Catalog of Ideas for Developing Courses and Circular Competencies - Executive summary + table of content

Research Project: International Circular Competencies with Urban Mining as a Case

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Executive Summary

The present catalog of ideas for developing courses and circular competencies within higher education is a comprehensive compilation of educational strategies, institutional practices, and collaborative student projects centered around the themes of circular economy and urban mining. It is produced within the partner network of the international research project titled: Global Circular Competencies with Urban Mining as a Case, funded by Karl Pedersen and Hustrus Industrifond. The overall purpose of the research project is to develop approaches and methods to strengthen Danish students' global circular competences, so that resource use is minimized, and waste streams are utilized better.

The catalog comprises the following project deliverables: 1) A baseline on teaching circular economy and urban mining at different European educational institutions, 2) a comprehensive documentation of the International KEA Charrette 2023 on global circular competences with urban mining, 3) ideas for developing an elective course for KEA design focusing on developing circular design competencies, and 4) a detailed description of the resulting elective course 'Green Change Agents' for students at the Entrepreneurship and Design program at KEA Design.

KEA Design, part of Copenhagen School of Design and Technology (KEA) is leading the project[1]. The project partners are:

The international partners:

- Politecnico di Milano, Department of Architecture and Urban Studies (Italy) (**Andrea Bortolotti** and **Matteo Clementi**)
- Amsterdam University of Applied Sciences (the Netherlands) (**Kasper Lange**)
- OWL University of Applied Sciences and Arts (Germany) (**Susanne Schwickert, Lisa Pusch, and Christin Schäfers**)
- LAB University of Applied Sciences (Finland) (**Anne-Marie Tuomala**)

The Danish partners:

- MiMa – Center for Minerals and Raw Materials[2] (Jakob Kløve Keiding and **Rune Clausen**)
- Nordic Urban Mining (**Jasmin Skøtt** and Nikolai Bach-Andersen)
- DAKOFA (Waste and Resources in Denmark) (**Morten Carlsbæk**)
- Copenhagen Municipality (**Lauge Clausen**)

The KEA team:

- Rasmus Simonsen (2023, project lead)
- **Eva Brandt** (project lead in 2024 - 2025)
- **Ditte Dam Bangsund** (2024 – 2025)
- Lotte Jørgsholm Nerup (2024 – 2025)
- **Snorre Näsman** (2024 – 2025)
- **Emilie Victoria Ferraro Steuch** (2024 – February 2025)
- **Rikke Sigmer Nielsen** (March 2025 – December 2025)

The people mentioned in **bold** have been involved in creating the idea catalog. Thus, this publication is the result of joint work among the different partners in the research project. The executive summary refers to a large number of appendixes (app.) where more details can be found. The appendixes include written texts and slides from various presentations. In all, the publication is 1127 pages. Please be aware and respect that some images/ diagrams etc. in the presentations might be subject to copyright. For this reason, slides cannot be copied and used in other settings.

[1] On July 1st 2025, KEA merged with CphBusiness. The new institution's name is 'Business Academy Copenhagen' – in Danish 'Erhvervsakademi København' (EK).

[2] In May 2025 MiMa was re-founded and continues under the name 'Danish Mineral Intelligence Centre' (D-MIC).

1. Circular Economy and Urban Mining at Partner Institutions

The catalog provides a baseline on teaching circular economy and urban mining internationally anchored in project partners' initial presentations from 2023. At KEA, Senior Lecturer, PhD. Rasmus Simonsen was project coordinator and lead. He framed urban mining as a response to "anthropoceneophobia," a term describing the anxiety associated with human-induced environmental change. He argues for responsible pathways to futures shaped by resource scarcity and climate crisis. Urban mining is defined as the systematic reuse of anthropogenic materials from urban areas, including buildings, infrastructure, and e-waste. Simonsen highlights the hidden presence of conflict minerals in consumer electronics and the potential for material recovery through recycling, citing that one million recycled smartphones can yield significant quantities of copper, palladium, silver, and gold. Simonsen also introduces the Danish company Nordic Urban Mining, and the general objective of the international Charrette 2023 on Urban Mining (app. 1.1), which brought together the project partners and 84 international students during a one-week intensive design workshop in Copenhagen.

LAB University of Applied Sciences (LAB) in Finland, is represented by Anne-Marie Tuomala, Senior Lecturer and Project Manager. LAB emphasizes the integration of circular economy into applied research, education, and innovation. The university offers online degree programs in Sustainable Solutions Engineering and Urban Sustainability, and participates in international joint degrees such as a Master's in Urban Climate and Sustainability. LAB's urban mining activities include the Niemi Living Lab project in Lahti, which explores material reuse in a partially demolished industrial area. Other initiatives involve the reuse of windmill metals, mixed construction and demolition waste, and underground pipeline materials. LAB's pedagogical approach includes flipped learning, project-based courses, peer review, and collaboration with external commissioners (app. 1.2).

Amsterdam University of Applied Sciences (AUAS), represented by Kasper Lange, PhD, contributes with a detailed overview of its circular economy education and -research. AUAS integrates circularity across faculties, particularly within the Faculty of Technology, which hosts educational programs in engineering, logistics, and urban technology (e.g. MSc. Urban Technology) as well as a research group on Circular Design and Business. Lange describes the use of game-based learning to teach circular business model innovation, referencing the "Re-organise" game, which was developed in collaboration with other researchers. AUAS also supports interdisciplinary collaboration through Communities of Practice and high-tech labs such as the Data Lab, Maintenance Lab, Urban Design Lab, and Robot Lab. Research projects include the reuse of insulating glass, circular wood systems, and organic waste valorization (app. 1.3).

Politecnico di Milano (DAStU), represented by Andrea Bortolotti and Matteo Clementi, focuses on urban mining as a design and planning methodology. In their research and didactic activity, they approach urban mining primarily as a lens through which it is possible to map material stocks and flows in the built environment. The aim is to assess waste & resource stocks but also to better understand local management practices, to inform situated planning and design. The teaching and research programmes of Politecnico di Milano employ a range of analytical tools such as GIS-based modeling, Material Flow Analysis (MFA), and environmental footprint assessments. These tools enable students to understand the material composition of urban environments and to identify opportunities for reuse and circular transformation. Also, sociotechnical analysis, participatory action research, and interdisciplinary collaboration are increasingly explored in this institution, especially at the LABSIMURB laboratory for urban simulation. Students are encouraged to engage with real-world contexts, conduct fieldwork, and develop design proposals that respond to environmental, infrastructural, and social challenges. The institution's emphasis on circularity is reflected in its curriculum, which includes courses on regenerative design, agroecology, and urban metabolism (app. 1.4).

The University of Applied Sciences and Arts OWL (TH OWL) has long-standing expertise in Sustainability, Circular Economy, and Urban Mining, developed at the Detmold School of Architecture and Interior Architecture and at the Institute for Energy Research (iFE) in the Circular Lab. Research at TH OWL explores circular strategies at multiple scales, combining material research, life-cycle assessment, and prototyping. Research initiatives such as the Smart Recycling Factory, CirQualityOWL plus, ProZirkulär, CO2BAU, Urban Pulse and Circular Playground expand these principles into practice. They focus on circular planning, construction, and

operation of existing and new buildings, as well as the role of gray energy and recyclable materials, anthropogenic storage and urban mining, and circular design in public spaces. One focus is on circular regulations and methods such as the building resource passport or the application of circular assessment methods.

This application-oriented research approach is evident in real-world laboratories with practical partners in the region. Here, specific buildings are analyzed for their reuse and recycling potential, and circular concepts for reuse and circular construction methods are developed and evaluated.
The Circular Lab also focuses on the process perspective of the involved stakeholders and the participation of the population. Within the Circular Lab at iFE, interdisciplinary teams work on transitioning from linear to circular construction models, integrating environmental data, digital tools, and reuse strategies. TH OWL's contribution emphasized practical, research-based methods to promote circular transformation in design and building education (app. 1.5).

2. KEA International Charrette 2023

A major joint effort for everyone in the research project has been to contribute to an intense international one-week design workshop (a Charrette on Global Circular Competences in Urban Mining) hosted by KEA in Copenhagen October 8-13, 2023 (app. 2). 84 Danish and international students attended the charrette in 2023. The students came from 21 different educational programs at 10 institutions: Berlin Hochschule für Technik (Germany), Fontys University of Applied Sciences in Eindhoven (the Netherland's), University of Applied Sciences (Austria), FH Saltzburg (Austria), George Brown College in Toronto (Canada), Senac University (Sao Paolo), Toronto Metropolitan University (Canada), Humber College (Canada), Sheffield Hallem University (UK), and KEA. 38 Danish and international teachers and researchers provided talks, supervision etc., and 10 Danish organizations and companies attended.

Students were divided into ten international design teams, each assigned to one of five urban areas in Copenhagen: Utterslev Square, Skjolds Plads, Red and Black Squares, Rentemestervej, and Fuglekvarteret. Each team worked with a local collaborator—such as community organizations, cultural centers, or municipal partners—to explore available resources, identify stakeholders, and develop circular solutions tailored to the specific neighborhood.

Snorre Näsman from KEA introduced the Charette and the Double Diamond design process, which includes four phases: Discover, Define, Develop, and Deliver. This model encouraged students to begin with broad exploration and problem identification, followed by focused ideation and prototyping. The process emphasized divergence and convergence, iterative thinking, and stakeholder engagement. Näsman also highlighted issues to be aware of when working with wicket problems in practice. The brief was integrated by Rasmus Simonsen from KEA, who framed urban mining as a methodology for reclaiming materials from cities and disrupting wasteful consumption patterns. In the design brief students were challenged to design solutions that:

- Focused on a specific type of human-made material available in the assigned local urban environment.
- Created value for a local company or organization.
- Incorporated at least one circular economy principle (reuse, repair, refurbish, recycle).
- Engaged everyday citizens in the design process.

Deliverables included video documentation of the design process, a physical prototype, a longer digital presentation, and a one-pager summarizing the concept. During the final presentations each team presented to their local collaborator and a jury composed of advisors and external experts.

In app. 2.6 – 2.10, slides from different kick-off presentations from the project partners, aiming to inspire the students, can be found. Rasmus Simonsen made an introduction to urban mining and the design brief. Kasper Lange made a presentation on 'Advancing Urban Mining: Lessons from Circular Economy Research and Education in Amsterdam'. Furthermore, Rune Clausen from Center for Minerals and Raw Materials talked about: 'The Circular Economy – Examples of Challenges and Possibilities'. With a decade of experience in mineral

intelligence, Clausen explained the key forces driving raw material demand in the ongoing green transition—from declining fossil-based extraction to increasing metal mining. He identified supply risks and metallurgical challenges in metal recycling as major concerns and emphasized the paradoxical nature of concepts such as the 'circular economy' and 'sustainable mining' in an economy with growing demand. As solutions for increasing recycling, Clausen: 1) introduced the concept of raw-material criticality as an assessment tool for prioritizing recycling efforts; 2) demonstrated the importance of design for recycling (DFR), using a dismantled computer as an example; 3) emphasized the need for systemic analysis to identify the most effective solutions to waste problems; and 4) proposed lifecycle supply-chain partnerships to support effective urban mining strategies.

The catalog also includes a curated research and resource package designed to support participants in the KEA Charrette and future course development. This package compiles key academic texts, conceptual frameworks, and practical tools related to urban mining and circular economy (app. 2.11 – 2.13). The resource package begins with a reflection on the Anthropocene, emphasizing the profound impact of human activity on planetary systems. Drawing on thinkers such as Crutzen, Cheng, and Saito, the document explores how industrialization, overconsumption, and global capitalism have led to ecological crises. It introduces alternative conceptualizations like the "Capitalocene," which critiques the role of corporate globalization and petrocapitalism in driving environmental degradation.

Urban mining is defined through the work of Cossu and Williams (2015) as the reclamation of compounds and elements from anthropogenic stocks, including buildings, infrastructure, and e-waste. The resource package outlines the stages of urban mining—prospecting, exploration, development, and exploitation—and contrasts it with traditional mining, highlighting its environmental and economic benefits. It stresses the importance of understanding material flows and stock availability to assess feasibility and impact. The circular economy is presented as a systemic alternative to the linear "take-make-dispose" model. Referencing the Ellen MacArthur Foundation and European Parliamentary Research Service, the resource package explains how circularity involves reusing, repairing, refurbishing, and recycling materials. It also addresses implementation challenges, such as market-driven consumption and the need to engage citizens as active stakeholders.

In addition to academic literature, the resource package provides links to image banks, maps, and data collection resources. These include historical archives, statistical databases (e.g., StatBank Denmark), and platforms like Euromonitor and Conzoom for demographic and market analysis. These tools enable students to contextualize their projects, understand local dynamics, and support evidence-based design. Thus, the resource package serves as both a theoretical foundation and a practical toolkit for educators and students working with circular economy and urban mining. It reinforces the interdisciplinary nature of the field and encourages critical engagement with environmental, social, and economic dimensions of sustainability.

Students' Final Presentations

The student projects developed during the KEA International Charrette 2023 are a central component of the catalog, showcasing examples of how interdisciplinary teams can apply circular economy and urban mining principles to real urban contexts in Copenhagen. Each group was assigned a specific area and collaborated with local stakeholders to identify challenges, resources, and opportunities for circular interventions (app. 3).

Utterslev Square featured two projects. Group 1 designed a community workshop system that repurposes end-of-life materials such as wood, textiles, and cardboard into new products. The initiative aimed to engage families through educational workshops and foster a sense of ownership and sustainability. Group 2 collaborated with the local social space Mamma Mia to promote circularity through urban mining workshops and a locally-based community network for sharing hand tools and skills.

Skjolds Plads was addressed by Groups 3 and 4. Group 3 proposed a physical installation made from reclaimed wood and plastic tiles, representing community events and growth. The structure would be relocated to a new kindergarten after five years, symbolizing continuity and circularity. Group 4 focused on transforming waste into welcoming spaces, creating modular furniture and installations that promote social interaction and environmental awareness.

Red and Black Squares inspired two projects. Group 5 developed a flexible wood system designed to be modular and recyclable. It utilized sidestreams from a local wood processing workshop used for educational purposes. The resulting wooden cubic system was multipurpose – suitable for sitting and children to play, decoration, plant cultivation, and more. It supported activities in the ”World’s Smallest Culture House”, emphasized community building and sustainability. The jury evaluated Group 5’s performance as the best. Group 6 created chess pieces from recycled cardboard pulp, enabling spontaneous play at public tables. The project used QR codes to connect residents with local stores that lend chess sets, promoting engagement and circular thinking.

Rentemestervej was the focus of Groups 7 and 8. Group 7 designed “Urban WoodWorks,” a youth engagement initiative that repurposes construction waste into adaptable playground structures. The project included a companion app and emphasized social inclusion. Group 8 proposed a creative workshop space at Klub Smedetoften, where unwanted furniture could be deconstructed and rebuilt. The initiative targeted young adults and aimed to foster community through engaging in circular design.

Fuglekvarteret was explored by Groups 9 and 10. Group 9 designed “The Bird House,” a pavilion made from reclaimed wood and glass, located near a local café. The structure included seating and a community garden, promoting green space and social cohesion. Group 10 developed “Hej Fugle,” a play-based workshop for children and parents, using recycled textiles to create hand-knitted objects. The project emphasized sustainability education and community connection.

Each project demonstrated creative use of reclaimed materials, stakeholder engagement, and alignment with circular economy principles. Students produced physical prototypes, digital documentation, and strategic plans tailored to their assigned neighborhoods. The diversity of approaches reflected the interdisciplinary nature of the Charrette and the adaptability of urban mining as a design methodology.

Evaluation of KEA Charette 2023

Following the documentation of student projects, the catalog presents a comprehensive evaluation of the KEA Charrette 2023, based on feedback from participating students and local collaborators. The evaluation highlights both the strengths and challenges of the Charrette, offering insights into its pedagogical impact and areas for improvement.

Strengths identified by students include:

- The interdisciplinary nature of the teams, which allowed for diverse perspectives and collaborative problem-solving.
- The opportunity to work on real-world challenges in Copenhagen, engaging directly with local communities and stakeholders.
- The hands-on approach to circular design and urban mining, which provided practical experience and fostered creativity.
- The cultural exchange and networking opportunities, which enriched the learning environment and broadened students’ horizons.

Students appreciated the Double Diamond design process, the inspirational talks, and the structured yet flexible format of the week. Many reported gaining confidence in their abilities, learning to work under time pressure, and developing new skills in teamwork, communication, and sustainability practices.

Still, several challenges were also noted:

- Time constraints were a recurring concern. Students felt that the five-day intense format was too short to fully develop and refine their concepts.
- Accommodation issues at the hostel were mentioned, including overcrowding and lack of quiet spaces for rest and study.

- Clarity of the brief was another point of critique. Some students found the assignment too open-ended, leading to confusion about expectations and deliverables.
- Group dynamics varied, with some teams experiencing unequal participation or interpersonal conflicts.
- Advising sessions received mixed reviews. While some advisors were praised for their support and expertise, others were perceived as disconnected from the local context or overly prescriptive.

Feedback from **local collaborators** emphasized the importance of earlier engagement in the design process. Collaborators suggested meeting with students mid-week rather than only on Friday, to allow for meaningful dialogue and integration of feedback. They also highlighted the value of projects that addressed specific community needs and demonstrated long-term potential.

The feedback to the jury was similarly mixed. Some students felt that the jury lacked understanding of the neighborhoods and the social dimensions of the projects. Others appreciated the constructive criticism and the opportunity to present their work in a professional setting.

The Charrette was widely regarded as a transformative experience, offering students a unique opportunity to engage with circular economy and urban mining in a collaborative, international setting.

3. Ideas for developing courses on circular design competencies

In spring 2024, the international partners provided input on developing an elective course on circular competencies and the green transition based on their own teaching. For instance, Andrea Bortolotti and Matteo Clementi described the syllabus for their own 2023 course, ‘Urban Planning Laboratory’, which is part of the POLIMI-AUIC School Bachelor program in architecture (app. 5.1). During the first 2,5 months of the course, Bortolotti and Clementi introduce urban design and planning theory in combination with group tasks in selected urban regeneration areas in Milan. The students then conduct fieldwork; map selected built environments and make spatial inventories of buildings based on datasets etc. In the remaining part of the course, student groups develop their own proposal for tackling major socio-spatial and environmental issues that emerged from the analysis.

Another example from Polimi was a six-week summer school ‘Architecture for Agroecology’ taught by Matteo Clementi. Here, the core subject matter is the integration of agroecological principles into architectural design to move beyond a human-centric model and create regenerative, circular systems supported by local material harvesting and micro-economies. Focus is on designing in harmony with natural ecosystems starting from a solid theoretical framework on circular design in local contexts. In their projects, students are to explore ”how urban and peri-urban mining can support circular generative design through the implementation of specific harvest maps and material libraries”. The design suggestions must utilize locally available materials and incorporate self-sustained systems for temporary buildings.

Among other things, Anne-Marie Tuomala suggested having the students make a ‘future forecast’ about how, for instance, city parks will look in the future, which is part of her course ‘Managing Urban Change’. LAB University of Applied Sciences also offers online courses in English, which could be announced as a prerequisite. Flipped learning was recommended, where video lectures are provided beforehand to encourage more discussion and reflection by students when meeting in class. (app. 5.3)

Kasper Lange provided links to, for instance, a 20-week Urban Innovation minor. A key objective of the minor is to train students as junior urban innovation consultants. A central theme is Urban Mining, which views the city as a complex system of resource flows (material, energy, data). The overarching goal is to transform the city into a fully circular, maintainable, and locally regenerative system by implementing small, innovative initiatives. Students work in interdisciplinary teams on a real-world external client assignment (e.g., companies, government) to develop innovative solutions. Lange also suggested game-based learning activities related to closing material loops. (Appendix 5.4)

Drawing on four bachelor courses in architecture and interior design developed by Lisa Pusch and Christin Schäfers at TH OWL, Pusch and Schäfers described how circular design competencies can be taught through integrated, practice-oriented learning. They shared the thoughts behind developing such courses, including how this requires a cross-disciplinary approach that links material understanding, design experimentation, and systemic thinking. Based on TH OWL's experience, effective learning formats combine theoretical frameworks of life-cycle thinking with hands-on methods such as material prototyping, digital mapping, and reuse strategies. Courses should integrate Life-Cycle Assessment (LCA) as a creative design tool, enabling students to evaluate environmental impacts while developing new forms of reuse and transformation (*Life-Cycle Assessment Workshop*). Studio work and workshops can operate as "circular laboratories," where students test dismantling concepts, explore design-for-disassembly principles, and develop 1:1 prototypes from reclaimed materials (*Urban Mining elective course*). Didactic experiments that translate circular concepts into educational practice (*Cycle Daycare project*) can broaden the social dimension of circular education. Embedding digital tools such as BIM-based material databases, blockchain documentation, or material flow analysis enhance data literacy and transparency in circular planning (*Smart Recycling Factory*, *NachLadBaR*). Finally, pedagogical formats should include interdisciplinary teamwork, reflective learning, and real-world application to foster agency and innovation in circular design practices (*Circular Lab, Institute for Energy Research – iFE*).

4. The Green Change Agents Course

The remaining part of the catalog presents the elective course 'Green Change Agents', which was held in 2024 at the Entrepreneurship and Design program at KEA Design. As described in the introduction to the course, the elective "is fundamentally about taking up the fight against the feeling of powerlessness we all encounter when facing" seemingly insolvable problems as climate change". The ambition is to develop and strengthen the students' circular competencies and provide them with the motivation and tools to contribute to the green transition. Working in small groups, the students collaborated with different start-up companies to explore how they could strengthen sustainable businesses through extensive research and codesign processes. (app. 6.1)

The course lasted six weeks including one week for the exams. Preliminary drafts of the course content etc. have been discussed with both national and international project partners. At the core is a series of lectures, hands-on tasks and critical reflection individually and in groups. In app. 6.2, the overall course plan and structure can be found. 13 lectures were held by international partners and faculty from KEA. In the following, the main content of the various lectures is presented in chronological order with references to slides in appendix for inspiration.

The Situation and Circular Economy

This first lecture by Snorre Näsman (KEA) was part of the elective's introduction. The goal was to give students a comprehensive overview of the global environmental situation, emphasizing the urgency of transitioning to a circular economy, and encourage personal reflection on why we as human beings have moved in a direction which clearly is not sustainable. In this respect, part of the lecture was a short presentation of how human societies evolved from nomadic lifestyles to settled agricultural communities, gradually separating themselves from nature. Scientific and industrial revolutions reinforced a mechanistic worldview, enabling technological progress but intensifying environmental pressures through mass production, resource extraction, and fossil fuel use. Today, socio-economic inequalities are stark, with a small fraction of the population controlling most global wealth, while resource consumption and environmental impact continue to rise. The Stockholm Resilience Centre's Planetary Boundaries framework was introduced as well as the main climate agreements from the 1987 Brundtland Report to COP28 in 2023, which were discussed to clarify the need for urgent systemic changes. A circular economy was presented as a way to address challenges by closing material loops, extending product lifespans, promoting reuse, recycling, and regenerative practices, and integrating both biological and technical material cycles. Businesses are encouraged to adopt durable, repairable, and dissemblable designs, supported by material banks and lifecycle documentation. Another important aspect of the sustainable transition is that it requires aligning individual behaviors, corporate strategies, and public policies to respect ecological limits, reduce material footprints, and regenerate natural systems. Thus, students discussed how they as individuals play a part in fostering a globally sustainable and resilient future. (app. 6.3)

A Material World – Do We Need New Architects?

Lisa Pusch from TH OWL gave a presentation on the topic of the new roles of planners and architects. She described the current role models for planners, which was also discussed interactively with the participating students. Then, using three examples from the circular value chain, Lisa presented new professional fields for planners: Re-use and design for disassembly (1), Urban mining (2), and Digital methods and assessments (3). These result in new job profiles, including tasks and skill sets: digital planner, component hunter, material expert, creative designer, and circularity consultant. In a concluding interactive Q&A session, the students shared their impressions of the future of construction in a circular economy. The key takeaways were consistently positive and forward-looking: changing professions, many new opportunities, the construction industry as a major innovator, and many different possible job profiles for planners. Opportunities and challenges were conveyed with a look at the construction industry and planning landscape in Germany, and transfer knowledge was successfully generated (app. 6.4).

Keeping Value by Keeping Materials in Loops

In her presentation, Anne-Marie Tuomala (LAB) explained how the circular economy keeps materials in continuous loops through design and planning, which is essential in reducing waste and emissions. The EU Waste Hierarchy prioritizes prevention, with landfill as the last resort. The R-Ladder shows that most circularity is determined at the design stage. Upcycling creates higher-value products, while downcycling lowers material quality. Recycling spans, primary, reuse to chemical and energy recovery, supported by processes like shredding and pyrolysis. Extending product life via repair, modularity, and service models slows material flows. Technical and biological cycles enable circulation, using monomaterials, bio-based alternatives, and nature-derived solutions. Hybrid products complicate recyclability, often leading to downcycling or disposal. Emerging trends include urban mining, material flow data, and viewing buildings as material banks. CE ultimately demands systemic change in design, business models, and consumer behavior for sustainable material use. (app. 6.5)

The New Role of the Designer

Today, design extends far beyond aesthetics or industrial production, encompassing the creation of experiences, systems, and solutions that address complex societal challenges. In this lecture Snorre Näsman (KEA) talked about how traditional design emphasized form-giving for mass production. Meanwhile, contemporary approaches position designers as facilitators, collaborators, and problem-solvers who work with diverse stakeholders. He gave a brief overview of how design practices have evolved from linear, method-driven processes to iterative, context-sensitive, and co-creative approaches. Modern design engages users as active participants, embraces interdisciplinarity, and navigates “wicked problems” where understanding and solution development evolve together. Designers balance divergent and convergent thinking, act intuitively, and operate across temporal and spatial scales, considering both immediate impacts and long-term societal consequences. The systemic design framework British Design Council’s Beyond Net Zero was introduced, in which designers act as connectors, storytellers, and systemic thinkers, fostering collaboration, empathy, and knowledge sharing across organizations and communities. Underlying this approach is the belief that complex problems require diverse perspectives, collective creativity, and collaboration over competition. In the elective, students are encouraged not to provide ready-made solutions but to guide organizations toward new strategic directions, facilitating experimentation, reflection, and co-creation in uncertain and dynamic contexts. (app. 6.6)

Introduction to codesign and codesign research

To assist the students gain confidence as facilitators and change makers, one week of the Green Change Agents course was dedicated to having the third semester students attending the course plan, lead and guide 84 first semester students to conduct design research on circular design and circular everyday behavior. Thus, in this presentation Eva Brandt (KEA) introduced codesign as a collaborative design approach and design-anthropological research of everyday practices. As an inspirational example, she presented how design students

had conducted research on dementia and Alzheimer's. The students gathered real stories from patients and relatives, and they incorporated the research in their design of codesign dialogue tools to support conversations on everyday life changes and challenges. Authentic stories were used to highlight identity, dignity, and relationships affected by the illnesses. Other dialogue tools supported conversations about early diagnosis and encounters with the healthcare system. The presentation highlights how co-design involves diverse stakeholders, material exploration, and collaborative meaning-making. It emphasizes rehearsing the future as an overall approach and strategies such as exploratory inquiry, sustained participation, and generative prototyping, where participants rehearse possible futures instead of merely analyzing existing conditions. The presentation also links codesign approaches to broader societal issues—health, welfare, sustainability, and citizenship—and discusses the importance of dealing with uncertainty, avoiding premature conclusions, and engaging deeply with people's everyday practices. Overall, the presentation positions co-design as a collaborative design practice for imagining and shaping better futures. (app. 6.7)

Introduction to Sustainable Materials and Circular Business Models

Ditte Dam Bangsund (KEA) introduced key principles of eco-design and circular business models as foundational tools for sustainable transformation in this lecture. Drawing on Martin Charter's *Designing for the Circular Economy*, eco-design was presented as the integration of environmental considerations across the entire product life cycle, supported by practical checklists and strategic decision tools. The lecture distinguished between incremental sustainability improvements in products, processes, or services and more fundamental shifts in business models, such as product-as-a-service and closed-loop systems. Several circular business model archetypes were explored, including dematerialization, life-cycle extension, and recovery of secondary raw materials. The concept of product integrity was introduced to emphasize the preservation of value and functionality over time, alongside a comparison of open-loop and closed-loop systems. In the second part of the lecture, selected insights from Daniel Liden's *Better Things* were used to build material literacy, with a particular focus on textiles. Students were introduced to fiber categories, renewable versus non-renewable materials, recycling limitations, and regulatory drivers such as the EU Green Deal. Overall, the lecture equipped students with conceptual frameworks and critical perspectives for advising organizations on sustainable materials and circular strategies. (app. 6.8)

Introduction to Systems Thinking - Part I and II

System thinking provides a framework for understanding complex, interconnected systems and identifying leverage points for meaningful change. At its core, a system consists of elements, connections, and purpose; the interactions among these define system behavior, often through reinforcing or balancing feedback loops. Real-world systems are dynamic, hierarchical, and self-organizing, exhibiting delays, emergent phenomena, and multiple possible futures. Understanding these characteristics is critical for diagnosing challenges and designing effective interventions. Thus, in two consecutive lectures by Snorre Näsman (KEA) system thinking was introduced, and a few methods were explored by the students. In the first lecture students worked with practical tools for analyzing complexity, including Multiple Cause Diagram. This tool helps visualize causal relationships, detect self-reinforcing patterns, and uncover hidden dependencies within personal routines or societal systems, such as energy consumption. By mapping these causes and effects, students tried to identify high-impact intervention points and develop coherent narratives to guide action. In the second lecture, the analysis extended to future-oriented strategies, and students worked with Joseph Voros' Futures Cone and Sohail Inayatullah's Future Triangle as ways to guide decision-making. The concept of tipping points was introduced and Sharpe and Lenton's concept of "tipping cascades" was presented as an example of accelerating system change. Finally, a brief introduction to Life Cycle Assessment (LCA) was made for students to understand the complexity of measuring environmental impacts across the entire product lifecycle. (app. 6.9)

Urban Metabolism: Design with Flows

In this lecture, Andrea Bortolotti (Polimi) explained that by concentrating resources, capitals, and people in spatially defined areas, cities are increasingly seen as global hotspots for material and energy consumption. Not

only do cities contribute to a large share of global environmental impacts (CO_2 emissions), but they also have an impact on the local scale on biogeochemical cycles, water cycles, and air pollution. Within this context, the study of the metabolism of cities has undergone impressive developments over the last decades. The urban metabolism concept emerged both as a metaphor (the city as a living organism) and an actual measurable aspect of the processes of energy, water, and food supply, accumulation, and disposal that sustain life in cities. Over the years, the list of metabolic studies of real cities has expanded to include Tokyo, Hong Kong, Vienna, and Stockholm, among others; accounting models have multiplied, ranging from material flow analysis to more complex life cycle analyses. Yet, few studies have attempted to move beyond analysis into re-designing sustainable or resource-efficient cities. Primarily, this is because of its *black-box* approach to resource flow analysis, which considers what is entering, exiting, and remaining in a system, but does not provide further details about the internal variables explaining the functioning of the system (*who* is using what flow, and where). By designing with flows, urban planners and designers approach the territory itself as a scarce and limited resource to be protected from further (over)consumption, for example, by reusing and densifying already existing urban fabrics. This approach is essentially territorialized: it looks at the context and situated resources, making the designer an agent of "care" and a mediator between parties with sometimes conflicting interests. (app. 6.10)

The Systemic Approach in Sustainable Environmental Design: References to the Ecology of Living Systems - Principles, Tools, Indicators and Strategies

In this lecture Matteo Clementi (Polimi) illustrates a systemic approach to sustainable environmental design, drawing on ecological principles and systems theory. It introduces foundational concepts from Herman Daly and Howard Odum to explain how living ecosystems regulate energy and material flows, and how these models can inform the design of anthropized systems. Key analytical tools are presented—such as Energy Systems Language, material flow analysis, and urban metabolism indicators—to map and quantify the interactions between human activities and natural ecosystems. The role of a person as a functional unit is emphasized for assessing sustainability through impacts such as energy consumption, CO_2 emissions, and ecological footprint. The presentation also explores global sustainability benchmarks, strategies derived from ecological "goal functions," and the operational implications for design: Maximizing circularity, enhancing local resource use, reducing non-renewable energy inputs, and improving system resilience. Finally, it introduces bioregional development strategies and multiscalar GIS-based tools (impact and resource geographies, user histograms) that support scenario-building and design decision-making, illustrated through case studies and supply-chain analyses (bread, hempcrete). The conclusion highlights how integrated, open-source, circular infrastructures (Local Atlas, Peri-urban Material Library, Open-Source Projects Hub) can guide sustainable local development. (app. 6.11)

Facilitation Techniques

This lecture introduced facilitation as a core competency for designers and change agents working with complex sustainability challenges. In the presentation Ditte Dam Bangsund (KEA) framed facilitation as process leadership rather than content delivery, emphasizing the facilitator's role as a neutral catalyst who creates direction, ownership, and momentum in group processes. Drawing on Implement and Høier et al., the session highlighted facilitation as deliberate work before, during, and after an intervention. The Design Star framework was presented as a practical planning tool, focusing on purpose, participants, form, environment, and roles. Attention was given to understanding participant preferences, power dynamics, and the importance of meeting participants "where they are," inspired by Kierkegaard's notion of the art of helping. The lecture explored the balance between being overprepared and understructured, enabling facilitators to respond constructively to uncertainty and emerging needs. During the facilitation phase, key behaviors such as creating meaning, managing energy, asking questions, and being conscious of power were addressed. The session concluded by emphasizing the post-process phase, focusing on documentation, ownership, and ensuring that workshop outcomes translate into concrete organizational action. (app. 6.12)

Organizing Codesign Events through Telling, Making, and Enacting

A central task for the students was to arrange and facilitate a workshop with the start-up companies to explore how more sustainable business models could look like. Instead of using 'one-size fits all' techniques and tools, the students should design collaborative activities and tools for the specific company grounded it its present reality. Thus, in the first part of the lecture Eva Brandt (KEA) explained Sander's diagram on how the use of different techniques evokes different kinds of knowledge, and how generative design tools can be used to connect past memories, present experiences, and future possibilities. Additionally, Eva provided examples of how collaborative design practices combine telling, making and enacting when exploring possible futures. In the second part of the lecture, examples of a space design process, and how design games in different variations can support ideation and reflection through speculative material explorations, were given. Throughout, the students were involved in discussions about how the examples could be used as inspiration when designing their own workshop activities for the companies. (app. 6.13)

Working as a Change Agent

This lecture explored what it means to act as an effective change agent in organizations undergoing sustainability transitions. Ditte Dam Bangsund framed change agency not as a formal leadership role, but as a practice that can be exercised by employees at multiple organizational levels. Drawing on perspectives from sustainability leadership, the lecture emphasized transformational change as the alignment of vision, organizational context, and concrete action. Students were introduced to a practical framework outlining key competencies of effective change agents, including understanding the core business, building credibility, and connecting sustainability initiatives to existing business strategies. The importance of timing, patience, and breaking complex ambitions into manageable steps were highlighted as critical for organizational uptake. The lecture also addressed relational and political dimensions of change, such as engaging constructively with leadership, challenging decisions respectfully, and navigating power dynamics. The students were encouraged to balance passion with strategic restraint to maintain credibility. Sustainability was positioned as something that must be embedded in organizational DNA rather than treated as an individual or temporary initiative. The lecture concluded with an applied exercise in which students developed concrete action proposals for driving sustainability change within an institutional context. (app. 6.14)

Green Agents – Green Change Makers

The last lecture was held by Anne-Marie Tuomala (Lab). It explored how individuals and organizations can drive sustainability by adopting strong environmental priorities and future-oriented thinking. A key driver of sustainable behavior is future orientation, the ability to consider long-term consequences over short-term gains. The presentation emphasized the role of change agents, who can be professional consultants, specialists from related fields, or managers acting without formal training. Leadership is central: Effective green leaders combine results-driven focus with people-centric values, and they require resilience, emotional intelligence, ethical integrity, and adaptability. Sustainable leadership is dynamic, evolving with globalization, technology, and cultural shifts. Practical implementation begins with actions such as waste reduction, energy efficiency, green purchasing, and transparent communication—avoiding greenwashing while engaging partners and suppliers. In project management, sustainability should be embedded from strategy to execution, with project managers applying "green lenses" to decisions. Finally, the presentation underscored that sustainability leadership is not static; it demands continuous learning, monitoring, and authentic engagement to align business success with environmental and social responsibility. (app. 6.15)

To summarize, the idea catalog emphasizes the importance of fostering global circular competencies—skills and mindsets that enable students to critically engage with sustainability challenges across disciplines, cultures, and contexts. Throughout the catalog, urban mining is presented not merely as a technical process of material recovery, but as a design philosophy and pedagogical strategy. It encourages students to view cities as dynamic resource systems, where waste can be reimagined as opportunity, and where design can catalyze social, environmental, and economic transformation.

In the catalog we have provided numerous examples of experiential learning, demonstrating how interdisciplinary collaboration, stakeholder engagement, and creative prototyping can lead to meaningful outcomes. By compiling examples of various educational institutional practices, pedagogical frameworks, and student projects, we hope that the catalog offers a rich resource for educators and researchers to foster the systematic integration of circular competencies in design education.

Enjoy the reading,

Andrea Bortolotti
Christin Schäfers
Ditte Dam Bangsund
Emilie Victoria Ferraro Steuch
Eva Brandt
Jasmin Skøtt
Kasper Lange
Lauge Clausen
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Morten Carlsbæk
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December 2025

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