ETH zürich

Informationsveranstaltung am 07.11.2024, 17:00 Uhr

Master-Arbeiten und Master-Projektarbeiten am IBI

Prof. Dr. B.T. Adey, Prof. Dr. Catherine De Wolf,
Prof. Dr. G. Habert

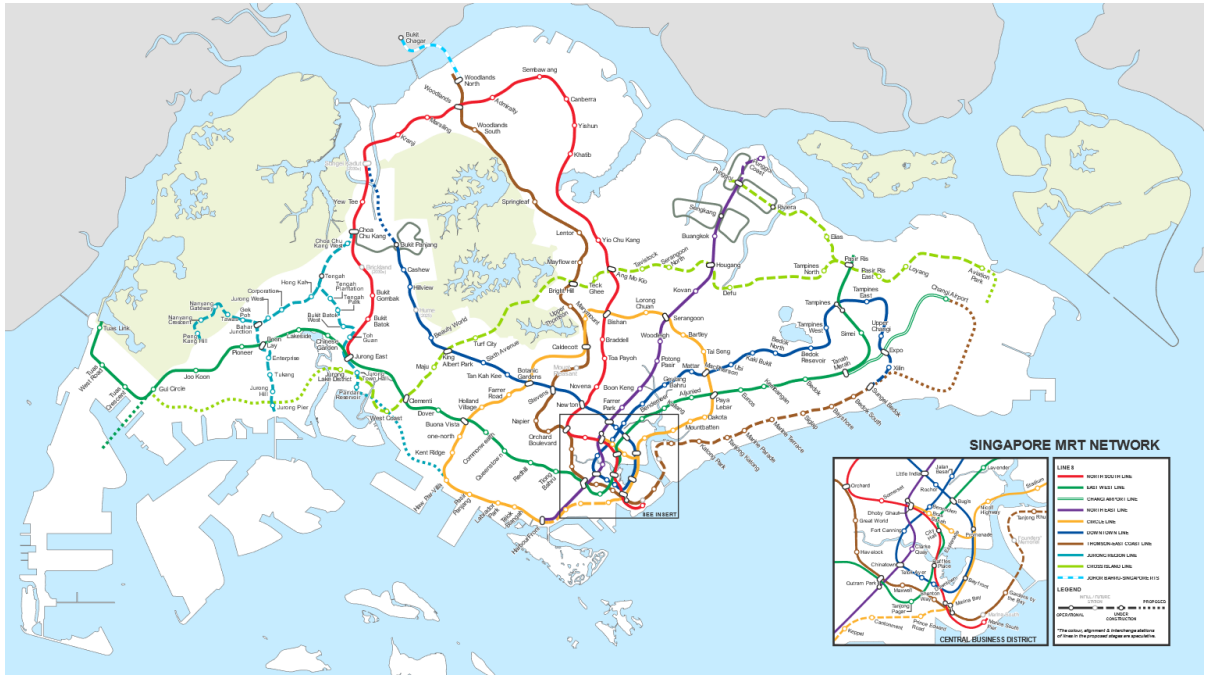
IBI is structured along 3 main streams

- Infrastructure Management
  - Prof. Dr. Bryan T. Adey

- Circular Engineering for Architecture
  - Prof. Dr. Catherine De Wolf

- Sustainable Construction
  - Prof. Dr. Guillaume Habert

Switzerland



Singapore

Infrastructure Management Group

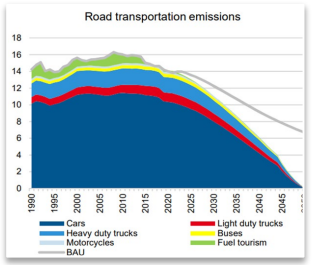
Collaborations

- BAW
- ASTRA
- Scottish Water
- FCL-G (Urban Redevelopment Authority and Land Transport Authority of Singapore)

Topics

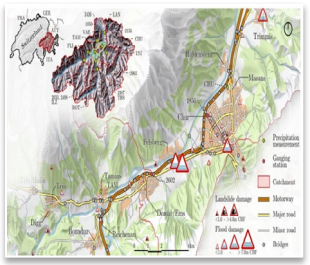
Master project and thesis

Master thesis



1. Identifying transport system transitions towards decarbonisation

2. Micromobility safety analysis through sensor data

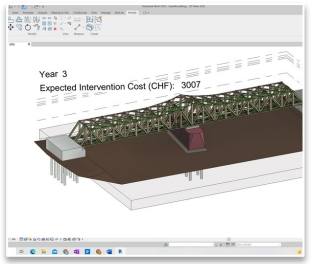


3. Exploratory modelling for climate resilience analysis

4. Predicting rail infrastructure development using geospatial tools

5. Land-use transport modelling to enable optimal cycling infrastructure in Singapore

6. Land-use transport modelling to enable optimal charging infrastructure in Singapore

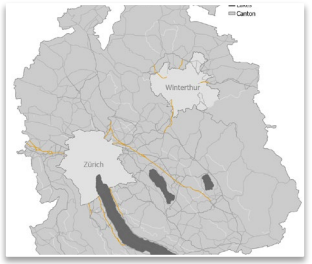


7. Connecting future predictions of asset condition and interventions to BIM

8. Estimating missing risk data with Bayesian networks

9. Use of extended reality for bridge inspections

10. Predicting future road condition



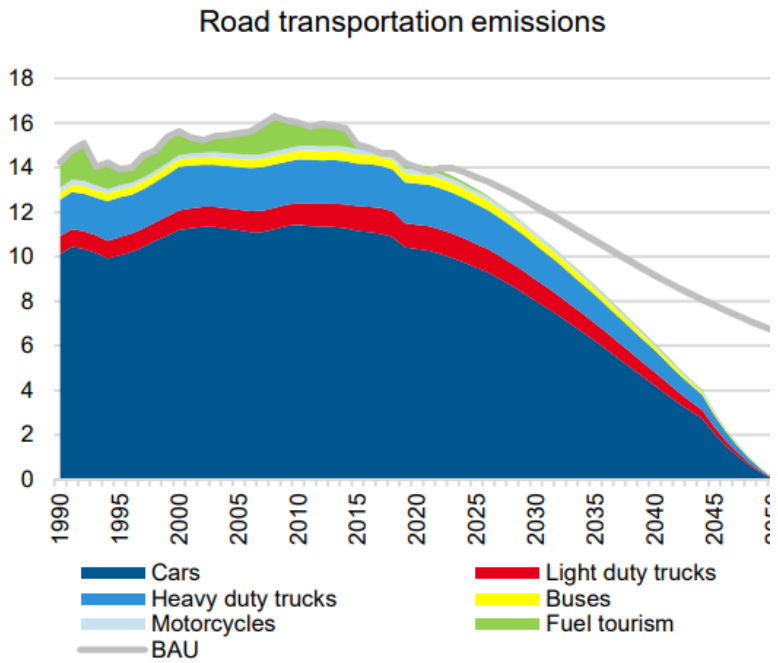
11 Cycling infrastructure network completion

12. Cycling crash analysis in Swiss cities

1 – Identifying transport system transitions towards decarbonisation

Limited to 2 persons

- **Supervisors:** O. Roman (roman@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To identify potential transitions of the Canton Zurich's transport system towards decarbonisation.
- **Main Tasks:** 1) Familiarize with datasets (e.g. Mikrozensus) and models (e.g. Nationales Personenverkehrsmodell) to study the transport system in the Canton of Zurich, 2) Analyze key transport system metrics such as modal shifts, carbon emissions and travel flows per municipality/zone, 3) Identify required changes in system performance towards decarbonisation such as electrification of transport and required modal shifts, 4) propose potential modifications in the transport system such as charging infrastructure, public transport and active mobility infrastructure improvements, multimodal interventions (e.g. mobility hubs), pricing and incentives, 5) estimate the costs and wider impacts (e.g. travel times) of the proposed modifications with transport models or qualitatively (e.g. through literature review and elasticities estimation).
- **What you will learn:** how to synthesize data collected from different sources and to develop arguments for decarbonising the transport system.
- **What is a successful project?** Convincing arguments on the transport system modifications/transitions required to achieve decarbonisation. Identification of the limitations of the work and broader impacts of achieving decarbonisation.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python, discussion with Mr. Roman and/or Prof. Adey.



https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/emission-reduction/reduction-targets/2050-target/climate-strategy-2050.html

Connected to: (FCL) FUTURE CITIES LABORATORY

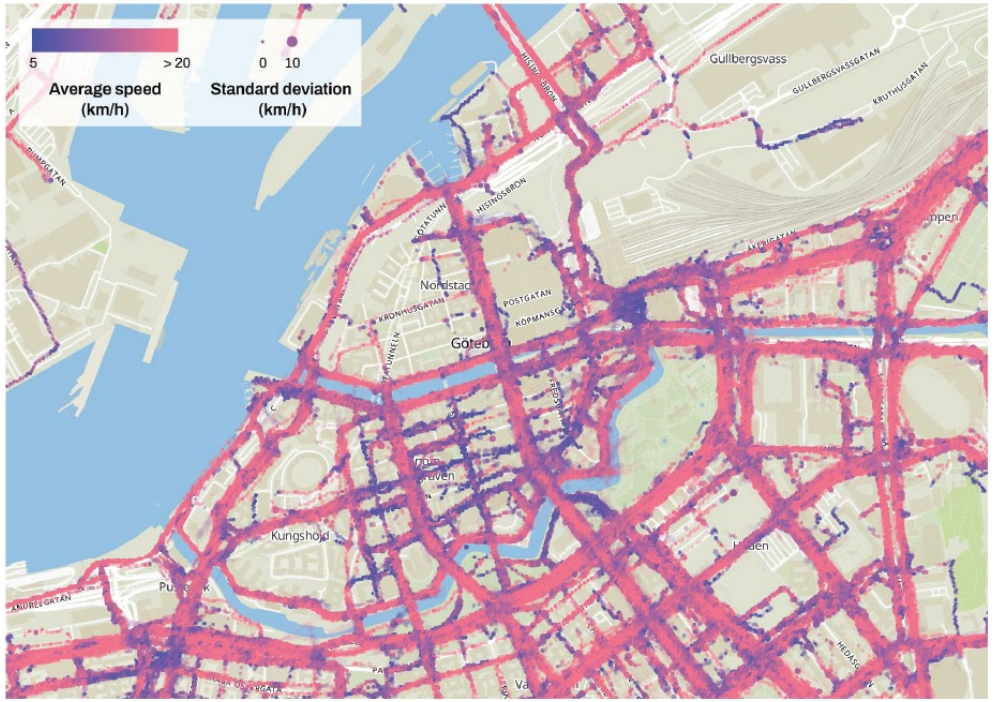
Institut für Bau- und Infrastruktur-management

D BAUG

2 – Micromobility safety analysis through sensor data

Limited to 2 persons

- **Supervisors:** O. Roman (roman@ibi.baug.ethz.ch), David Zani (zani@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To estimate crash risk hotspots in the transport network through micromobility sensor data (Inertial Measurements Units or IMUs) analysis.
- **Main Tasks:** 1) Preprocessing of infrastructure network data (e.g. Open Street Maps), tools will be provided, 2) preprocessing of micromobility IMUs data (GPS trajectories, initial and final locations, acceleration profiles, speed profiles, braking, etc), 3) connect the sensor data with safety incidents and near-crashes, 4) Identify crash risk hotspots in the transport network, 5) propose preliminary interventions in the infrastructure to improve safety.
- **What you will learn:** how to process and analyse sensor data to better understand human behavior and infrastructure conditions, how to identify crash risk hotspots and develop data-driven approaches for infrastructure planning.
- **What is a successful project?** Convincing arguments on the use of the analysis to evaluate micromobility safety and potential infrastructure improvements. Identification of the limitations of the work.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python or R, interest in urban data science, discussion with Mr. Roman and Mr. Zani. The study will be carried out in a selected European city.

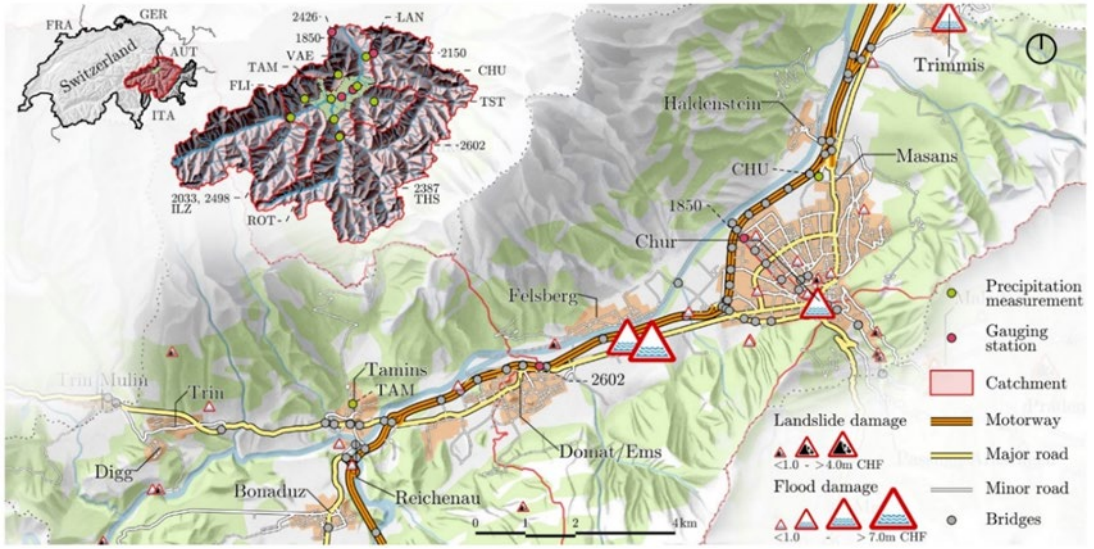


Connected to: Bolt

3 – Exploratory modelling for climate resilience analysis

Limited to 1

- **Supervisors**: O. Roman (roman@ibi.baug.ethz.ch), H. Nasrazadani (nasrazadani@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To use simulations to explore how different future conditions/scenarios will impact the resilience of transport systems.
- **Main Tasks:** 1) understand the transport system in Chur, Switzerland, 2) explore how the system representation can be modified (i.e., development of future conditions/scenarios), the hydroclimatic model for Chur will be provided, 3) run an ensemble of future scenarios, 4) use machine learning techniques for clustering and analysis of relevant scenarios, Python software will be provided, 5) demonstrate how the exploration of a large ensemble of future scenarios can be used for climate resilience.
- **What you will learn:** how to use simulations and exploratory modelling to identify decision-relevant scenarios for climate resilience.
- **What is a successful project?** Convincing arguments for the development of future scenarios and how they impact climate resilience.
- **Prerequisites**: Infrastructure Management 1 or Infrastructure Planning, knowledge/interest in programming with Python, discussion with Mr. Roman and Mr. Nasrazadani.

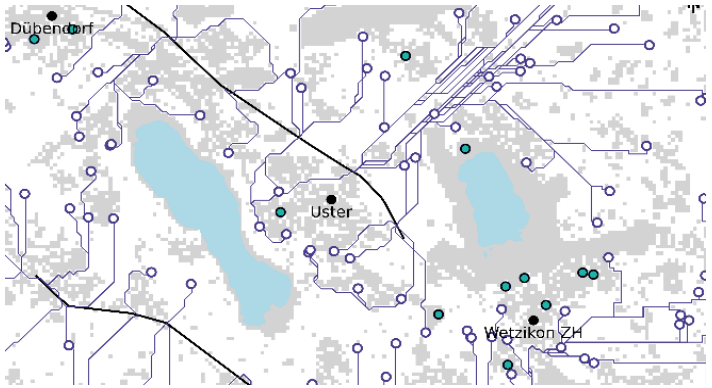


4 – Predicting rail infrastructure development using geospatial tools

Limited to 1

- **Supervisors:** A. Elvarsson (elvarsson@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goals:** To generate potential evolution of a rail network considering various influencing factors, e.g., population growth, shifts in travel demand and land use policies. The study is based on a case-study rail network and a state-of-the-art model exploiting spatial analysis.
- **Main Tasks:** 1) Gather information for planning rail infrastructure, 2) identify the planning objectives, 3) summarise literature findings on the growth and evolution of transport networks, including recent developments at IM Group, 4) develop at least three distinct scenarios that impact rail networks in future, 5) use a novel algorithm to generate changes to the rail network case study, 6) assess the changes to the network considering the stakeholders affected and 7) identify rail network changes that can provide societal benefits.
- **What you will learn:** develop programming skills useful for decision-support models, quantitative planning support, build arguments for decision-makers in infrastructure planning and communicate these to decision-makers
- **What is a successful project?:** Clear results illustrating a ranking of the rail infrastructure development projects by the related societal benefits that they provide. Optionally, drawing a comparison between different infrastructure types.
- **Prerequisites:** Infrastructure Planning, GIS and programming skills will be recommended. Discussion with Mr. Elvarsson and/or Prof. Adey.

Example: Generation of many possible highway access nodes



Connected to: (FCL) FUTURE CITIES LABORATORY

5 – Land-use transport modelling to enable optimal cycling infrastructure in Singapore

Limited to 2 persons

- **Supervisors:** J. Yap (jinyap@ethz.ch), Dr. Qiming Ye (qiming.ye@sec.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To quantify/model the benefits (e.g., carbon emissions, accessibility, accidents, noise, travel time) of car-lite interventions (e.g., road space reallocation, mobility hubs, pedestrianization) for a specific case study in Zurich or Singapore.
- **Main Tasks:** 1) Review the literature on how the benefits of car-lite interventions are estimated, 2) select a case study (e.g., mobility hubs in Zurich) and gather the required data, 3) develop/expand models (code and existing tools will be provided) to estimate selected benefits, 4) calibrate and validate the model, 5) use the model to evaluate potential future car-lite interventions.
- **What you will learn:** how to synthesize data collected from different sources, quantification of benefits/modelling of car-lite interventions, and how to use models for infrastructure planning.
- **What is a successful project?** Convincing arguments on the use of the model/quantification methodology to evaluate projects. Identification of the limitations of the work and suggestions on how to use these tools in planning practice.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python, discussion with Mr. Roman and/or Prof. Adey.

Connected to: (FCL) FUTURE CITIES LABORATORY

6 – Land-use transport modelling to enable optimal charging infrastructure in Singapore

Limited to 2 persons

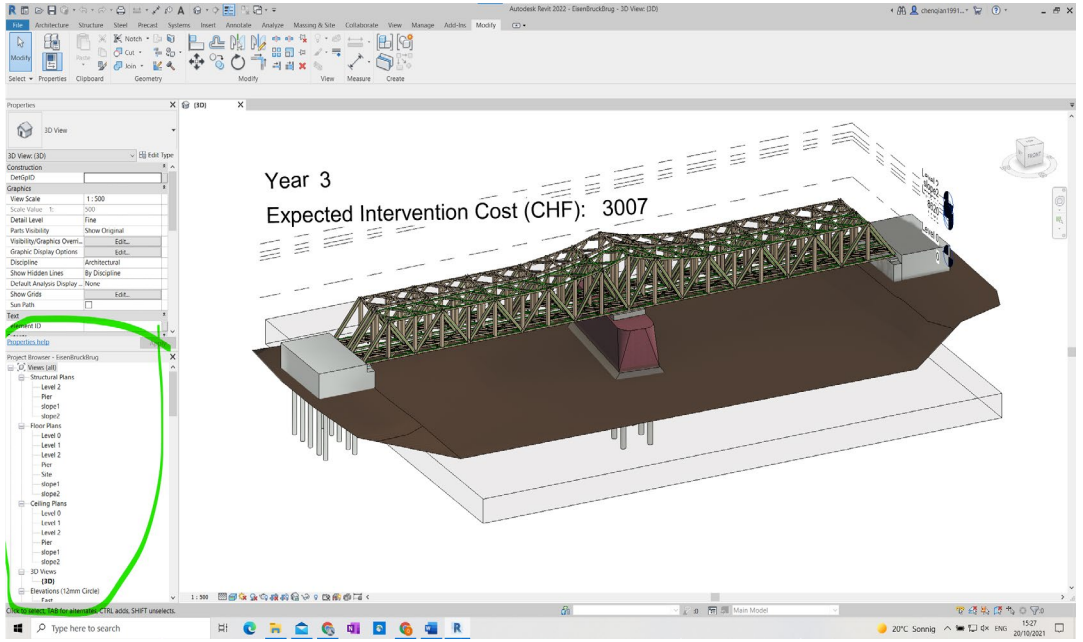
- **Supervisors:** Dr. Qiming Ye (qiming.ye@sec.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To quantify/model the costs and benefits of implementing charging infrastructure in Singapore.
- **Main Tasks:** 1) Review the literature on charging infrastructure and its costs and benefits, 2) understand the model developed by the AMIL module in Singapore for implementing charging infrastructure in Singapore, 3) develop/expand models (code and existing tools will be provided) to estimate selected costs and benefits, 4) calibrate and validate the model with data provided by the AMIL team, 5) use the model to develop an optimal adaptive plan for the implementation for charging infrastructure across Singapore.
- **What you will learn:** how to synthesize data collected from different sources, quantification of benefits/modelling of charging infrastructure, and how to use advanced models for adaptive infrastructure planning.
- **What is a successful project?** Convincing arguments on the use of the model/quantification methodology to evaluate projects. Identification of the limitations of the work and suggestions on how to use these tools in planning practice.
- **Prerequisites:** GIS and good knowledge/interest in programming with Python, discussion with Dr. Ye and Prof. Adey.

Connected to: (FCL) FUTURE CITIES LABORATORY

7 – Connecting future predictions to BIM

Limited to 2

- **Supervisors:** S. Hässig (haessig@ibi.baug.ethz.ch), S. Chuo (chuo@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To connect simulation software to BIM.
- **Main Tasks:** 1) understand how future condition state predictions are made for bridge components, 2) understand how future interventions are predicted, 3) develop a data base which contains this information, 4) connect the database to BIM, 5) illustrate the possible visualisations of the expected deterioration and possible interventions, 6) determine how to best illustrate uncertainty, 7) develop guidelines for implementation.
- **What you will learn:** How to predict deterioration and failure of bridge components in infrastructure management, how to predict future interventions automatically, and how to connect models to BIM.
- **What is a successful project?** Connection of prediction models to BIM and demonstration of the possible visualization.
- **Prerequisites:** Infrastructure Management 1 or Infrastructure planning, discussion with Simon Hässig or Prof. Adey



Connected to: ASTRA

8 – Estimating missing risk data with Bayesian networks

Limited to 2

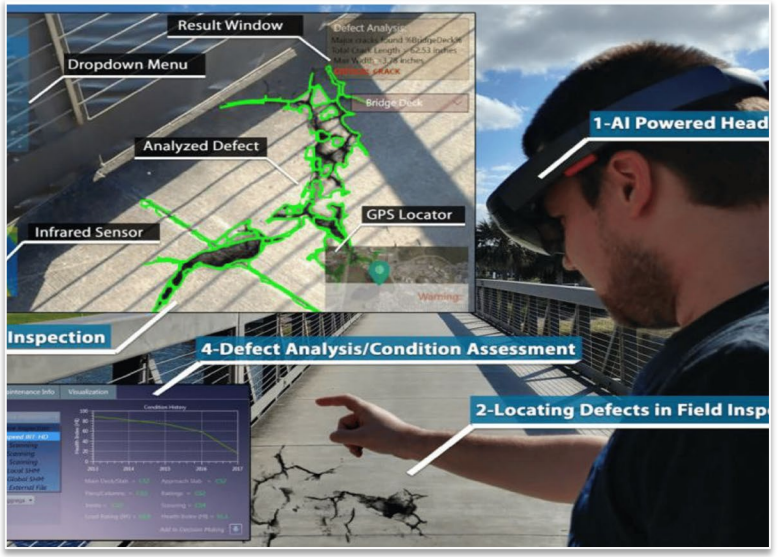
- **Supervisors:** S. Chuo (chuo@ibi.baug.ethz.ch), S. Hässig (haessig@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** To demonstrate how Bayesian networks can be used to estimating missing data for risk estimation for locks and weirs.
- **Main Tasks:** 1) understand how locks / weirs work, 2) understand how risk estimates are made, 3) develop a tailored risk estimate methodology for the locks / weirs of BAW, 4) identify all information required, 5) adapt an existing methodology from IBI to estimate the required values when there is no data and when there is partial data, 6) demonstrate how the methodology works on a set of locks / weirs.
- **What you will learn:** How to estimate risk on infrastructure assets, and how to make estimates of missing data using Bayesian Networks.
- **What is a successful project?** A clear demonstration of how good one can estimate missing data using Bayesian Networks to facilitate risk estimates.
- **Prerequisites:** Infrastructure Management 1 or Infrastructure planning, discussion with Simon Hässig, Steve Chuo, or Prof. Adey

Connected to: BAW, Germany

9 – Use of extended reality of bridge inspections

Limited to 1

- **Supervisors:** Yushu An (an@ibi.baug.ethz.ch), Simon Hässig (hässig@ibi.baug.ethz.ch), Prof Dr. Carl Haas (University Waterloo), Prof. Dr. B.T. Adey
- **Goal:** To demonstrate how extended reality and the supporting framework could be used to improve bridge inspection processes.
- **Main Tasks:** 1) understand how extended reality works, 2) understand how information needs to be structured so that it can be used in extended reality, 3) understand how information needs to be structured so that it is helpful for inspectors and managers to make decisions, 4) understand the different possible ways to display information, 5) learn how to connect information from existing data bases to extended reality devices, 6) determine how current inspection procedures would have to change and could be improved if extended reality was used, 7) provide an assessment of the advantages and disadvantages of using such a technology.
- **What you will learn:** how extended reality may (or may not) improve bridge inspections.
- **What is a successful project?** A clear demonstration the potential of improvement of bridge inspection processes through the use of extended reality.
- **Prerequisites:** Infrastructure Management 1; discussion with Prof. Adey.



Connected to: SBB

10 – Predicting future road condition

Limited to 1

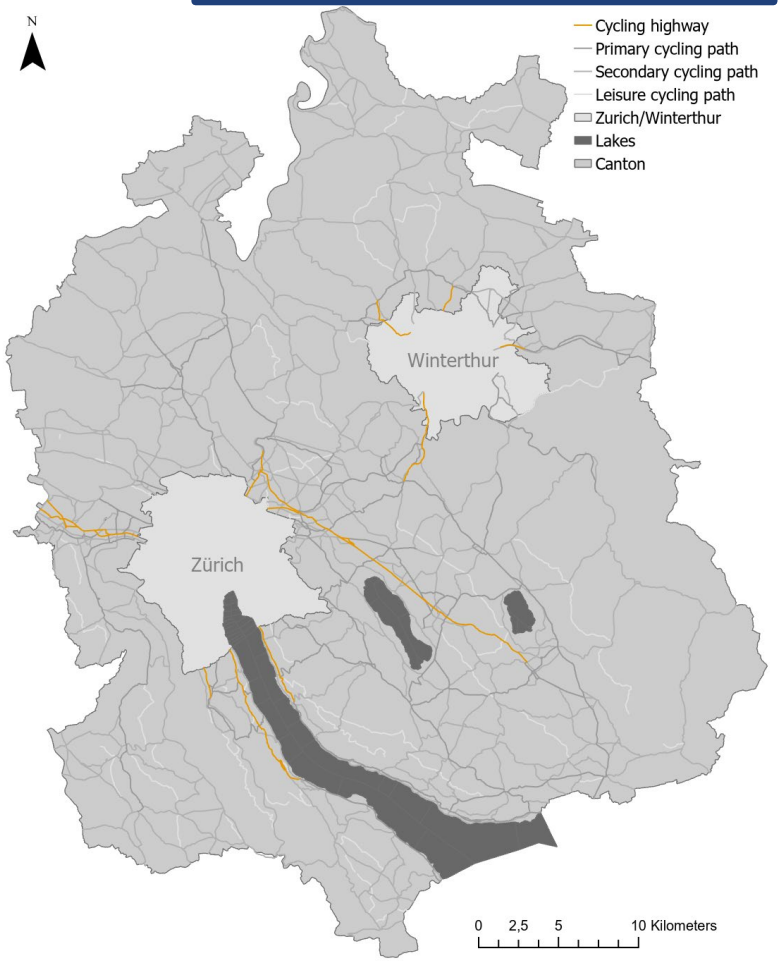
- **Supervisors:** Josia Meier (meier@ibi.baug.ethz.ch, Prof. Dr. B.T. Adey
- **Goal:** To predict the upcoming maintenance intervention need for road (highway) pavement sections on the A9 between Vevey and Lausanne.
- **Main Tasks:** 1) Analyzing the provided data, i.e., the measured pavement condition indicators from previous years. 2) Finding a suitable method to predict the indicator values into the future. 3) Use intervention strategies to determine which pavement interventions are needed and when they should be carried out. 4) You will approximate the costs of the interventions, and the time needed to execute them. 5) You will estimate the risk if the predicted interventions are not executed. 6) You will present your results and show them in a visually pleasing way, utilizing some form of 2D representation along the A9 axis.
  -> The programming needed will be helped with, please no fear because of that.
- **What you will learn:** Having an in deep knowledge on the tasks that infrastructure managers do, especially if they want to predicting maintenance needs for pavements.
- **What is a successful project?** Demonstrating in a visually pleasing way, what the upcoming pavement interventions for the A9 should be.
- **Prerequisites:** Infrastructure Management 1; basic coding knowledge and motivation to use it – Excel and (R or Python) will be used ; discussion with Prof. Adey.

Connected to: ASTRA

11 – Cycling infrastructure network completion

Limited to 1

- **Supervisors:** David Zani (zani@ibi.baug.ethz.ch), Arnór Elvarsson, Prof. Dr. B.T. Adey
- **Goal:** Assess different infrastructure projects at the network level necessary for completing a planned cycling network
- **Main Tasks:** 1) understand the cycling infrastructure planning process and its limitations, 2) apply state-of-the-art machine learning models to identify design solutions for existing network gaps over an entire network, 3) identify different ways in which the cantonal cycling network can be improved, 4) outline the required funding to complete the network in different possible designs, 5) discuss how these models contribute to decision-making and the efficiency and effectiveness of planning processes, and 6) (optional) make estimates about the impacts of the network once completed (considering, e.g., safety)
- **What you will learn:** How the cycling infrastructure planning process works, how to estimate cycling project costs at the network level, how to create an overview of interventions necessary to complete Canton Zurich's cycling network
- **What is a successful project?** An overview of the required interventions and costs to complete the planned cycling network in Canton Zurich
- **Prerequisites:** Infrastructure Management 1 or Infrastructure Planning; experience with coding (R or Python); experience with GIS (QGIS or ArcGIS); experience with machine learning is not required, but useful



Connected to: E-Bike City

Institut für Bau- und Infrastruktur-management

D BAUG

12 – Cycling crash analysis in Swiss cities

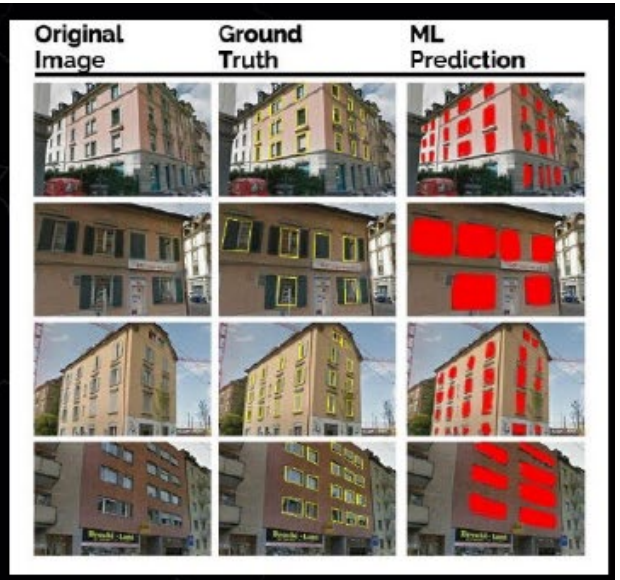
Limited to 3

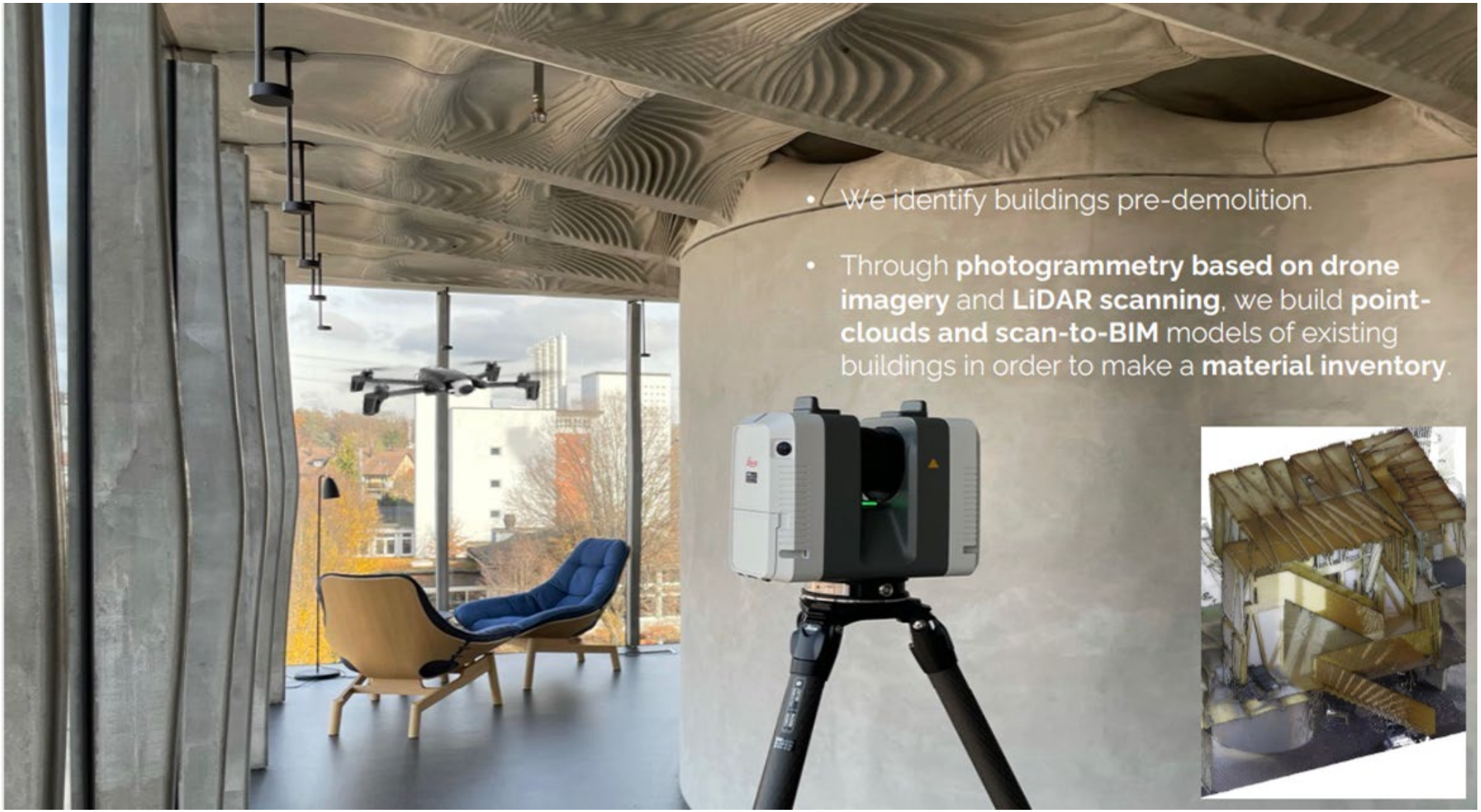
- **Supervisors:** David Zani (zani@ibi.baug.ethz.ch), Prof. Dr. B.T. Adey
- **Goal:** Provide a comparative analysis of cyclist crashes in different Swiss cities
- **Main Tasks:** 1) understand the nuances of analysing cyclist crashes, including seasonality, exposure levels, consequences, demographics, and causal factors, 2) adapt and apply developed algorithms to explore crashes in Swiss cities, relating them to spatial and temporal factors, 3) identify different crash trends in different cities and create and test hypotheses for the observed differences, 4), estimate updated crash risk values for different situations, and 5) outline the required further research and data collection to gain an even better understanding of crashes in Switzerland
- **What you will learn:** How a crash analysis is to be done and approaches to dealing with the challenges in working with limited available data
- **What is a successful project?** An overview and comparison of the crashes in different Swiss cities; possible explanations for the observed differences; updated crash risk values for different situations
- **Prerequisites:** Strassenverkehrssicherheit or Fuss- und Veloverkehr or discussion with supervisors; experience with coding (R or Python); experience with GIS (QGIS or ArcGIS)

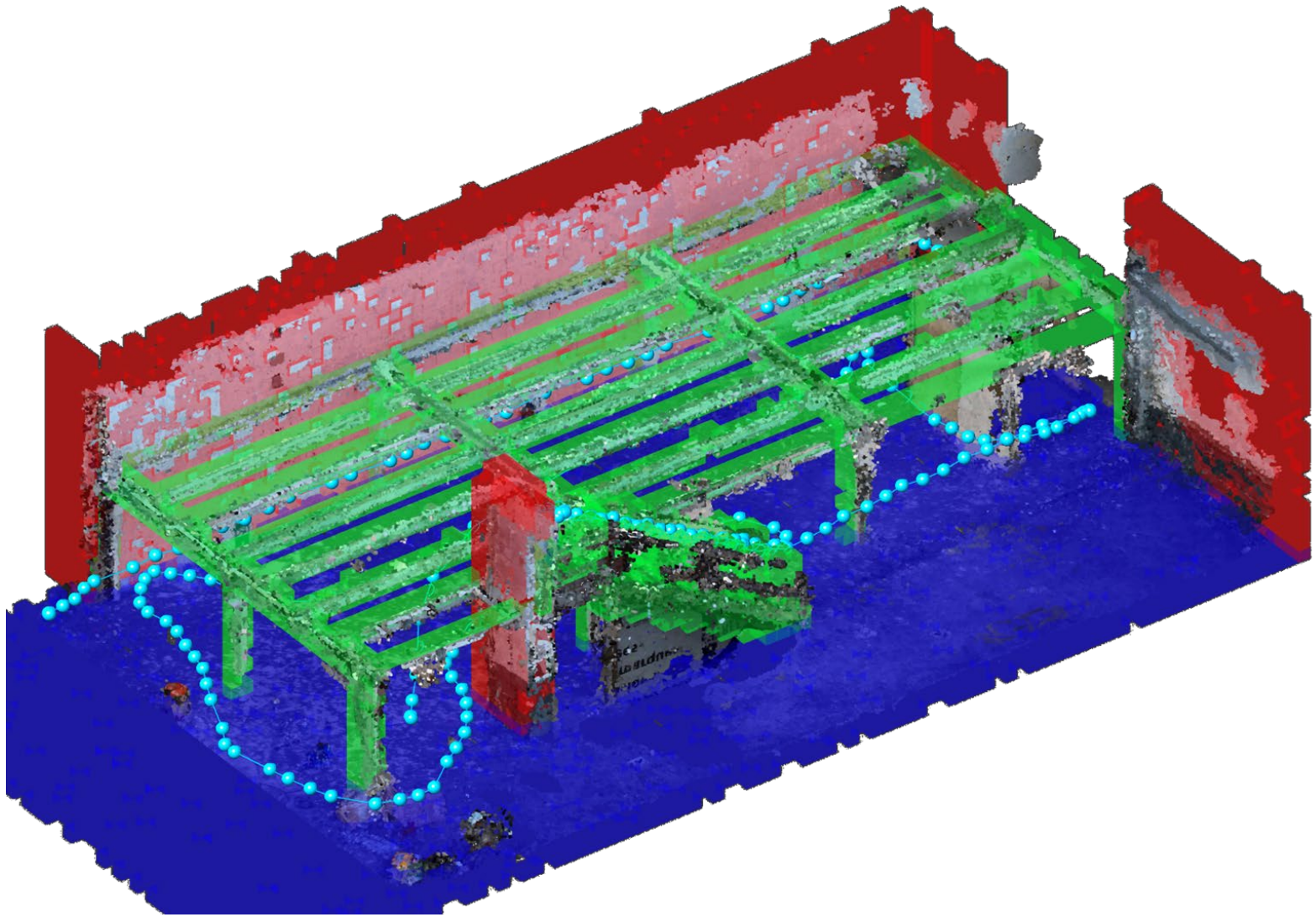
Connected to: E-Bike City

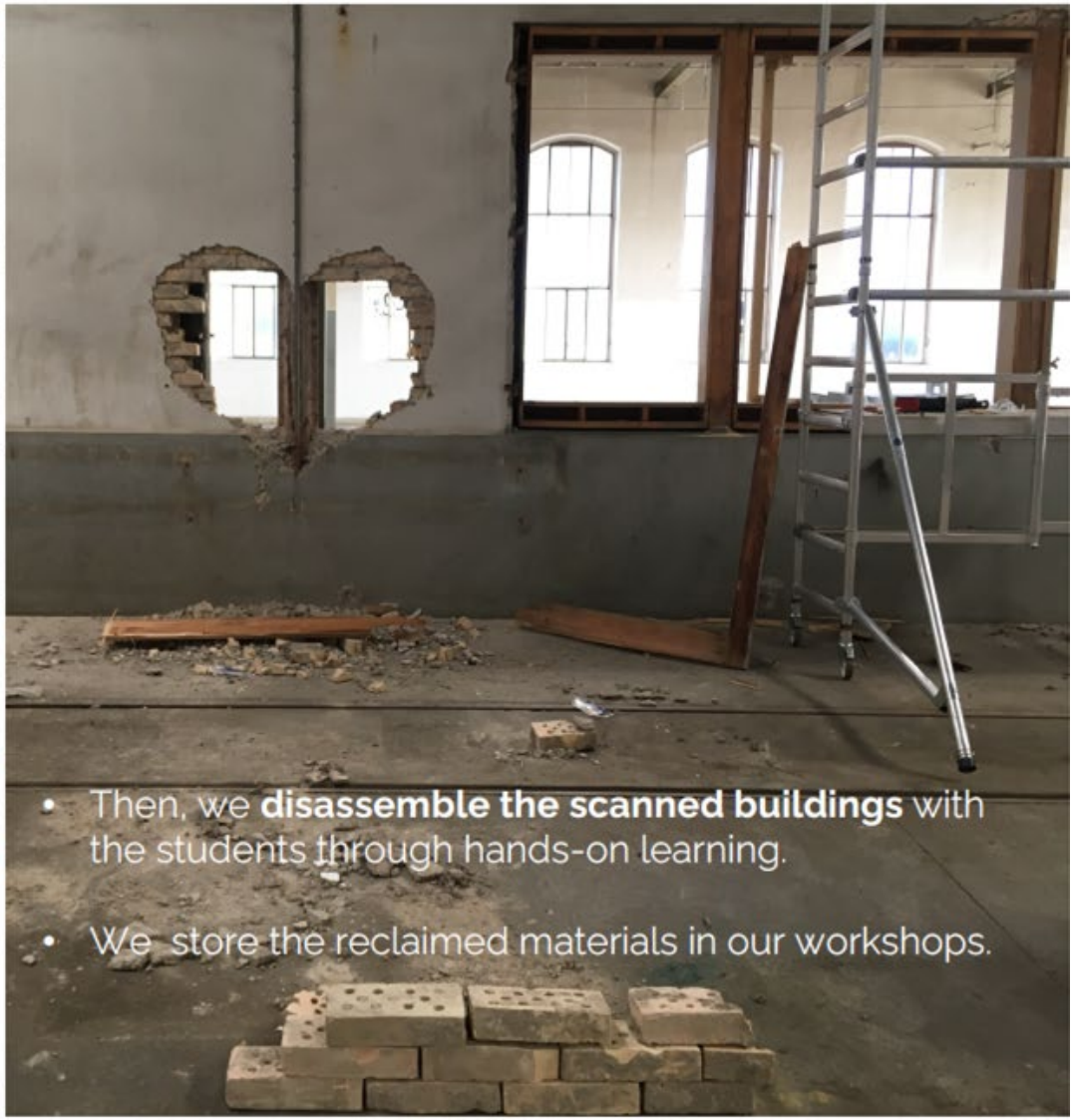

cea
Circular Engineering for Architecture
Prof. Catherine De Wolf
ETH zürich

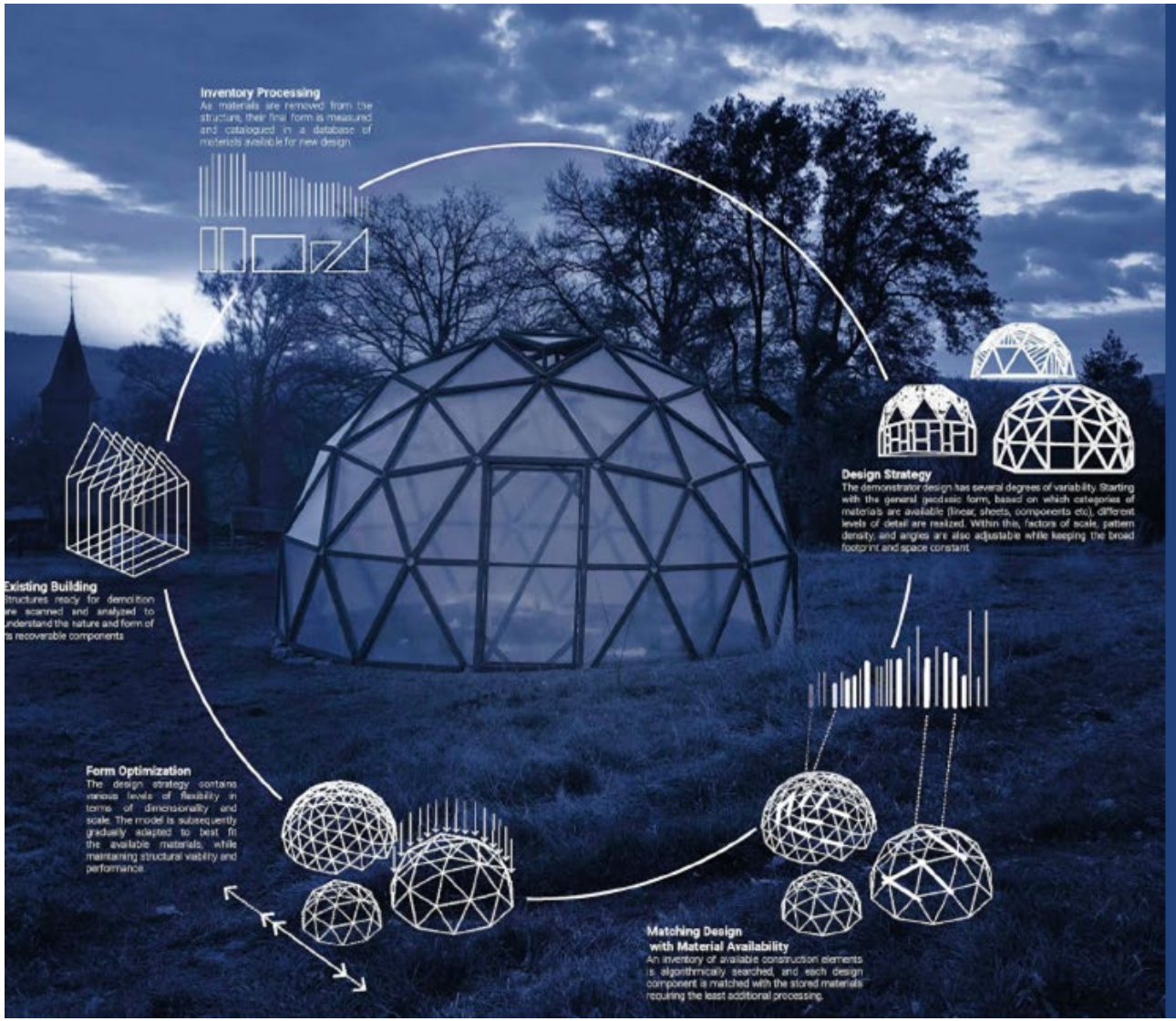
- Using **Machine Learning (AI)**, we predict which materials will become available for reuse based on Google Streetview data, cadastral data, photography, etc.




• We identify buildings pre-demolition.
• Through **photogrammetry based on drone imagery** and **LiDAR scanning**, we build **point-clouds and scan-to-BIM** models of existing buildings in order to make a **material inventory**.




• Then, we **disassemble the scanned buildings** with the students through hands-on learning.
• We store the reclaimed materials in our workshops.



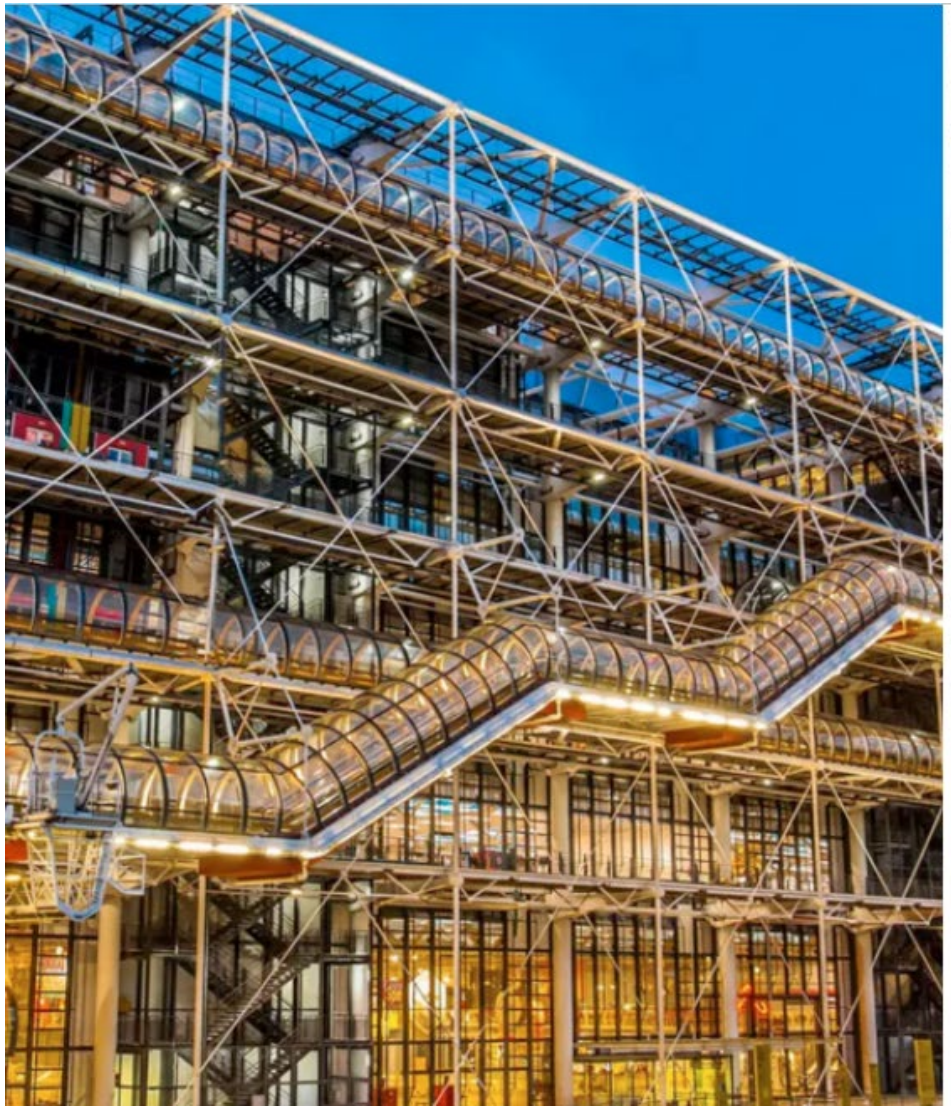
- Next, we use **computational design algorithms to match** our new design with the inventory of available materials.
- Finally, we **robotically assemble** the new structure with the reclaimed materials.

cea

Circular Engineering for Architecture

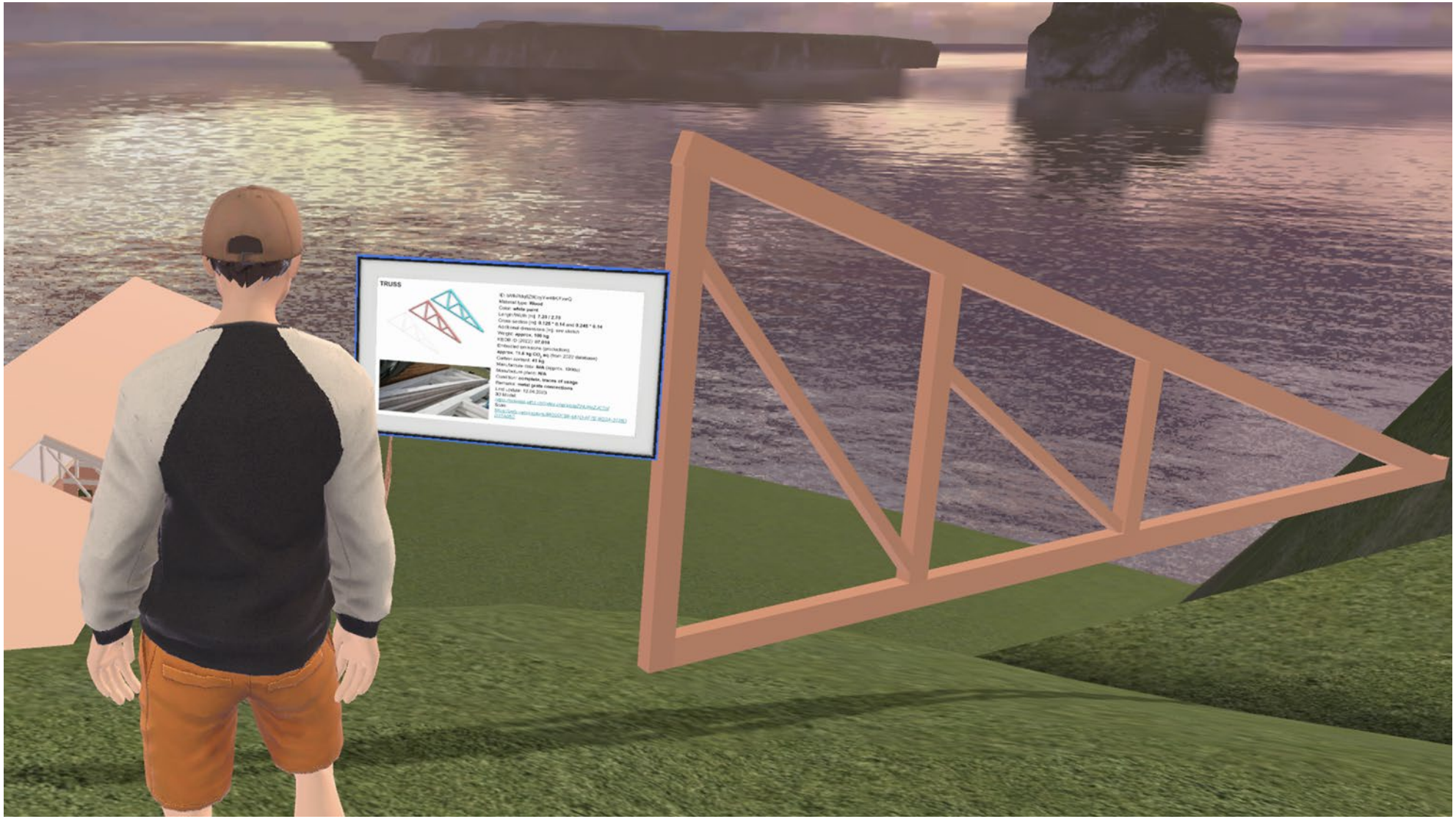
Prof. Catherine De Wolf

ETH zürich




The CEA lab fosters the reuse of **building materials** (such as the glass of the Centre Pompidou) through **digital innovation** to accelerate the transition to **a circular construction industry**

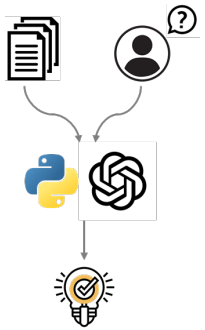
Ariza, Rust, Silvestru, Taras, Gramazio, Kohler, & De Wolf (2024).
"Lost and bound: adaptive detailing with robotic additive joining for reclaimed steel." Robarch


TRUSS

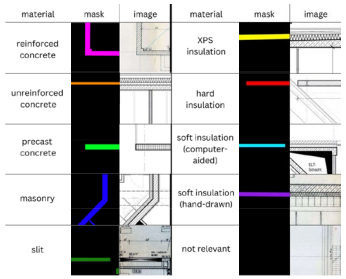
Topics

Master project

Master thesis



Leveraging AI for Intelligent Information Extraction from PDF Documents for Material Reuse in Architecture.



Material segmentation and classification using 2D architectural drawings

Chat with pre-demolition audit inventory – identify urban-wide hazardous materials using data mining and search augmentation

Pathways to Circularity: Investigating Product Take-Back Systems in the Construction Industry

COMPAS

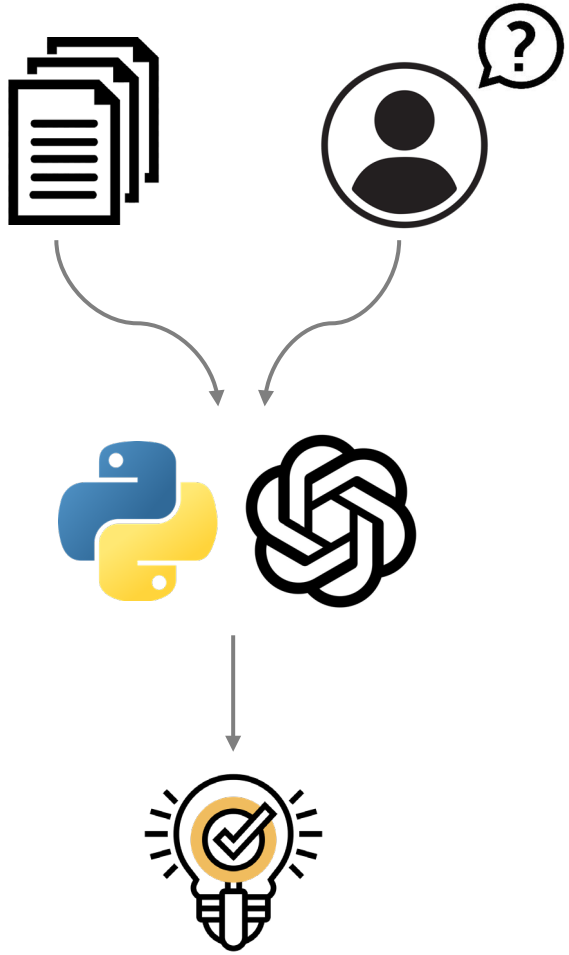
COMPAS LCA – a software package for life cycle assessment

Development of a pre-demolition audit and inventory tool

Leveraging AI for Intelligent Information Extraction from PDF Documents for Material Reuse in Architecture.

- **Supervisors:** Dr. Ioanna Mitropoulou (mitropoulou@ibi.baug.ethz.ch), Beril Önalan, Prof. Dr. Catherine De Wolf (D-BAUG)

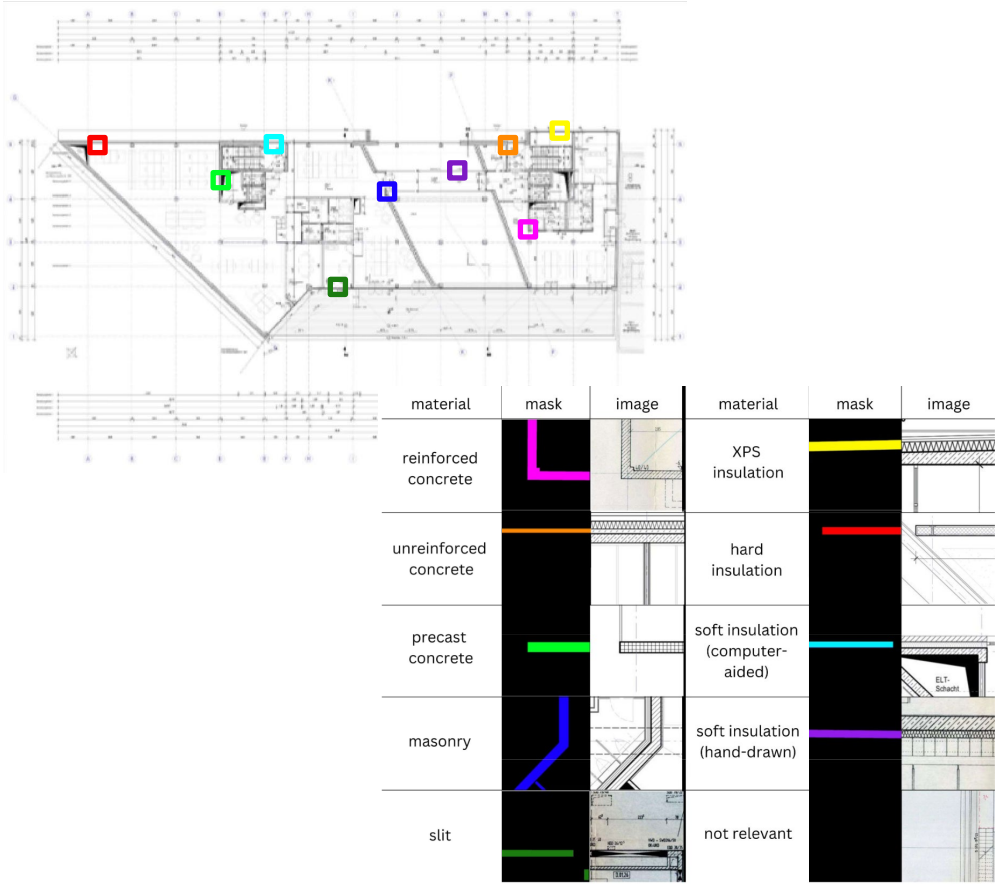
- **Goal:** Develop a Retrieval Augmented Generation (RAG) workflow that accesses and interprets information stored in a database of PDF files related to material reuse, leveraging AI methods to promote efficient material reuse. Challenges include:
  - How to parse PDFs, which are primarily designed to be human-readable, into meaningful segments that can be efficiently processed by the AI.
  - How to balance retrieval precision and generative capabilities to minimize hallucinations in the AI's responses.
- **Main Tasks:**
  - Setting up of the database with information on reuse, preprocessing the documents..
  - Development of algorithms for parsing the database, and handling different data types, such as text, images, and graphs.
  - Development of a user interface for data retrieval based on user input.
  - Evaluation of the accuracy of the responses by comparing with benchmarks.
- **What you will learn:** Using Large Language Models (LLMs) and RAG to retrieve information from databases to advance circularity in architecture and construction.
- **What is a successful project?** A successful prototype of a RAG workflow that returns accurate and relevant information in response to user input.
- **Prerequisites:** Curiosity and interest in AI and LLMs, experience with Python.



Material segmentation and classification using 2D architectural drawings

- **Supervisors:** Kasimir Forth (forth@ibi.baug.ethz.ch), Mikhael Johanes, Catherine De Wolf
- **Goal:** Detect, segment and classify materials from 2D architectural drawing and technical details for simplified Material Passports
- **Main Tasks:**
  - Collect and prepare relevant datasets of architectural drawings
  - Develop a workflow to detect, segment and classify materials
  - Implement prototypically, test and validate the method using prepared datasets
- **What you will learn:** State of the Art CV techniques, Material Inventory requirements of existing (as-designed) buildings
- **What is a successful project?** Improve accuracy of semantic segmentation compared to existing approaches[1]
- **Prerequisites:** Familiarity or willingness to learn Computer Vision tools for object detection and semantic segmentation, experience with Python

[1] Kairlapova, Ainur (2024): Material detection and classification in 2D architectural drawings using Computer Vision for Material Passports, Master thesis, Technical University of Munich



Kairlapova, 2024 [1]

Chat with pre-demolition audit inventory – identify urban-wide hazardous materials using data mining and search augmentation

- **Supervisors:** Dr. Pei-Yu Wu (pei-yu.wu@ai.ethz.ch), Carlo Schmid, Catherine De Wolf
- **Goal:** Most hazardous materials can not be detected from visual inspection during field surveys. Text mining and retrieval augmented generation (RAG) could provide an alternative solution to assess their presence in buildings
- **Main Tasks:** Creating a (semi-)structured database from pre-demolition audit inventories in Zurich and identify the patterns of hazardous materials using RAG
  1. Perform automated information extraction and organization from audit inventory
  2. Index relevant data and retrieve information as prompt for LLM
  3. Perform query and inference from the developed knowledge engine
  4. Quantify the uncertainty of inference to a larger building stock
- **What you will learn:** An opportunity to work with real-world building data from Zurich City Archive and learn cutting-edge AI techniques
- **What is a successful project?** A functional demo showcasing a digital workflow of data transformation and query
- **Prerequisites**: 1. Familiar with Python language and interested in ML in the building engineering field, 2. Preferably understand the German language
- **Extra**: The thesis is co-supervised by the Chair of Ecological Systems Design

Pathways to Circularity: Investigating Product Take-Back Systems in the Construction Industry

- **Supervisors:** Ana Bendiek Laranjo (abendiek@ethz.ch), Dr. Jens Hunhevicz, Prof. Dr. Catherine De Wolf (D-BAUG)
- **Goal:** Understand under which circumstances product take-back systems of manufactured products could be implemented as an innovative pathway towards circularity in the construction industry
- **Main Tasks:**
  - Conducting a literature review on existing product take-back (PTB) systems in the construction industry (CI) and other domains and identify existing cases of PTBs in the CI
  - Identify factors that could influence the implementation of these systems
  - Conduct a qualitative comparative analysis (QCA) to investigate the combination of factors that lead to PTB uptake
- **What you will learn:** Conducting QCAs and helping identify new business models to advance circularity in architecture and construction.
- **What is a successful project?** A successful review of PTB approaches in the construction industry and the conduction of a QCA
- **Prerequisites:** Curiosity and interest in qualitative research methods, business models, and using the programming language R

COMPAS LCA – a software package for life cycle assessment

- **Supervisors:** Heidi Silvennoinen (heidi.silvennoinen@ibi.baug.ethz.ch), Li Chen, Prof. Dr. Catherine De Wolf (D-BAUG)
- **Goal:** Implement a software package for life cycle assessment (LCA) within the COMPAS software framework.
- **Main Tasks:**
  - Review existing best practices in integration and automation of LCA in construction, including new approaches based on artificial intelligence and large language models [1].
  - Develop a COMPAS extension package for LCA with intelligent features and capabilities.
  - Validate the tool using project data provided by ITA (the Institute of Technology for Architecture), such as BIM models of various units from Empa's NEST platform.
- **What you will learn:** Conducting LCAs with state-of-the-art computational tools and AI; software development in the context of a large open source framework that is widely used in research and industry.
- **What is a successful project?** An open source LCA tool that produces useful results across a range of projects, and is interoperable with the wider COMPAS ecosystem.
- **Prerequisites:** Some familiarity with LCA; familiarity with Python.

The NEST units [2]

COMPAS

[1] Chen et al. (2024).Towards Automated Building Life Cycle Assessments: A Novel Approach Using Large Language Models and the COMPAS Framework https://app.iass2024.org/files/IASS_2024_Paper_471.pdf

[2] https://implenia.com/en/media/news-article/partner-empa-nest-beyond-zero/

Development of a pre-demolition audit and inventory tool

- **Supervisors:** Kasimir Forth (forth@ibi.baug.ethz.ch), Pascal Emmenegger, Arabelle de Saussure, Catherine De Wolf
- **Goal: Main Tasks:**
  - Research on current pre-demolition audit and inventory practice
  - Collaboration with stakeholders to identify component specific information requirements for inventories
  - Designing of a more user-friendly and error robust data capturing, insertion, and modification software tool/workflow based on a simple existing tool, incorporating new features identified (e.g. linking photos and inventory data)
  - Testing and usability evaluation with industry partners and on case studies
- **What you will learn:** Optimizing digital workflows for pre-demolition audits and efficient data management
- **What is a successful project?** Co-developing an app to collect inventory information for pre-demolition audits
- **Prerequisites:** curiosity in app development, interest in circularity and inventory processes

[1] Campanella, D.; Pietsch, R.; Dünger, O.; Sauer, S.; Mettke, A.; Schmidmeyer, S.; Teuffel, P.; Baitinger, M; Kroll, B.; Mees, K. (2023): DIN SPEC 91484 - Pre-demolition audit: https://www.din.de/de/wdc-beuth:din21:371235753

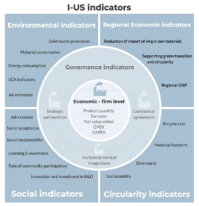
The Chair for Sustainable Construction gathers a group of scientists, engineers and architects who aim to ground sustainability in all disciplines involved in the built environment.

The objective is to identify the relevant parameters that influence the environmental impacts of buildings across spatial and temporal scales in order to implement sustainable practices throughout the development of innovative strategies adapted to each stakeholder.

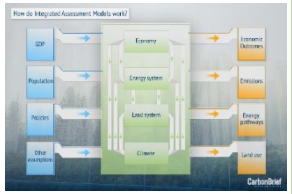
Topics

Master project and/or thesis

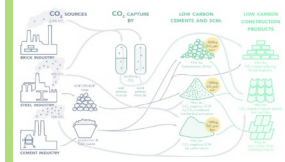
Master thesis



Circular economy indicators for urban-industrial symbiosis assessment



Building WLC emissions in IAMs for climate change mitigation



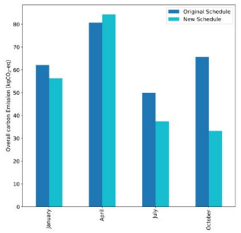
Estimation of CO2 and waste streams availability for carbon capture and storage in construction products in Europe

Assessing “Net-Zero” Strategies for the renovation of the HIL building

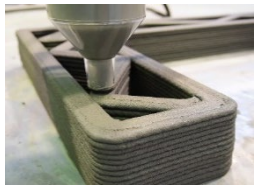
eco cocon STROH-MODUL

Assessment of prefabricated straw elements for Carbon negative construction

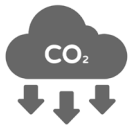
Carbon Intensity Estimation of Hyperloop Construction – A Case Study on EuroTube



Optimizing Prefabrication Schedules to Minimize Carbon Emissions



Optimising 3D-printed concrete structures for carbon capture and storage



Carbonate now or later? Dynamic LCA of construction products subject to enforced and natural carbonation

Assessment according to ESGs framework of water pipe maintenance technology

Master Project

Circular economy indicators for urban-industrial symbiosis assessment

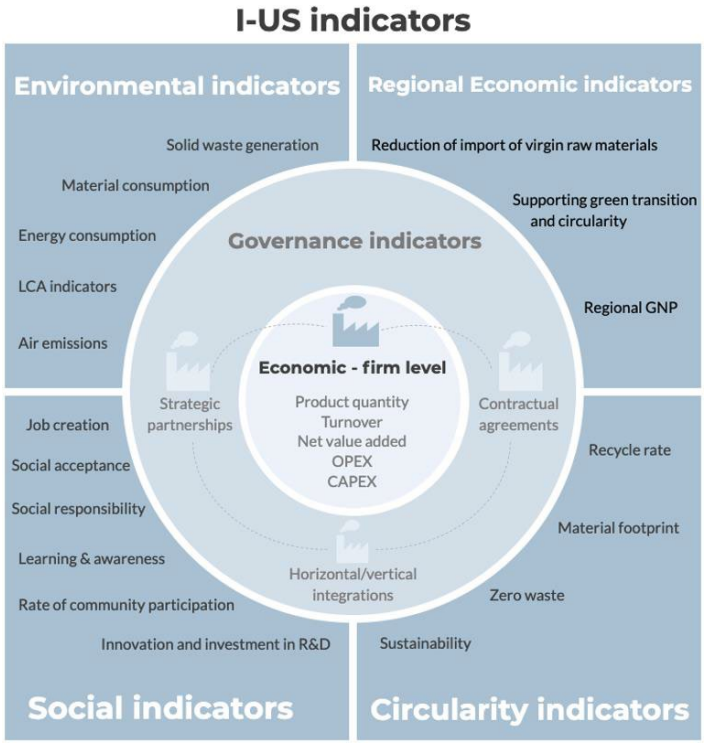
Supervisor: Anastasija Komkova (komkova@ibi.baug.ethz.ch)

Goal: Currently, there is a growing number of indicators used to assess sustainability of circular economy policies. Most of the indicators measure performance at material level. The objective is to screen the literature to identify indicators that evaluate sustainability of CE at meso levels that can be applied for urban –industrial metabolism within the context of waste recycling in construction materials.

Main tasks: Literature review of environmental, governance, economic, social, and circularity indicators. Weighting of indicators to identify the most relevant indicators for urban-industrial symbiosis assessment. Application to defined case study.

Prerequisites: Good analytical skills

Students: 1



Source: AshCycle project (2022) Indicator framework

Source: https://doi.org/10.1088/1742-6596/2600/17/172002.

Master Project / Master Thesis

Climate change mitigation models

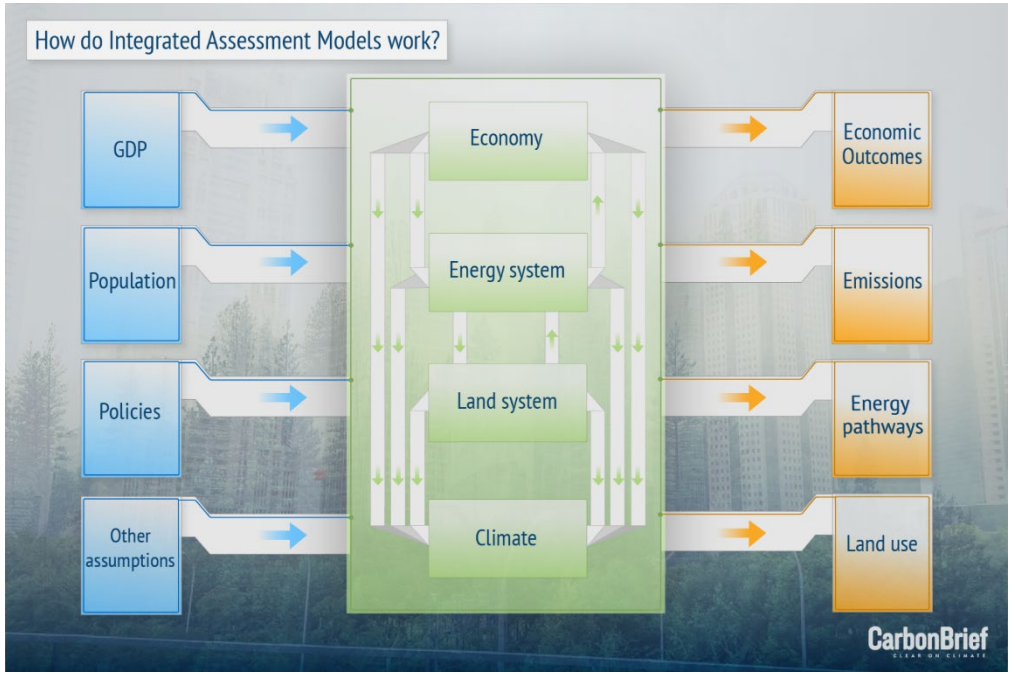
Understanding how building whole-life carbon emissions are considered by Integrated Assessment Models (IAMs) for climate change mitigation

Supervisor: Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)

Goal: To understand how Integrated Assessment Models (IAMs), which are used by the Intergovernmental Panel on Climate Change (IPCC) to analyse scenarios for carbon emission and mitigation options at the global scale, model the whole-life carbon emissions of buildings, including the identification of the parameters used to model the evolution of the building stock and corresponding emissions for the different Shared Socioeconomic Pathways (SSPs)

Main tasks:

- Review the documentation of the main IAMs used by the IPCC to identify the parameters used to model the carbon emissions of building-related sectors (buildings and construction materials industry)
- Compile the identified parameters in a systematic way
- Analyse and compare the modelling approach, the underlying premises, and the outcomes of the different IAMs for building-related carbon emissions



Source: CarbonBrief

Prerequisites: Good analytical skills / Interest in climate change mitigation

Students: 1

Master Project

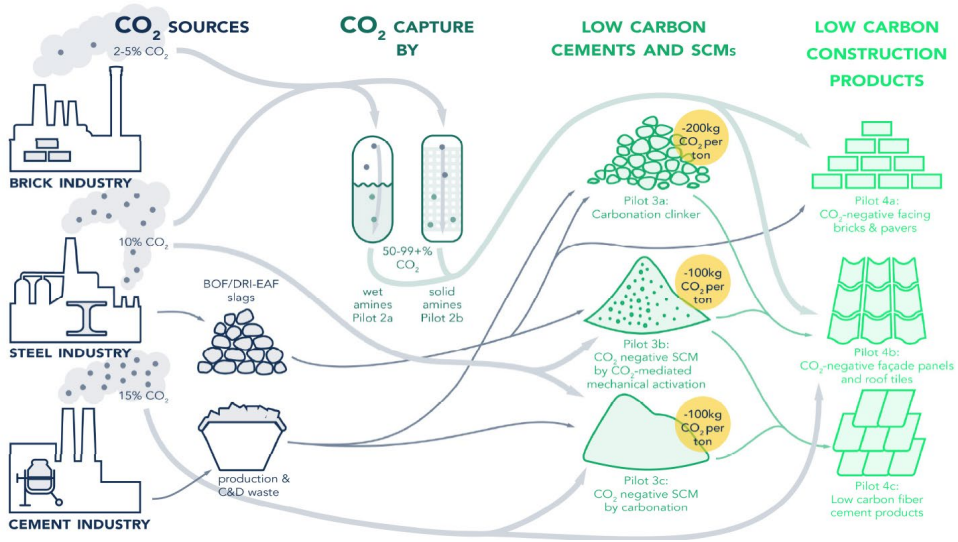
Estimation of CO2 and waste streams availability for carbon capture and storage in construction products in Europe

Supervisors: Nikhil Kunati (kunati@ibi.baug.ethz.ch)

Goal: To estimate the availability and location of large CO2 point sources and various waste streams such as steel slag, CDW fines, fibre cement waste and other relevant sources for CO2 mineralisation through carbonation into construction products

Main tasks:

- Identify CO2 and waste stream sources in Europe
- Understand the current flow patterns of these waste streams (use/disposal)
- Quantify CO2 and waste stream availability for carbonation
- Synthetize results in the form of a map



Source: Carbon4Minerals

Prerequisites: Basic knowledge about Material Flow Analysis (MFA) / GIS

Students: 1

Master Thesis

Assessing "net-zero" strategies for the renovation of the HIL building

Supervisors: Yasmine Priore (priore@ibi.baug.ethz.ch)

Goal: Define renovation measures and strategies for the HIL building and evaluate resulting life-cycle GHG emissions and biogenic carbon storage. Set-up of a potential pilot-project for a net-zero compatible renovation.

Main tasks:

- Identify renovation measures with low life-cycle emissions
- Identify materials with low-emissions and high carbon storage
- Define net-zero compatible goals for renovations
- Define scenarios
- Life Cycle Assessment calculations
- Estimate carbon storage potential

Prerequisites: Life Cycle Assessment (LCA) knowledge, basic knowledge about construction materials, knowledge of energy simulations, analytical skills

Students: 1

Bio based

Re-use

...

Master Project / Master Thesis

Assessment of prefabricated straw elements for Carbon negative construction

Supervisors: Christophe Beraudier (EcoCocon), Martin Paquot (Topophile), Guillaume Habert (habertg@ethz.ch)

Goal: EcoCocon is a growing and successful disruptive construction company, providing prefabricated element made with straw. How good is a good technology is the goal of the work.

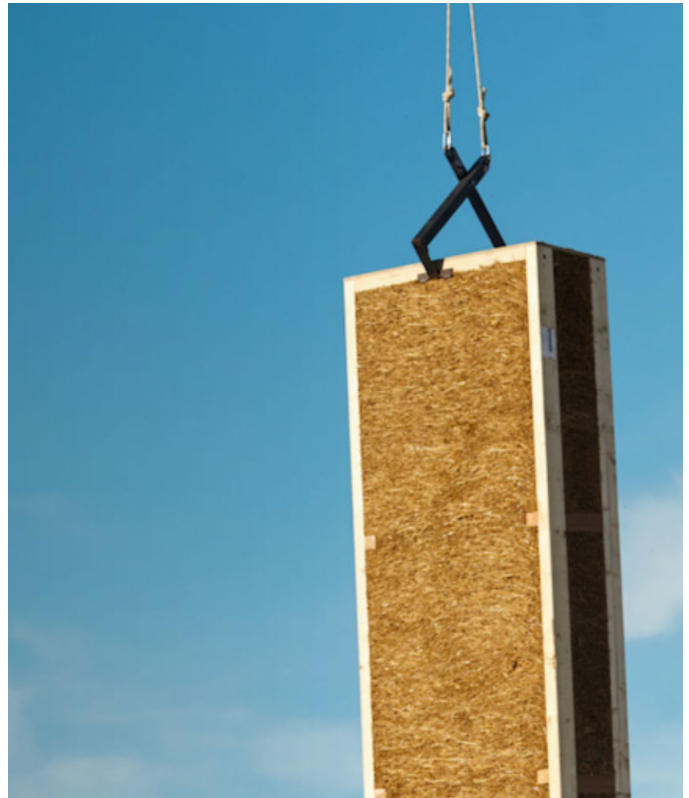
Main tasks:

- Calculate environmental impact from case study
- Test sensitivity of parameters
- Evaluate economic costs sensitivity
- Comparison and defining of optimal carbon negative options

Prerequisites: none except interested by strawbale construction

Students: 1

eco cocon STROH-MODUL



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Master Project

Carbon Intensity Estimation of Hyperloop Construction – A Case Study on EuroTube

Supervisors:
Jianxiang Ma (ma@ibi.baug.ethz.ch)

Industrial Partner: EuroTube Foundation

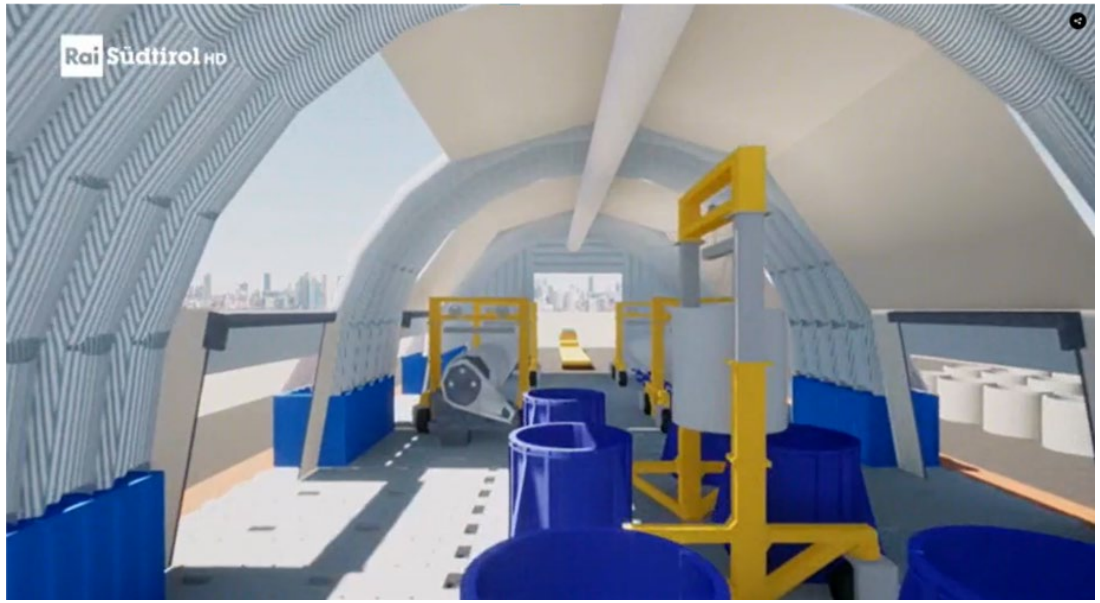
Goal: Evaluate the carbon emissions from the construction process of hyperloop infrastructure, including transportation, prefabrication, and on-site installation.

Main tasks:
- Conduct a literature review and collect relevant data
- Develop an LCA model for the construction process
- Perform a case study on the Zurich-to-Bern hyperloop construction

Prerequisites: Basic knowledge about Life Cycle Assessment

Students: 1

EuroTube Prefabrication Field Lab



Source: Smart Mobile Factory for Infrastructure Projects (SMF4INFRA)/

Master Project

Optimizing Prefabrication Schedules to Minimize Carbon Emissions

Supervisor: Jianxiang Ma (ma@ibi.baug.ethz.ch)

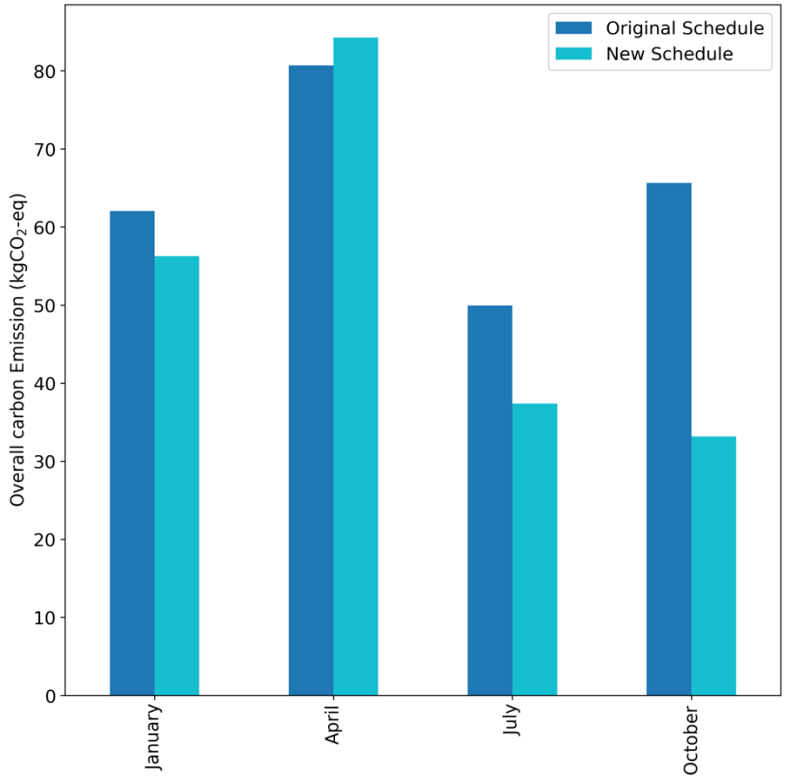
Industrial Partner: EuroTube Foundation
Goal: Evaluate the carbon reduction potential by optimizing the scheduling plan for the hyperloop pipe prefabrication based on dynamic CO_2 database reflects changes in the electricity mix.
Main tasks:

- Conduct a literature review on scheduling strategies and Life Cycle Assessment (LCA) in prefabrication
- Develop a mathematical model to calculate carbon emissions for different prefabrication schedules
- Apply the model in a case study on the EuroTube project from Zurich to Bern

Prerequisites:

- Basic knowledge about LCA and mathematical optimization
- Basic Python programming skills

Students: 1



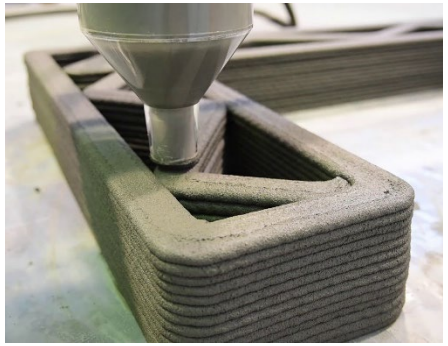
	Concrete pump	Post-tension machine	Coating sprayer	Vacuum pump
Electricity [kWh]	600	15	54	33
Original Schedule	10:00 -12:00	14:00-17:00	14:00-17:00	10:00-11:00
New Schedule	**14:00-16:00**	14:00-17:00	14:00-17:00	10:00-11:00

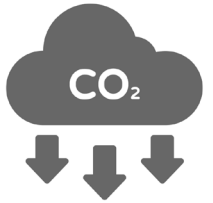
Master Project / Master Thesis

Optimising 3D-printed concrete structures for carbon capture and storage

Supervisors: Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)

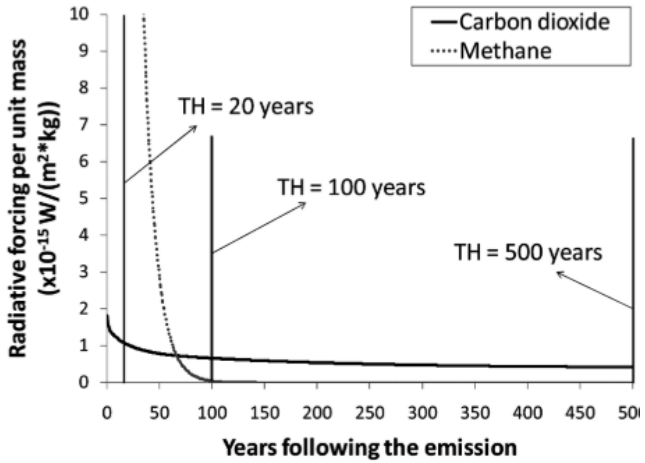
Goal: To define the combination of parameters required for 3D-printed concrete structures to have a lower global warming potential than conventional cast-in-place structures, considering the timing of CO2 emissions and removals due to natural carbonation





Main tasks:

- Identify the parameters required to calculate CO2 emissions and removals of a hypothetical concrete wall considering cast-in-place and 3D-printed alternatives
- Parametric modelling of the carbonation mechanism for quantifying CO2 removal
- Define ranges for the values of each of the parameters (min-max)
- Assess the GWP using dynamic LCA
- Defining the ranges/combinations of parameters that lead to 3D-printed structures with lower GWP than cast-in-place structures



Prerequisites: Life Cycle Assessment (LCA) knowledge, basic knowledge about construction materials, analytical skills

Students: 1

Master Project / Master Thesis

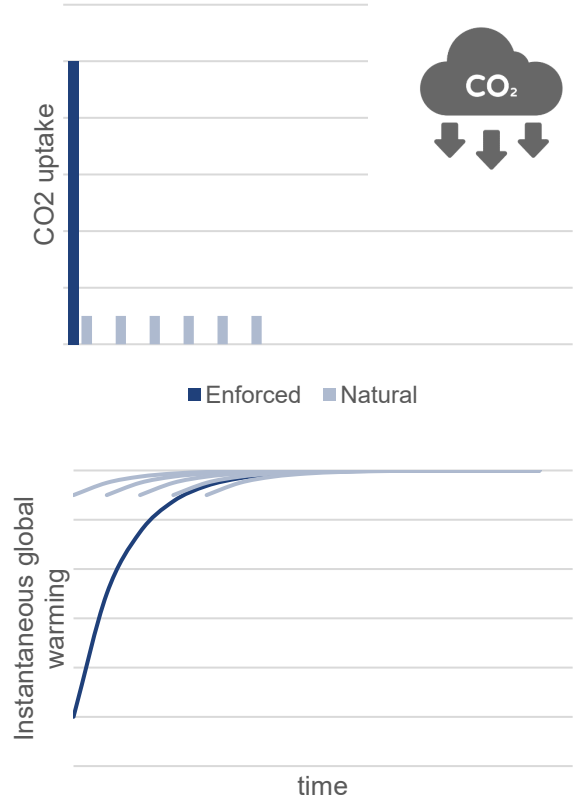
Carbonate now or later? Dynamic LCA of construction products subject to enforced and natural carbonation

Supervisors: Dr. Fernanda Belizario-Silva (silva@ibi.baug.ethz.ch)

Goal: To compare the global warming potential of construction products that absorb CO2 via enforced carbonation with alternatives subject to natural carbonation using dynamic LCA, to assess the environmental benefit of promoting carbonation at early stages

Main tasks:

- Model the CO2 uptake of mineral construction products subject to enforced carbonation
- Model the CO2 uptake of mineral construction products subject to natural carbonation over their service life for different application scenarios
- Assess the global warming profiles of the enforced and natural carbonation alternatives over time using dynamic LCA
- Compare the results to evaluate the environmental benefit of enforced carbonation (carbonation degree + carbonation speed)



Prerequisites: Life Cycle Assessment (LCA) knowledge, basic knowledge about construction materials

Students: 1

Institut für Bau- und Infrastruktur-management

D BAUG

Master Project / Master Thesis

Assessment of the environmental and societal impacts of Dipan services

Supervisors: Dr. Verena Göswein (goeswein@ibi.baug.ethz.ch)

Industrial Partner: Dipan

- **Project**:

Dipan is a company specializing in anti-corrosive treatments and maintenance of sanitary water, heating, sprinkler and cooling networks in the real estate sector. The company seeks to assess the benefits of its services in terms of sustainability. Many buildings in Switzerland are experiencing problems of deterioration of water distribution pipes, linked to the development of corrosion (crevice corrosion for galvanized steel pipes, pitting corrosion for copper pipes). To prevent these pipes from deteriorating, Dipan offers three-step treatments:

- chemical cleaning of pipes
- creation of a protective sodium silicate film inside the pipes
- maintaining this film by injecting a low concentration of this product (which is consumable) into the domestic water supply.

Dipan's core business is the treatment and maintenance of domestic water systems.

Dipan's clientele consists mainly of institutional clients representing real estate funds, some of which are listed on the stock exchange. As investors are becoming increasingly aware of sustainability issues, indicators have been introduced, such as ESG and energy indicators for real estate funds.

Main tasks: We would then like to compare the effects of these three solutions on ESG scores and the environmental indicator,

Students: 1 student.