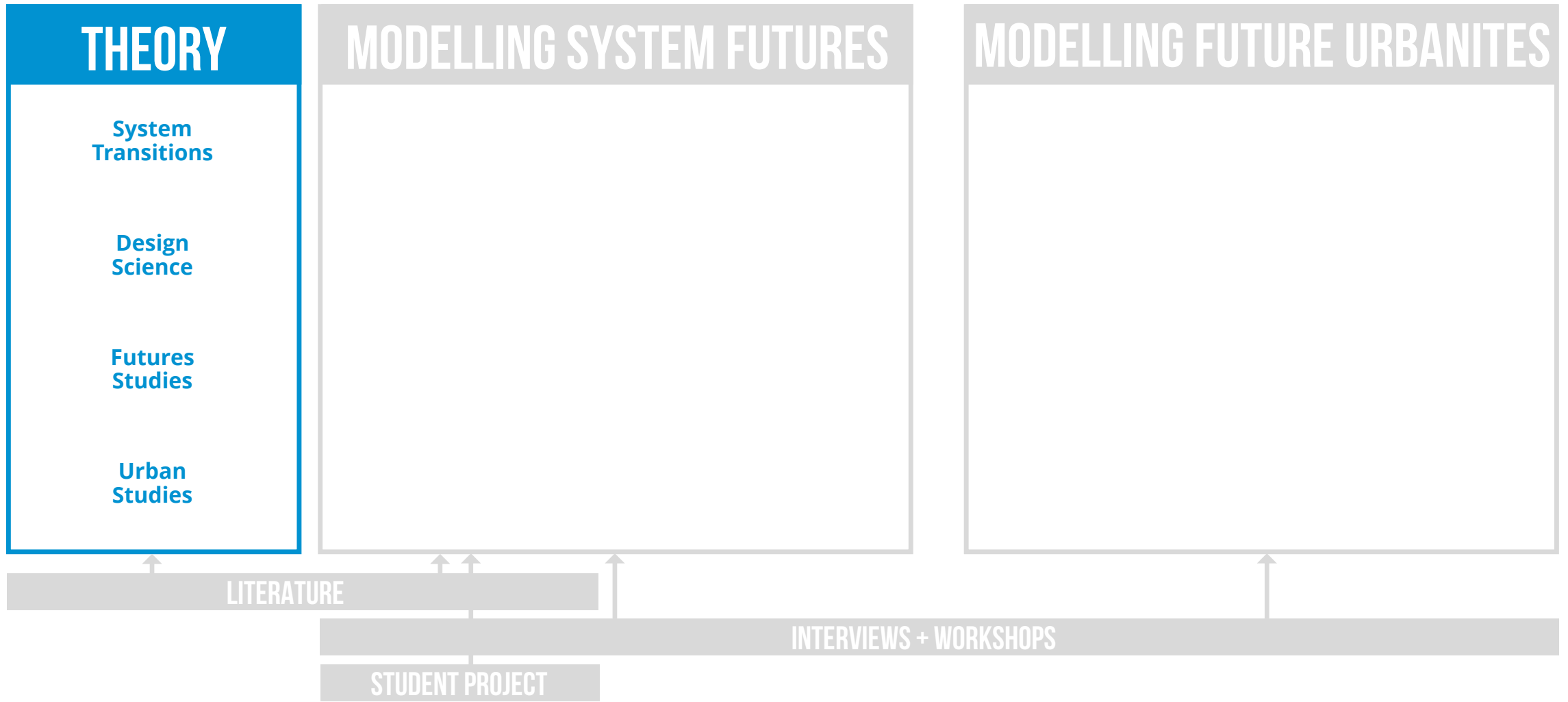
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THEORY

MODELLING SYSTEM FUTURES

MODELLING FUTURE URBANITES

START   SOURCES   ANNEX

THEORY

MODELLING SYSTEM FUTURES

MODELLING FUTURE URBANITES

LITERATURE

INTERVIEWS + WORKSHOPS

STUDENT PROJECT

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THEORY	MODELLING SYSTEM FUTURES	MODELLING FUTURE URBANITES
System Transitions **Design Science** **Futures Studies** **Urban Studies**		

LITERATURE

INTERVIEWS + WORKSHOPS

STUDENT PROJECT

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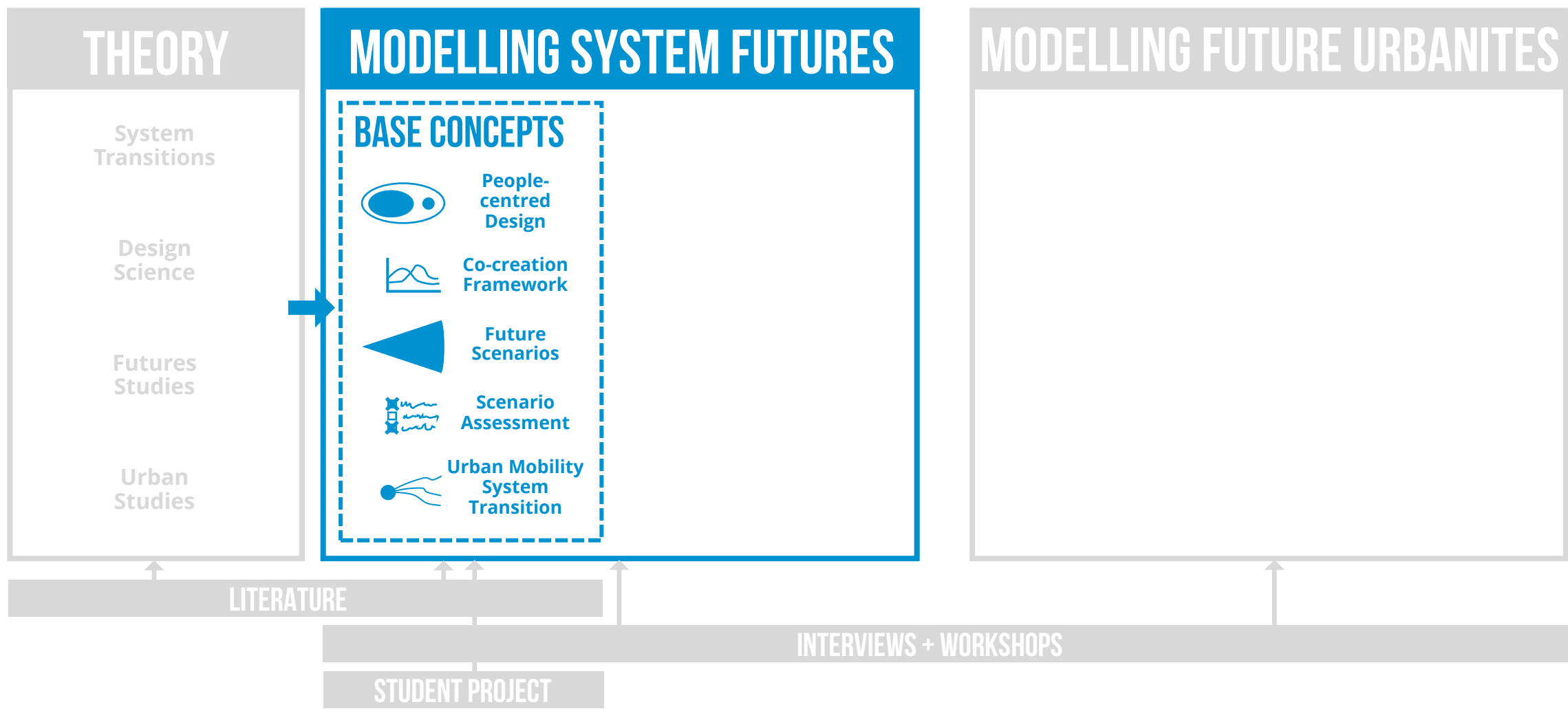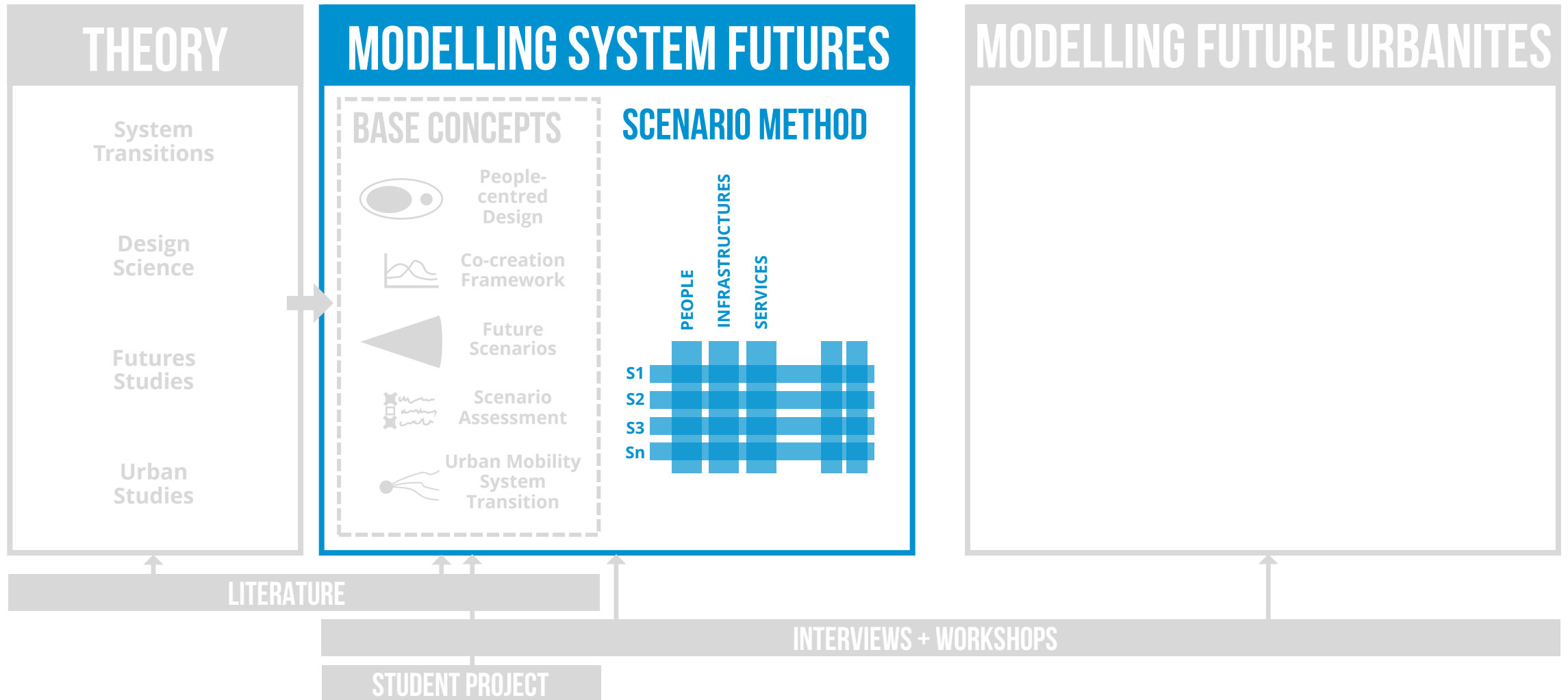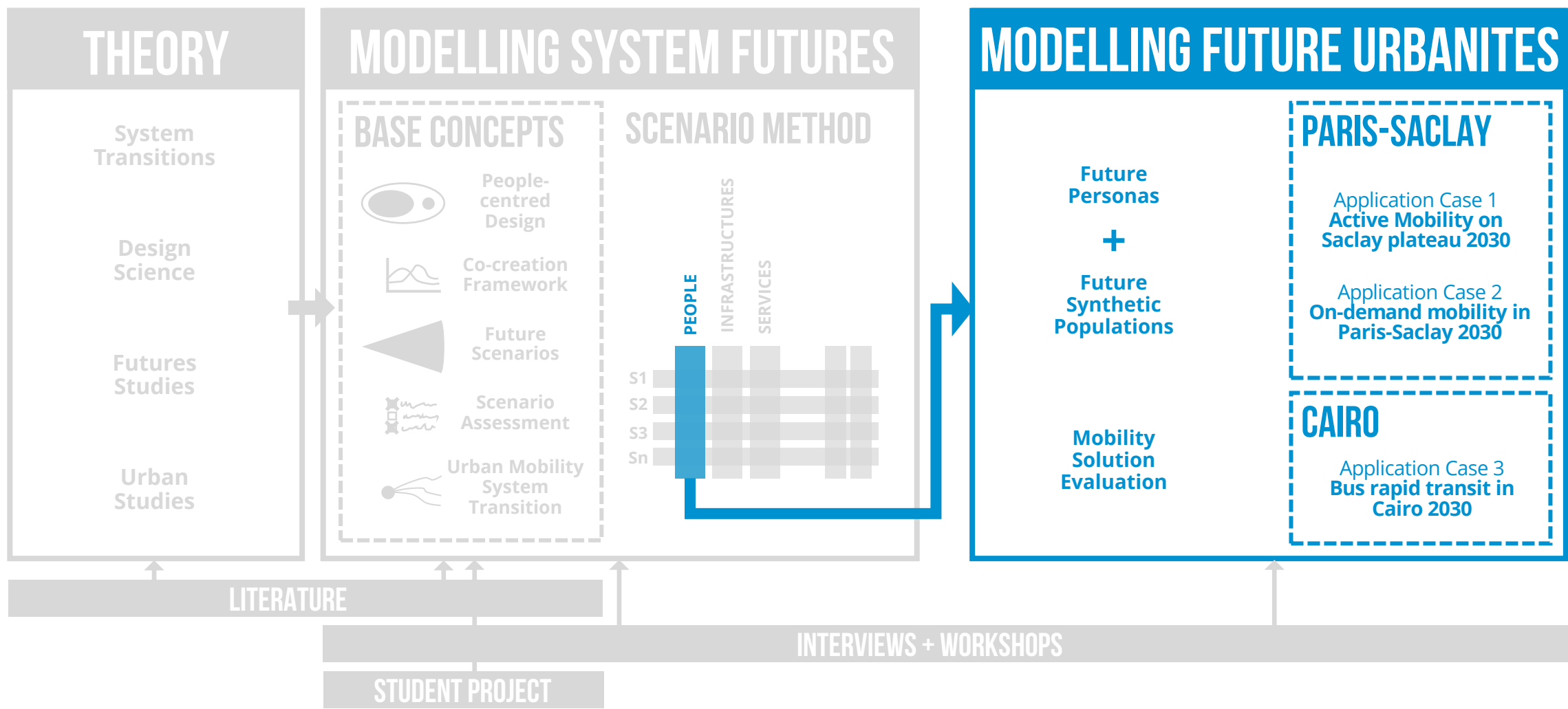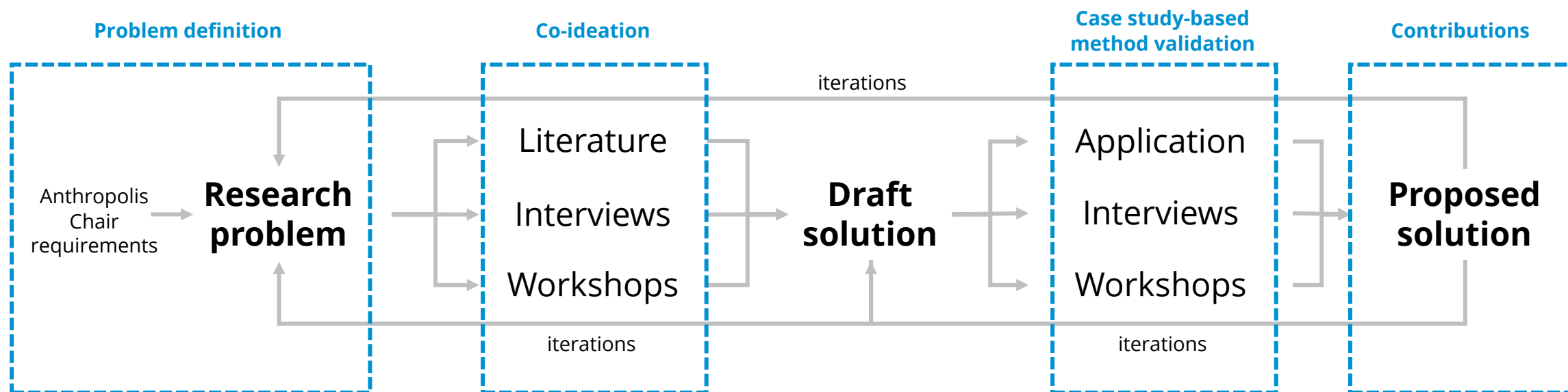
A **problem-based** mixed-method and case study-based **action research** at the interface of different fields, notably complex system engineering, design science, and future studies.

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Spring 2021
Partner expectations interviews
Online/France

December 2021
Assessing future scenarios
Paris-Saclay, France

Spring 2022
Urban mobility expert interviews
France/Europe

Autumn 2022
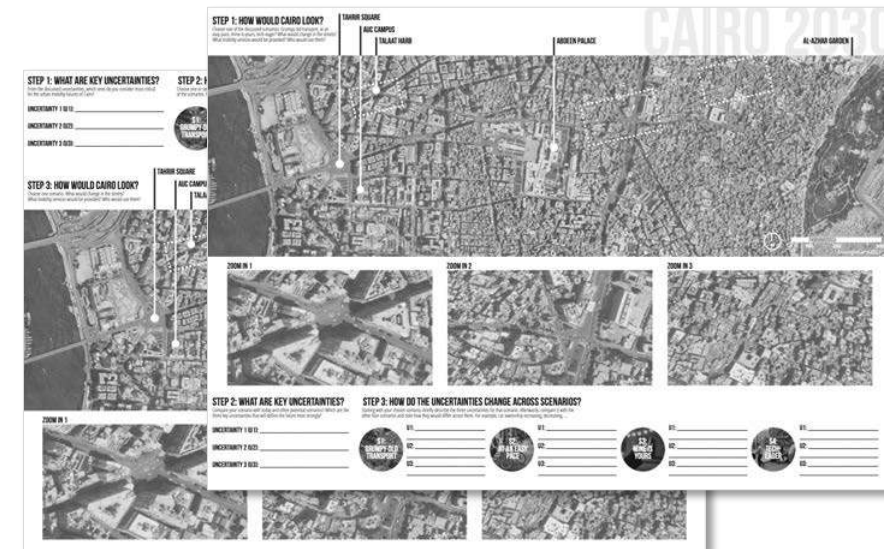**Local mobility expert interviews**
Cairo, Egypt

May 2021
Explorative future mobility situations
Online/France

November 2021
Spatialising urban mobility futures
Doha, Qatar

March 2022
Urban mobility scenarios of CPS
Paris-Saclay, France

May 2022
Enabling urban transitions
Paris-Saclay, France

Autumn 2022
Localising urban mobility futures
Cairo, Egypt

Workshop at American University in Cairo, 25 Nov. '22

A/B tests of order: Uncertainties <> Scenarios <> Localisation

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02 Urban System Scenarios

How can we model urban mobility system futures in a systemic and holistic manner to permit designing transitions towards alternative future states?

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People-centred Design

Co-creation Framework

Future Scenarios

Scenario Assessment

Urban Mobility System Transition

forward flow of time

PAST | PRESENT

FUTURE(S)

Gall, T., Vallet, F., Yannou, B. (2022) How to visualise Futures Studies Concepts: A Revision of the Futures Cone. Futures, 2022. https://doi.org/10.1016/j.futures.2022.103024
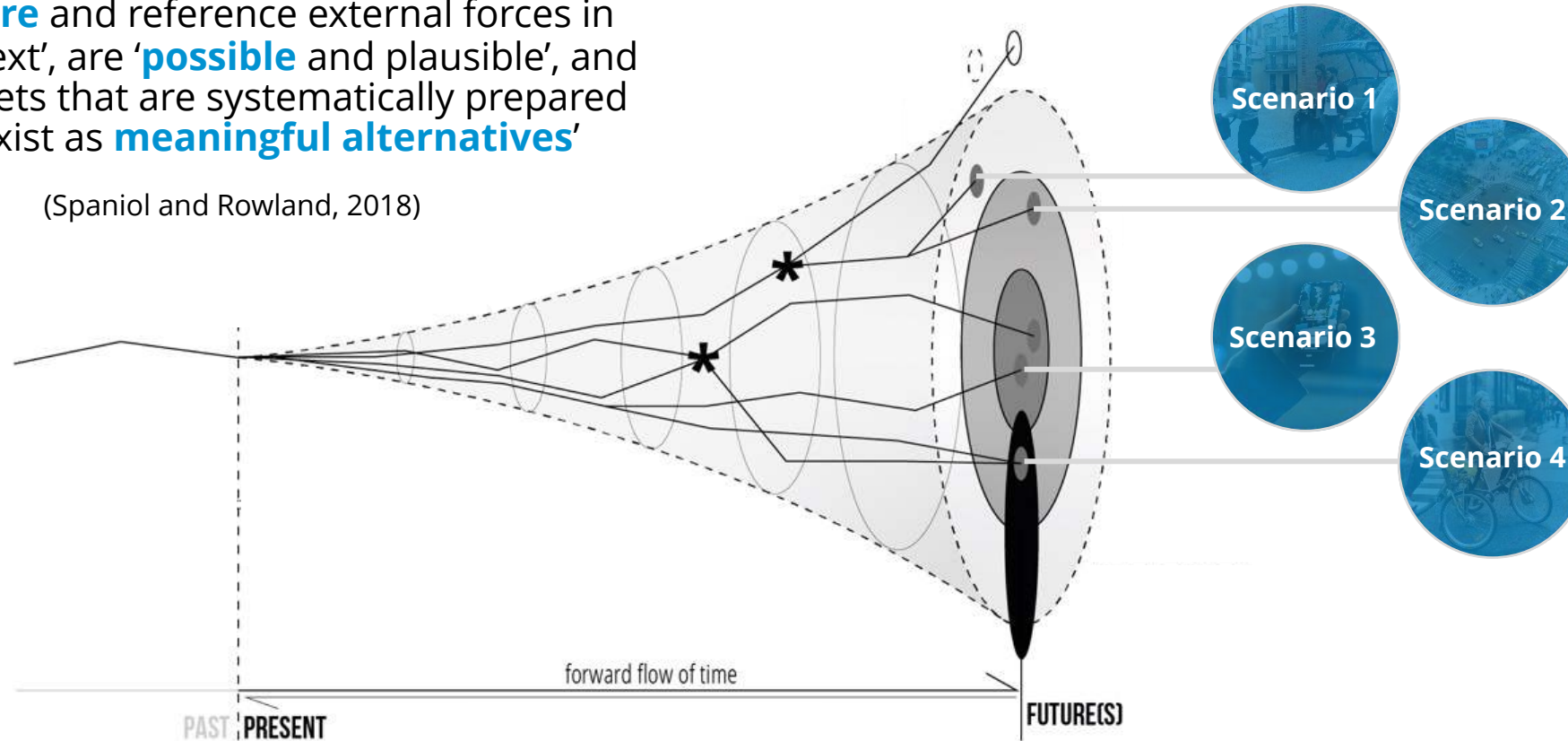**Gall, T.** (2021) Working with multiple Scenarios: Revising the Futures Cone. Conference paper, AESOP YA Conference 2021 in Tirana, Albania, March 2021.
Gall, T. and Allam, Z. (2022) Strategic foresight and futures thinking in urban development: Framing planning perspectives and decolonising urban futures, p. 10-19. In: Peric, A., Permezel, M., Stott, M., and Woo, A. Future Cities Series: Practical planning guidance for innovative, resilient and inclusive cities of the future: Discussion paper 1. Nairobi/The Hague: UN-Habitat and ISOCARP.

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Co-creation Framework

Future Scenarios

Scenario Assessment

Urban Mobility System Transition

Scenarios have '**temporal property** rooted in the **future** and reference external forces in that context', are '**possible** and plausible', and 'exist in sets that are systematically prepared to coexist as **meaningful alternatives**'

(Spaniol and Rowland, 2018)

Scenario 1

Scenario 2

Scenario 3

Scenario 4

forward flow of time

PAST | PRESENT   FUTURE(S)

Gall, T., Vallet, F., Yannou, B. (2022) How to visualise Futures Studies Concepts: A Revision of the Futures Cone. Futures, 2022. https://doi.org/10.1016/j.futures.2022.103024
Gall, T. (2021) Working with multiple Scenarios: Revising the Futures Cone. Conference paper, AESOP YA Conference 2021 in Tirana, Albania, March 2021.
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Urban Mobility System Transition

What shapes transitions pathways?

> Trends

> Uncertainties

Gall, T., Vallet, F., Yannou, B. (2022) How to visualise Futures Studies Concepts: A Revision of the Futures Cone. Futures, 2022. https://doi.org/10.1016/j.futures.2022.103024

Gall, T. (2021) Working with multiple Scenarios: Revising the Futures Cone. Conference paper, AESOP YA Conference 2021 in Tirana, Albania, March 2021.

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Trends are anticipated future developments with high level of certainty that are assumed to hold true for all different future scenarios**, for example:**

Population growth

Ageing society

Metro 18

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People-
centred
Design

Co-creation
Framework

**Future
Scenarios**

Scenario
Assessment

Urban Mobility
System
Transition

Uncertainties are anticipated future developments with high level of uncertainty that are assumed to change for different future scenarios, for example:

Car ownership

User preferences

Built-up density

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People-
centred
Design

Co-creation
Framework

**Future
Scenarios**

Scenario
Assessment

Urban Mobility
System
Transition

Uncertainties are anticipated future developments with high level of uncertainty that are assumed to change for different future scenarios, for example:

Many trends & uncertainties = infinite scenarios?

Car ownership

User preferences

Built-up density

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People-
centred
Design

Co-creation
Framework

**Future
Scenarios**

Scenario
Assessment

Urban Mobility
System
Transition

Archetypical scenarios are dominant scenarios extracted from existing literature to categorise and simplify future trends and uncertainties.

**Grumpy old
transport**

**At an easy
pace**

**Mine is
yours**

**Tech-eager
mobility**

(Dator, 2019; Fergnani and Jackson, 2019; Miskolczi et al., 2021)

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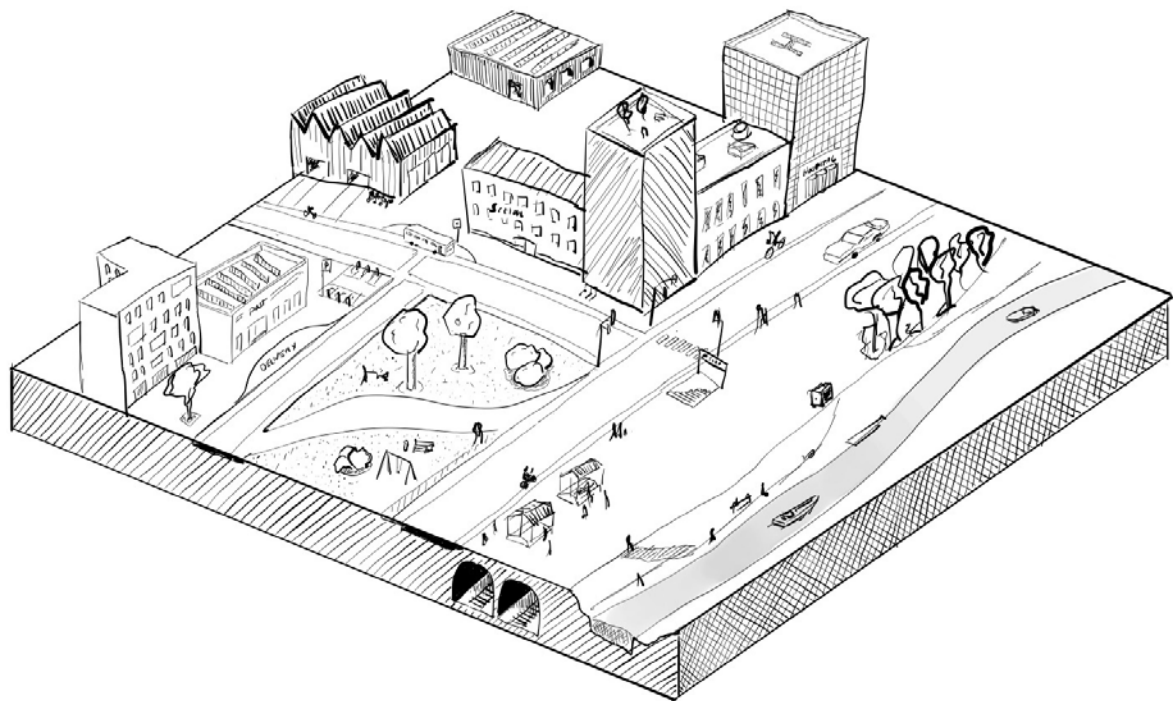
Simplified model visualisation resulting from literature, workshops, and 15+ expert interviews

People-centred Design

Co-creation Framework

Future Scenarios

Scenario Assessment

Urban Mobility System Transition

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Simplified model visualisation resulting from literature, workshops, and 15+ expert interviews

People-centred Design

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Future Scenarios

Scenario Assessment

Urban Mobility System Transition

FUNCTIONS
PEOPLE
MOBILITY ICT
AIR MOBILITY
LAND USE/ DENSITY
ENERGY
URBAN LOGISTICS
CHARGING SYSTEMS
PUBLIC TRANSPORT
ROADS/RAILS
ACTIVE MOBILITY
MOTORISED VEHICLES
WATER MOBILITY

START   SOURCES   ANNEX

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Simplified model visualisation resulting from literature, workshops, and 15+ expert interviews

People-
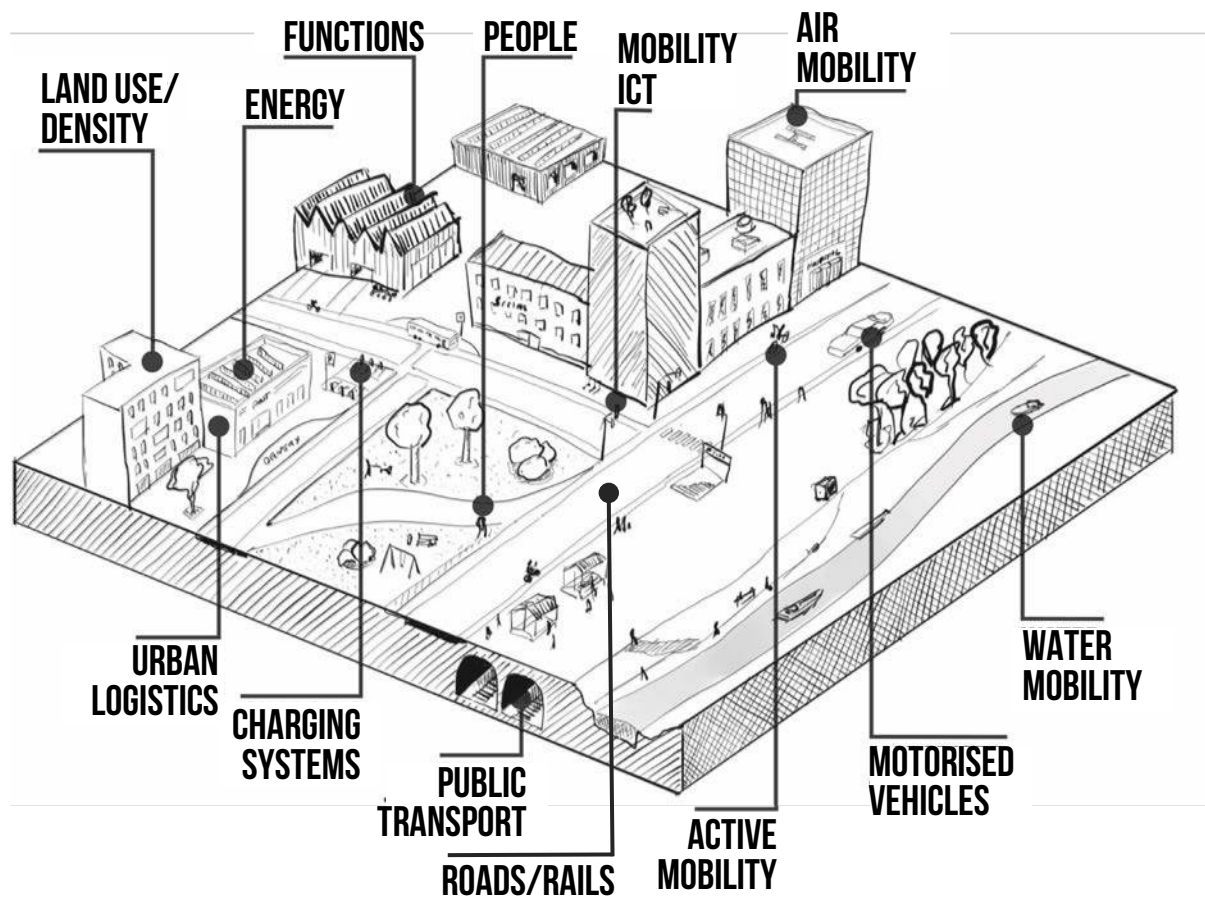centred
Design

Co-creation
Framework

Future
Scenarios

Scenario
Assessment

**Urban Mobility
System
Transition**

**UM systems (UMS) can be modelled as socio-technical system with
<u>people</u>, <u>services</u>, and <u>infrastructures</u> as main layers**

**1. People define infrastructure
(where people live/work/...) &
services (demand)**

**2. Infrastructure constraints
service offer**

PEOPLE   ACTIVE
MOBILITY

PEOPLE
E.g., Individual behaviours,
Social Practices,
Preferences

AIR
MOBILITY   MOBILITY
ICT   PUBLIC
TRANSPORT
MOTORISED
WATER   VEHICLES   URBAN
MOBILITY   CHARGING   LOGISTICS
SYSTEMS

SERVICES

Routes, schedules, ...

LAND USE/
DENSITY   FUNCTIONS

ENERGY   ROADS/RAILS

INFRASTRUCTURES

Roads, rails, buildings, ...

START   SOURCES   ANNEX

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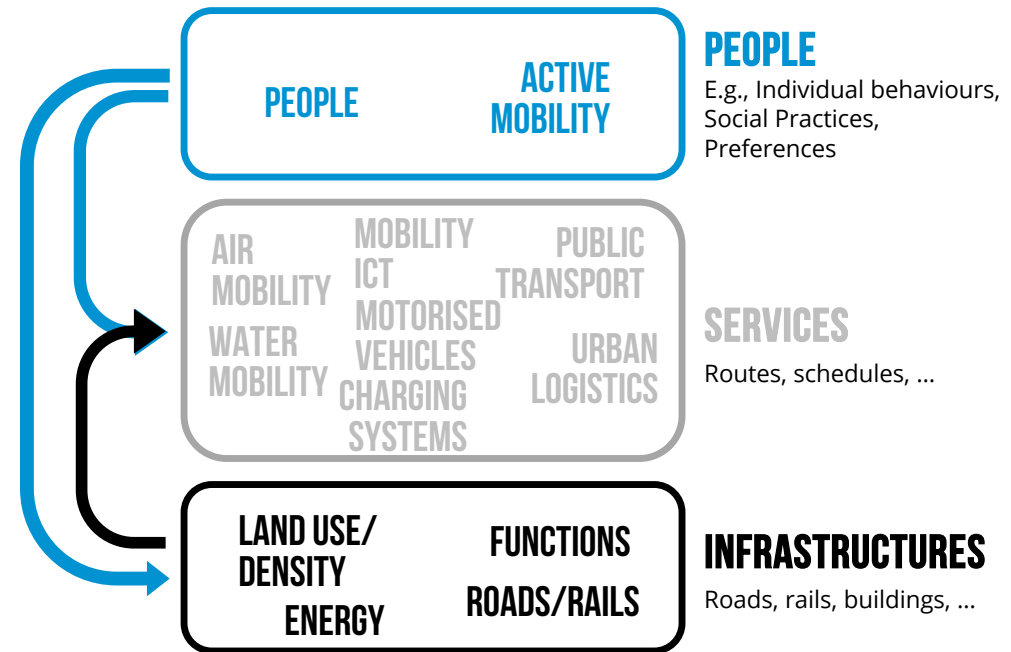
Combining scenarios and UMS layers allows us to model UMS futures

START   SOURCES   ANNEX

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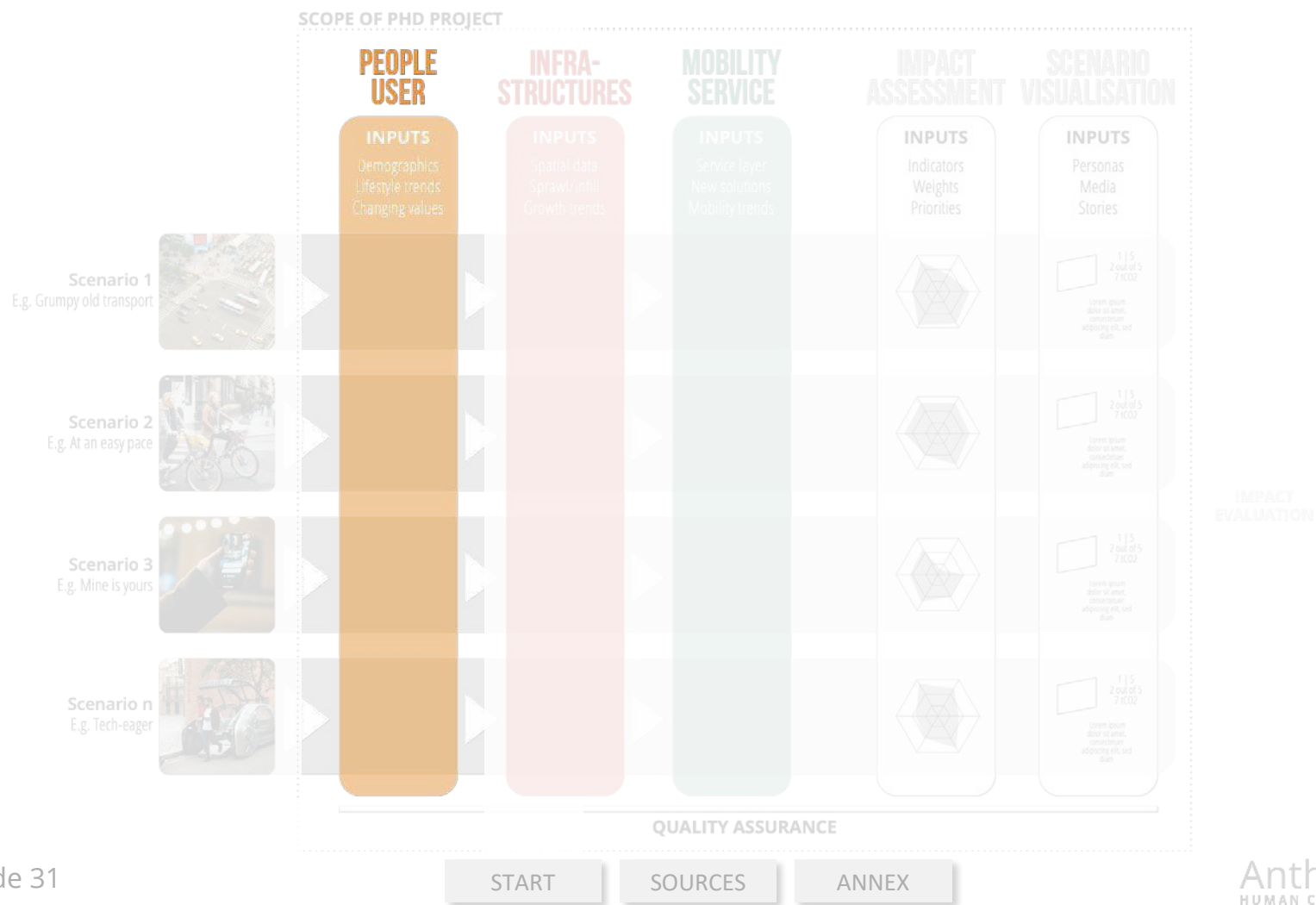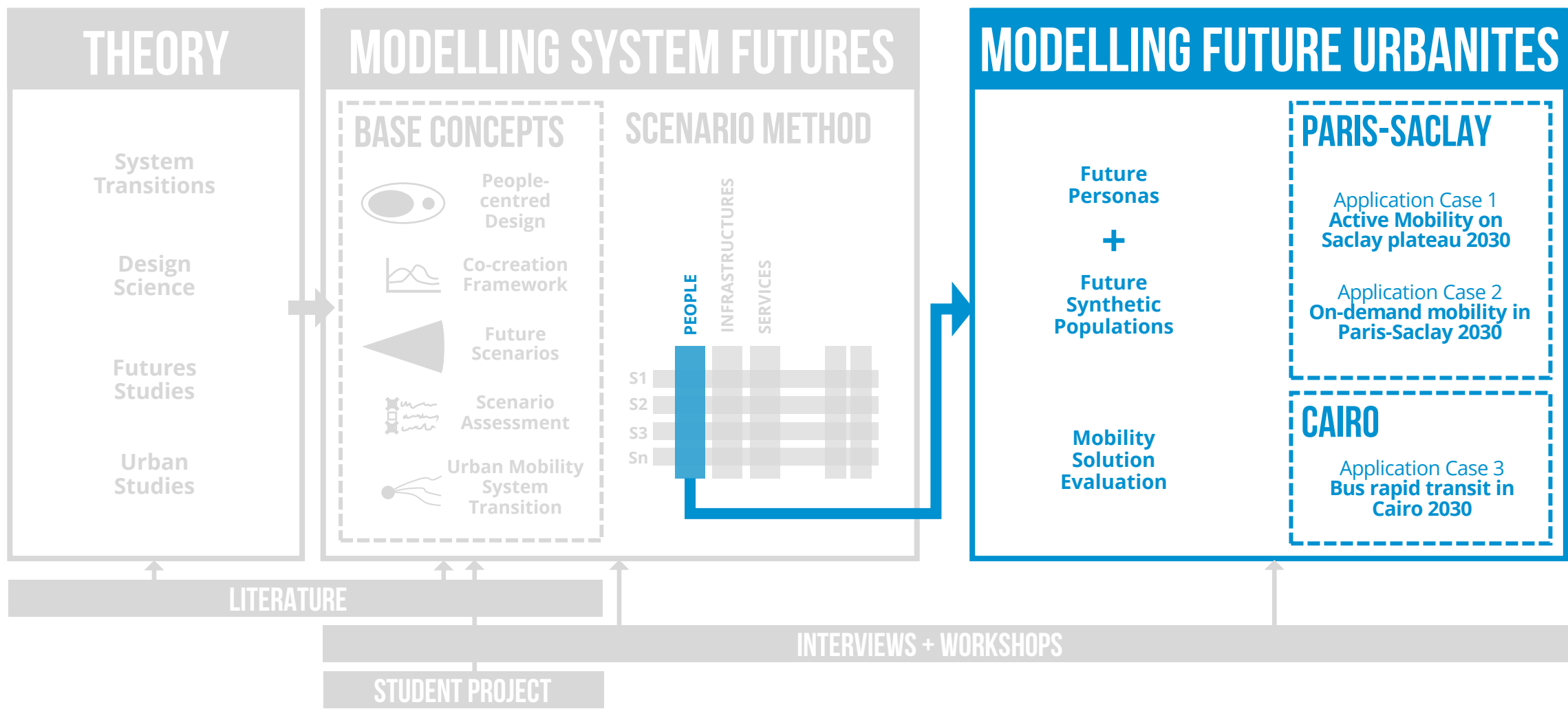
03 Future Urbanites

How can we work with diverse future urbanites across qualitative and quantitative design methods in urban system design?

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How can we model and represent future urbanites?
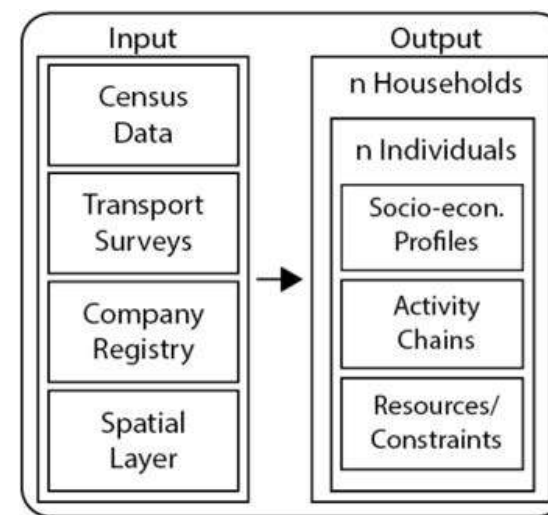

Personas

Mostly qualitative, subjective.
Mostly present, partially future.

Used for design and policymaking.

Synthetic Populations (SP)

Mostly quantitative, objective.
Mostly present and recent past.

Used for agent-based simulations.

START   SOURCES   ANNEX

How can we adapt future urbanites across scenarios?
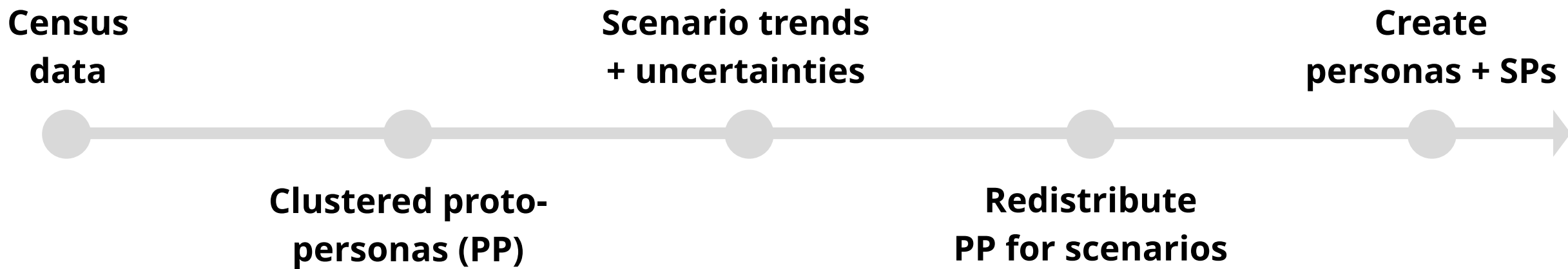
Census data

Clustered proto-personas (PP)

Scenario trends + uncertainties

Redistribute PP for scenarios

Create personas + SPs

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CASE 1

Active mobility on Saclay plateau 2030

CASE 2

On-demand mobility in Paris-Saclay 2030

CASE 3

Bus rapid transit in Cairo 2030

	CASE 1	CASE 2	CASE 3
Location	Saclay plateau	Paris-Saclay (CPS)	Greater Cairo
Goal	Aid decisions between interventions to increase active mobility	Evaluating potential mobility-on-demand services	Increase accessibility and improve sustainability
Objective	Test utility of scenarios and personas in qualitative process	Test utility of scenarios + synthetic populations in future simulations	Replicate method in different context and validate its utility
Method	Solution compilation, qualitative design, cost-effectiveness analysis	Persona + SP creation, agent-based simulation and solution calibration	Persona + SP adaptation, agent-based simulation and impact evaluation
Collaboration	Researchers from Italy, Belgium, Germany via Institut Pascal seminar	Simulation experts @IRT, inter-council partnership Paris-Saclay	American University in Cairo, Transport for Cairo, Simulation experts @IRT

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THEORY

System Transitions

Design Science

Futures Studies

Urban Studies

MODELLING SYSTEM FUTURES

BASE CONCEPTS

People-centred Design

Co-creation Framework

Future Scenarios

Scenario Assessment

Urban Mobility System Transition

SCENARIO METHOD

PEOPLE
INFRASTRUCTURES
SERVICES

S1
S2
S3
Sn

MODELLING FUTURE URBANITES

Future Personas

+

Future Synthetic Populations

Mobility Solution Evaluation

PARIS-SACLAY

Application Case 1
Active Mobility on Saclay plateau 2030

Application Case 2
On-demand mobility in Paris-Saclay 2030

CAIRO

Application Case 3
Bus rapid transit in Cairo 2030

LITERATURE

INTERVIEWS + WORKSHOPS

STUDENT PROJECT

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24 M people

Core challenges
- low air quality,
- limited accessibility aggravated by resettlements,
- low but rising car ownership,
- regular standstill of traffic,
- limited affordability.

Mass public transport most promising solution, but limited resources; **challenge to make right choices** in volatile and fast-changing context

Objective: Test method in different context to assist decision making in public transport design.

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01 MOTIVATION

- **Apply + test method in very different context**

- **Work in an area partly representative for key global challenges**
  I.e. urbanising metropolis with informal developments

- **Test approach in context with limited data**

02 METHOD

Strategic collaborations
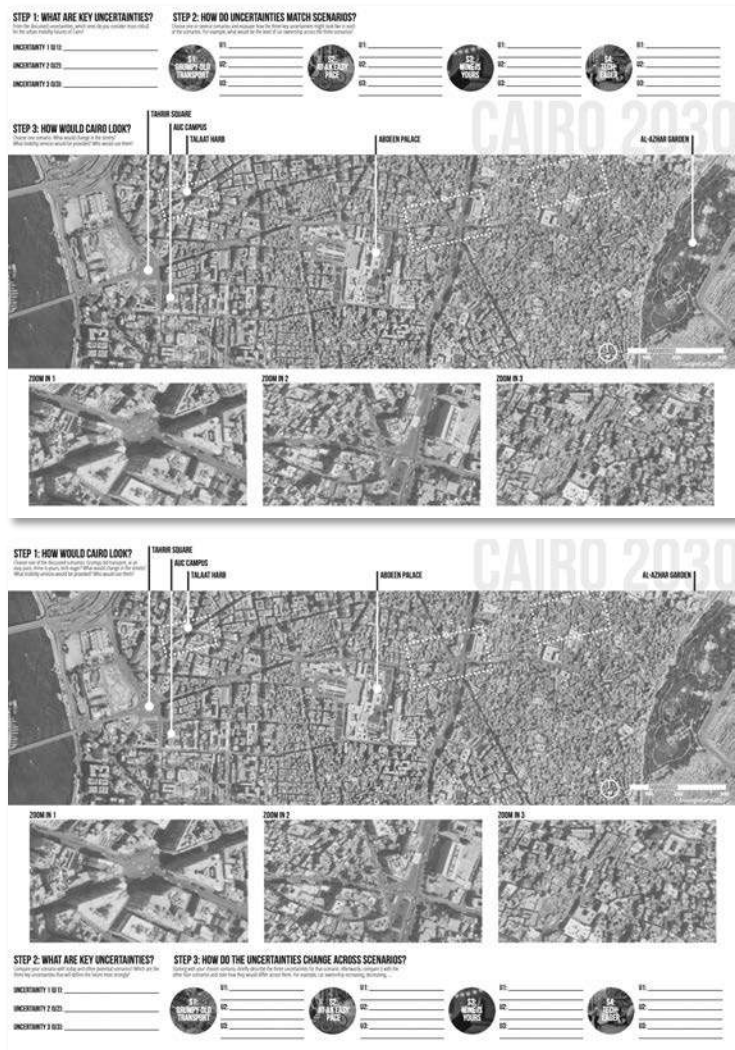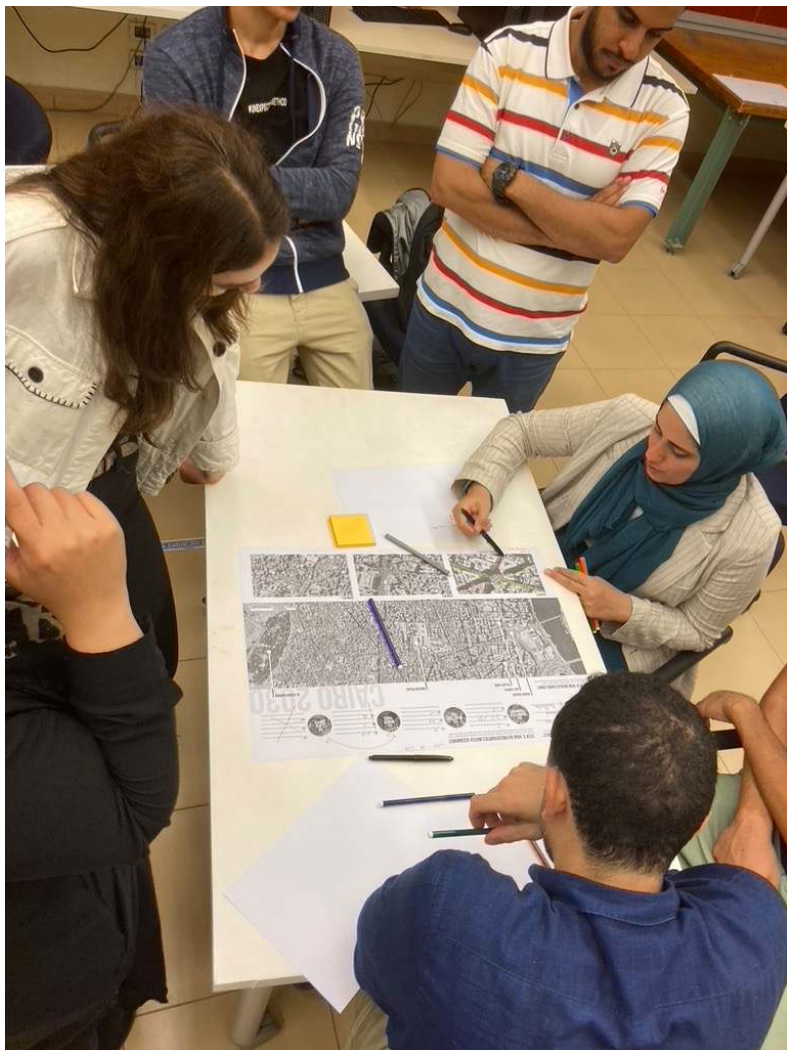

Field visits

Interviews + Workshop

Secondary data collection

START   SOURCES   ANNEX

Key outcomes

- Utility of intermediary design objects

- Trends vs. uncertainties quiz worked as capacity development tool

- UMS model adopted: Infrastructure, people, service helpful for systemic thinking

- High level of interest and curiosity

- Moving between uncertainties, scenarios, and local implementation worked best

Challenges

- Who's hat we wear (user, idealist, realist, often switching throughout)

- Not making a least, medium, most preferred scenario

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03 OBJECTIVE SETTING

A Increase **accessibility** while reducing emissions and other negative externalities

B Exploit potential of **agent-based simulation** to test large scale interventions impact.

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04 ONGOING WORK

A Base simulation

Data preparation and synthesis for **base simulation**

Potential utilisation of **base proto-personas** (assumption of similar mobility behaviours)

B Scenario localisation

Local **scenario co-creation** via archetypical scenarios

Outstanding **trend and uncertainty** survey

C Future urbanites

Creation / transfer of proto-personas, **synthetic population** adaptation, **persona** creation

D Evaluation

Impact evaluation of improved **1) walkability** around stations, **2) intermodality**, and **3) Bus Rapid Transit**

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INTERVENTIONS TO EVALUATE

WALKABILITY

Improving walkability around stations can lead to significantly increased catchment areas.

Interventions:
- Urban design (sidewalks, ...)
- Safety (crossings, lightening)
- Comfort (shade, nature, ...)

INTERMODALITY

Changing between modes is one of the key determinants to talk public transport in Cairo (and elsewhere).

Interventions:
- Coordination across modes
- Improved Information/MaaS
- Improved station/stop design

BUS RAPID TRANSIT (BRT)

Public transport is a significant but usually rewarding investment. Large rail-based projects are underway, BRT are discussed.
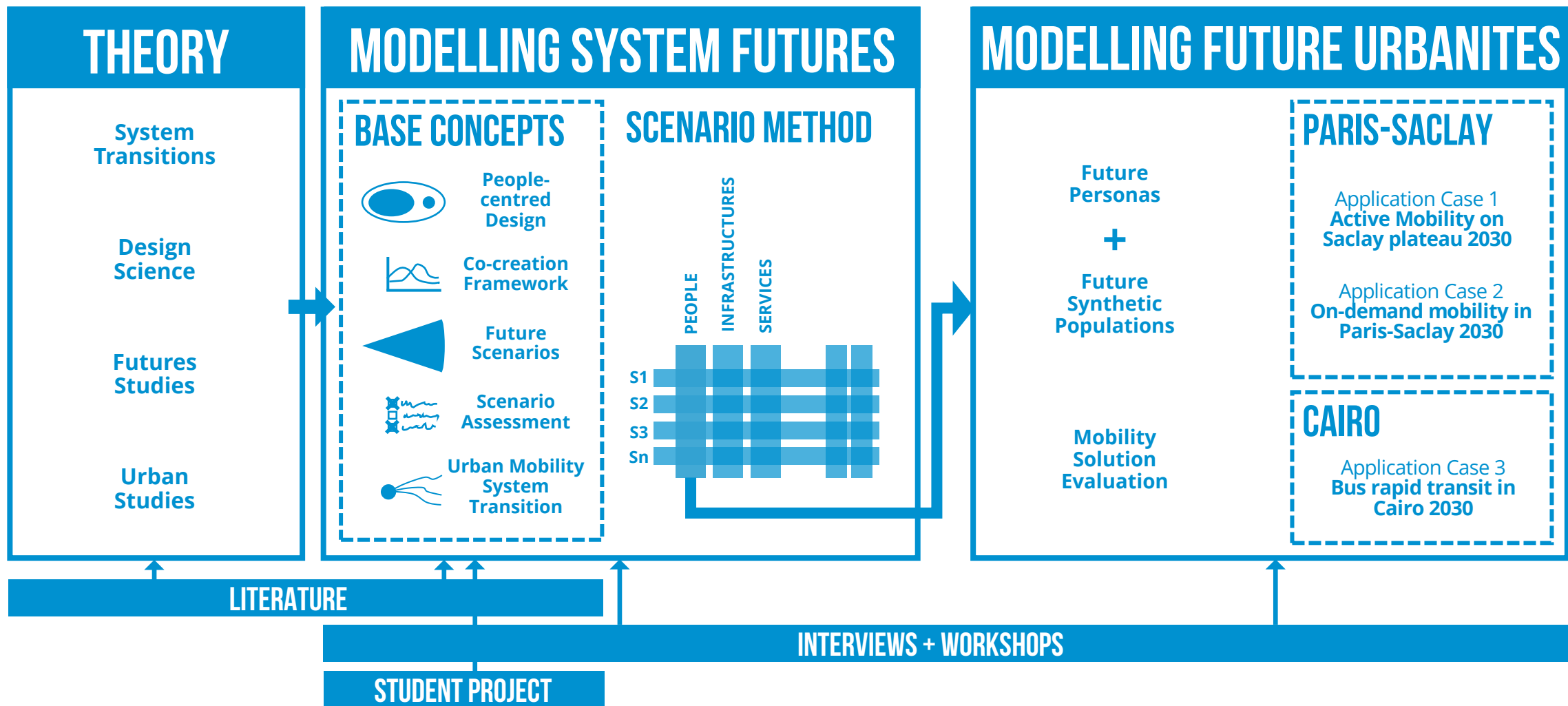
Question is where, how, when, in what way?

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05 OVERVIEW OF CONTRIBUTIONS

1. First **Cairo-scale agent-based mobility simulation** with (probably) most complete data-set to date (100% open source)

2. **Set of localised scenarios** as available intermediary design objects to be used across design process

3. Potential approach to develop **base personas that can be redistributed** according to limited local data (to be explored)

4. Potential **input for decision making** in public transport design and investment

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04 Discussion + Conclusion

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Research question (RQ): How can we support design processes of people-centred, place-based urban mobility solutions in contexts of uncertainty?

RQ1: How can we model local urban mobility futures in a systemic and holistic manner to permit designing transitions towards alternative states?

RQ2: How can we work with diverse future users and stakeholders across qualitative and quantitative design methods in urban system design?

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To respond to the question, we:

01 Used 5 base concepts to develop an **approach that models the current and multiple future states** of an urban mobility system within limited resources

02 Focused on the people dimension and developed a **method that allows to create several sets of present and future personas and synthetic populations** for qualitative and quantitative urban mobility solution design

03 Applied the method to the two applications cases in Paris-Saclay and the one in Cairo to validate its function and their utility

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- **Validation of futures** > Tried to address through mixed-method approaches and partial validations

- **Focus on people-dimension** > Only limited work on infrastructure and service modelling

FUTURE WORKS

- Further validation with longer timespan or past/geographical changes

- Geographical/spatial modelling of infrastructure growth + service adaptation

- Application to other urban systems, e.g., housing, logistics, local businesses

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- Transitioning towards a **people-centred and sustainable urban future** requires the consideration of **trends** and **uncertainties** to design adequate solutions today

- **Scenario-based design** methods can support the design processes of urban solutions in both quantitative and qualitative environments (as well as mixed ones)

- Elements such as **personas/archetypes** allow widespread replication and permit to work more effectively with the unknown tomorrow

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05 References + Publications

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05 REFERENCES

Dator, J. (2019) What Futures Studies Is, and Is Not, in: Jim Dator: A Noticer in Time. Anticipation Science, Vol. 5, Cham: Springer. https://doi.org/10.1007/978-3-030-17387-6_1

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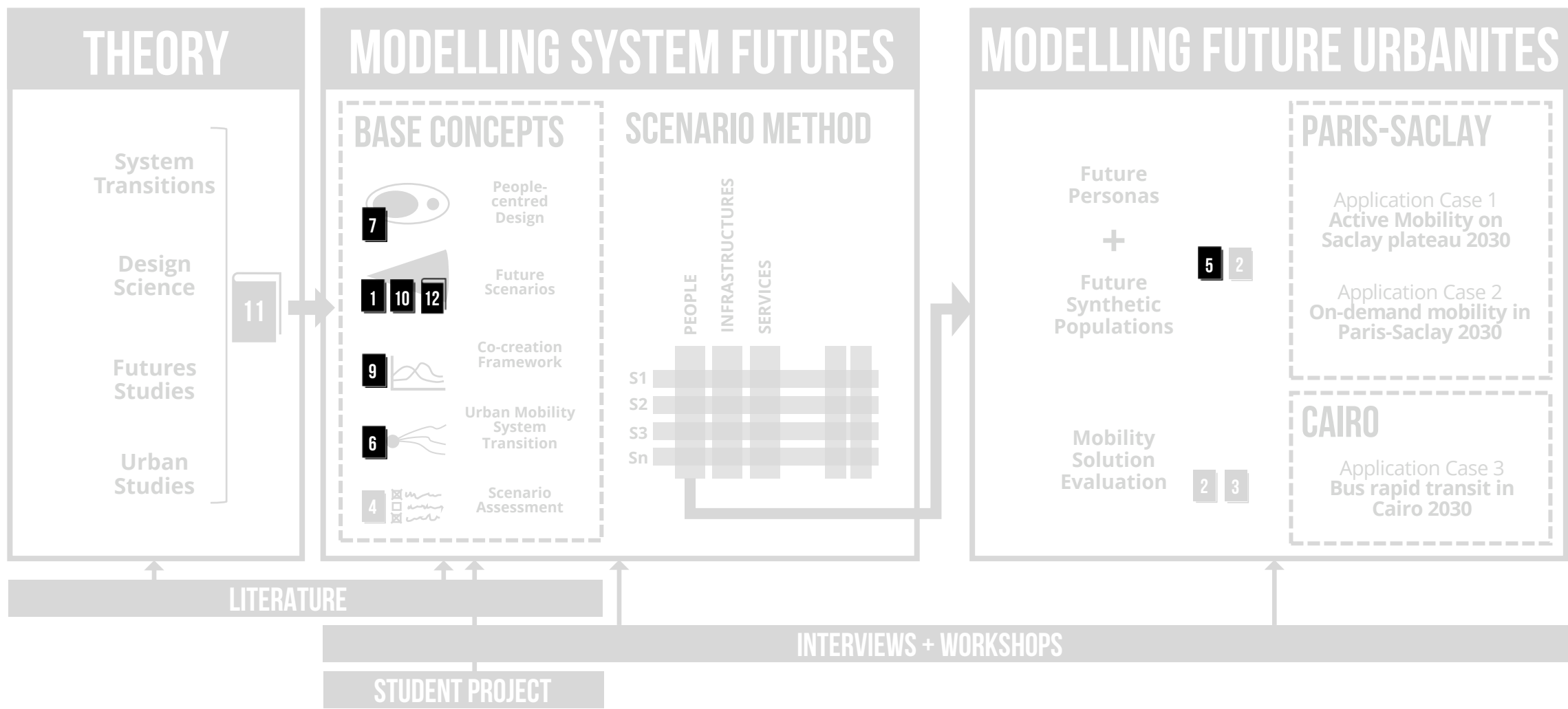
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05 PUBLICATIONS

● **Completed**

○ **In progress/pending**

Journal papers

1. **Gall, T.**, Vallet, Fl., and Yannou. B. (2022) How to visualise futures studies concepts: Revision of the futures cone. Futures, 143/103024. https://doi.org/10.1016/j.futures.2022.103024

2. **Gall, T.**, Hörl, S., Vallet, F., and Yannou, B. (2023) Integrating future trends and uncertainties in people-centred urban mobility design via data-driven personas. [submitted]

Conference papers (peer-reviewed)

3. **Gall, T.**, Chouaki, T., Vallet, F. and Yannou, B. (2023) Considération des incertitudes et tendances dans la simulation multi-agents de la mobilité : Apport des scénarios futurs. [submitted to s.mart colloque]

4. **Gall, T.**, Vallet, F., Ben Ammar, M. and Yannou, B. (2023) Supporting design for uncertain futures: A guide for assessing and evaluating scenarios [submitted to ICED23]

5. Vallet, F., Hörl, S., and **Gall, T.** (2022). Matching Synthetic Populations with Personas: A Test Application for Urban Mobility. Proceedings of the Design Society, 2, 1795-1804. https://doi.org/10.1017/pds.2022.182

6. **Gall, T.**, Vallet, F., Douzou, S. and Yannou, B. (2021) Anticipate, Adjust, Adapt: Managing Sustainability Transitions through multiple Scenarios of Urban Mobility Futures. 49th European Transport Conference, online, Sept. 2021.

7. **Gall, T.**, Vallet, F., Douzou, S., & Yannou, B. (2021). Re-defining the System Boundaries of Human-Centred Design. Proceedings of the Design Society, pp. 2521-2530. https://doi.org/10.1017/pds.2021.513

Other conference papers

8. **Gall, T.** (2023) Comparing potential impacts of place-based urban mobility solutions across scenarios: An application case of the Paris area. [abstract submitted to AESOP YA Conference in March 2023]

9. **Gall, T.**, Vallet, F. and Yannou, B. (2021) Co-Creating Sustainable Urban Futures: An initial Taxonomy of Methods and Tools. ISOCARP 56th World Planning Congress 'Post-Oil City – Planning for Urban Green Deals', Doha, Nov. 202

10. **Gall, T.** (2021) Working with multiple Scenarios: Revising the Futures Cone. Conference paper, AESOP YA Conference 2021 in Tirana, Albania, March 2021.

Book (chapters)

11. **Gall, T.**, Vallet, F., Reyes, M., Hörl, S., Chouaki, T., Puchinger, J. (2023) Sustainable Urban Mobility Futures: Transdisciplinary Challenges, Trends, and Pathways for Sustainability Transitions. London: Palgrave Macmillan/Springer [accepted]

12. **Gall, T.** and Allam, Z. (2022) Strategic foresight and futures thinking in urban development: Framing planning perspectives and decolonising urban futures, p. 10-19. In: Peric, A., Permezel, M., Stott, M., and Woo, A. Future Cities Series: Practical planning guidance for innovative, resilient and inclusive cities of the future: Discussion paper 1. Nairobi/The Hague: UN-Habitat and ISOCARP. Available at: https://hal.archives-ouvertes.fr/hal-03832837/

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THANK YOU

Anthropolis Chair Seminar | 11 January 2023

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Annex

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HUMAN CENTERED MOBILITY

People-centred Design

Co-creation Framework

Future Scenarios

Scenario Assessment

Urban Mobility System Transition

People-centred Design

Gall, T., Vallet, F., Douzou, S., & Yannou, B. (2021). Re-defining the System Boundaries of Human-Centred Design. Proceedings of the Design Society, pp. 2521-2530. https://doi.org/10.1017/pds.2021.513

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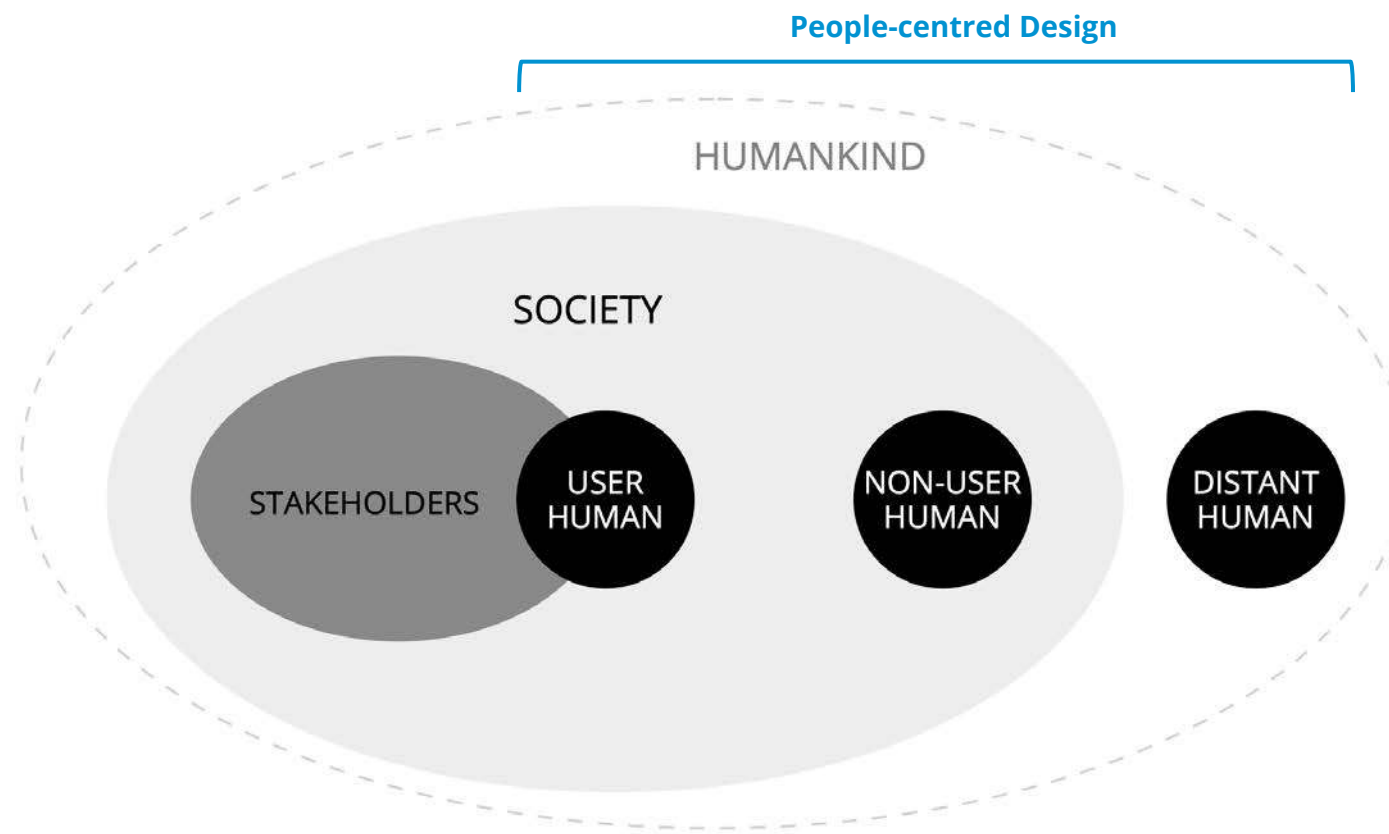
Resource-conscious people-centred design requires collaboration with the 'right' stakeholders at the 'right' time, balancing between maximum co-creation with minimum resources.
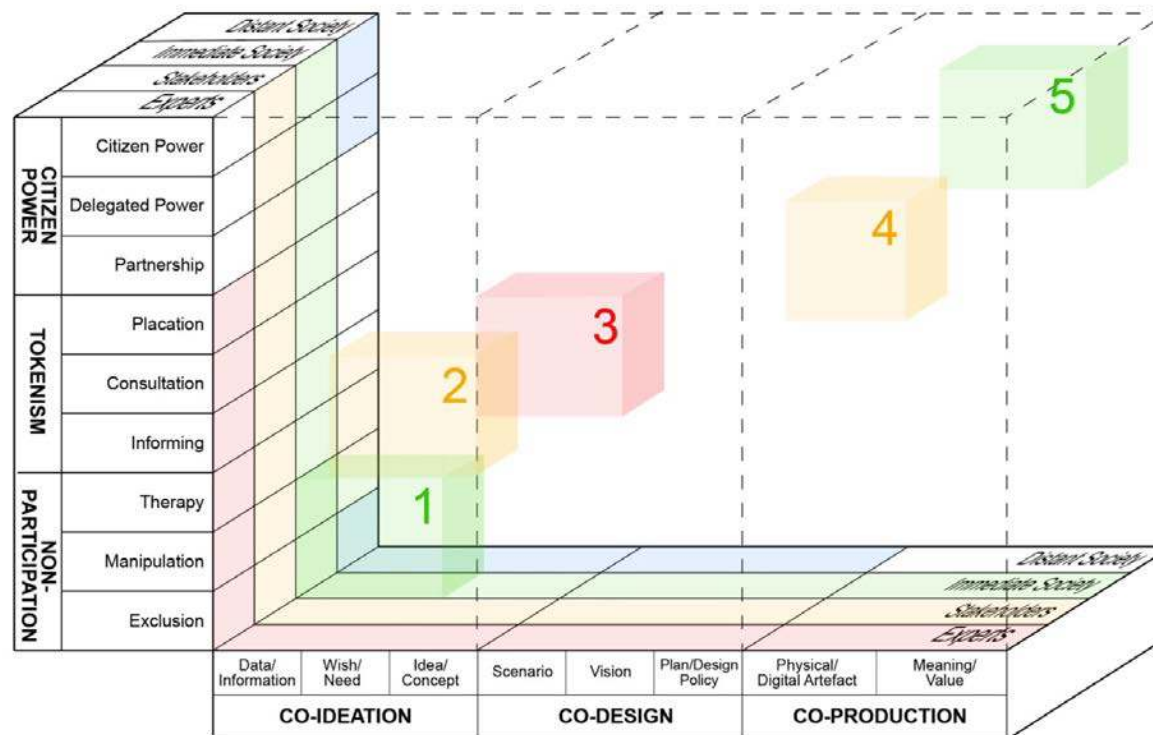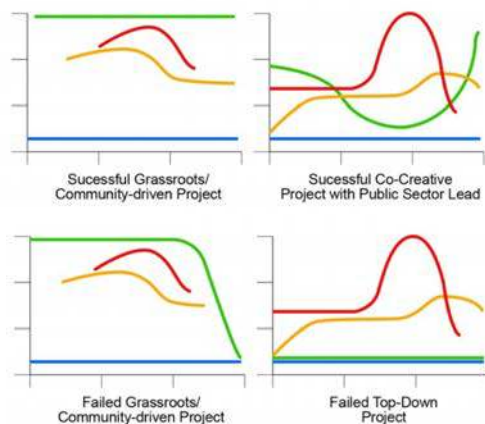
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People-centred Design

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Future Scenarios

Scenario Assessment

Urban Mobility System Transition

Evaluating some key requirements simplifies working with scenarios and enables to use existing ones, thus reducing the resource requirements.

	I/S	Quality Indicator/Reference	IV	WS	LT
Process	S	Are the required resources to transform this set of scenarios clear and acceptable?		X	
	S	Is the process of the creation known and sound?	X		
	S	Are the participants and their roles that were involved in the process clear? Do they ensure sufficient diversity?		X	
Characteristics	S	Is the number of scenarios adequate for the purpose (neither 2, 3, uneven, or too many)?	X	X	
	S	Is there a timeframe assigned to the scenarios? If yes, does it correspond with project needs?		X	
	S	Were the scenarios created for a specific location? If yes, does it correspond with the project's needs?		X	
	S	Do the scenarios provide meaningful alternatives? (Spaniol and Rowland, 2018)			X
	S	Is there no strong distinction between preferred and nonpreferred/utopia vs. dystopia?			X
	S	Are they temporally rooted in the future? (Spaniol and Rowland, 2018)			X
Content	I	Are all scenarios concerned with the same issues/challenges?			X
	I	Is the scenario coherent? Can the events be presented as a whole? (Chermack, 2006)			X
	I	Are the scenarios plausible and possible?	X		
	I	Is each scenario interesting? (Chermack, 2006)			X
	I	Is the information provided by the scenario relevant for those who use it? (Chermack, 2006)		X	X
	I	Does it combine qualitative and quantitative information?		X	
	S	Are the scenarios meaningful alternatives (Spaniol and Rowland, 2018) and distinct (Chermack, 2006)?			X
	I	Is the story challenging? Does it make you think differently?		X	
	I	Do we have information on the pathway between today and futures?		X	
	I	Is the scenario comprehensible?	X		
Representation	I	Does each scenario have a catchy, coherent, and descriptive name?		X	
	I	Is it possible to relate to the scenarios (Chermack, 2006; Vallet et al., 2020)?			X
	I	Is it communicated with an interesting story and/or narrative? (Spaniol and Rowland, 2018)			X
	I	Does it (allow to) integrate specific elements, places, and details relevant to the user?		X	
	I	Is it easy and effective to communicate in a supervised and unsupervised setting?		X	
	I	Are the intermediary design objects adapted to the target audience?			X
	I	Does it provide the required types of cross-media formats, e.g., graphics, sound, text?		X	

Gall, T., Vallet, F., Ben Ammar, M. and Yannou, B. (2023) Supporting design for uncertain futures: A guide for assessing and evaluating scenarios [submitted to ICED23]

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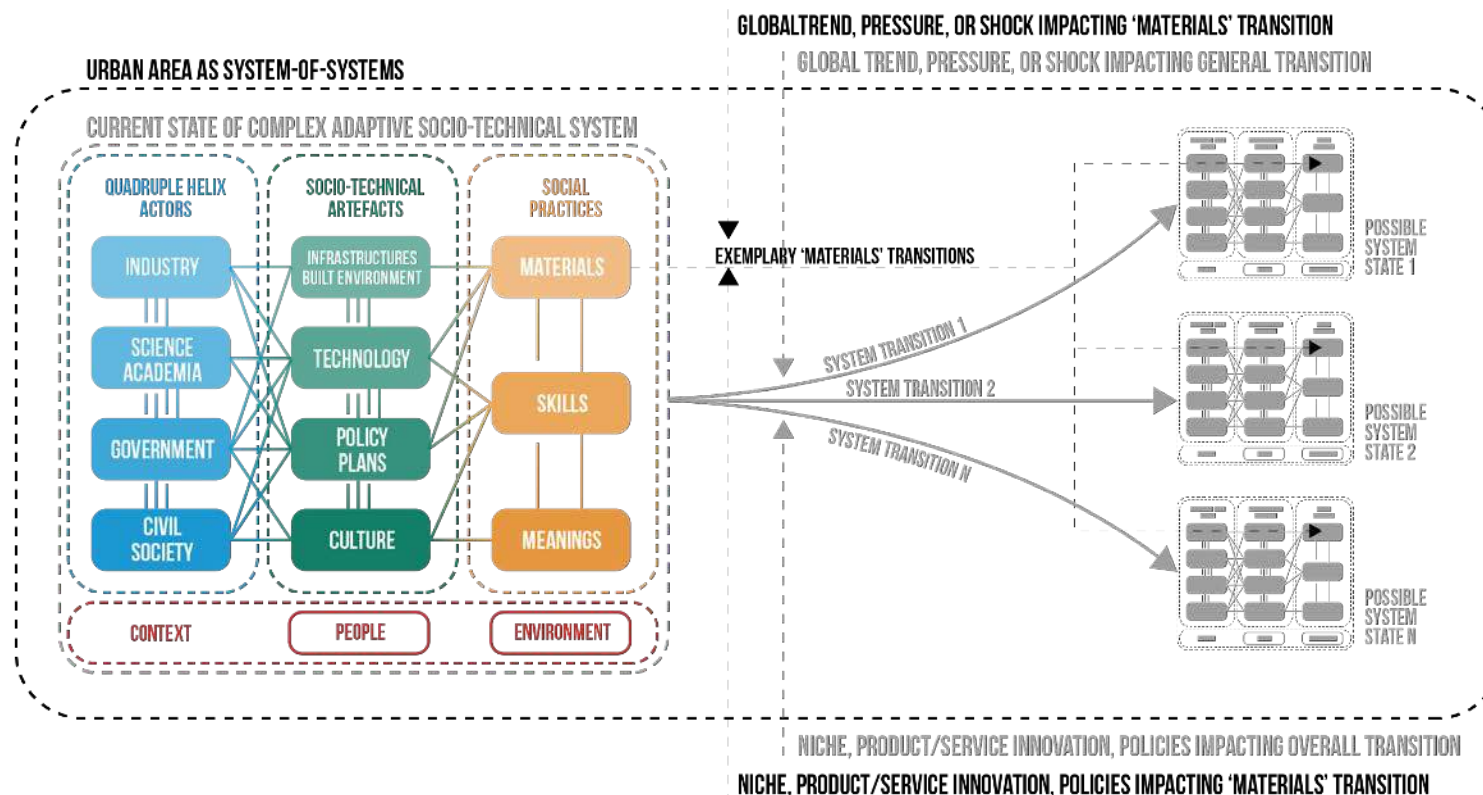
Future Scenarios

Scenario Assessment

Urban Mobility System Transition

System transitions theories, combining socio-technical systems, practices, and behaviours, allow to develop a holistic understanding of UM and model its development over time.

Gall, T., Vallet, F., Douzou, S. and Yannou, B. (2021) Anticipate, Adjust, Adapt: Managing Sustainability Transitions through multiple Scenarios of Urban Mobility Futures. 49th European Transport Conference, online, Sept. 2021.

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