When it comes to climate change, circularity has become a major topic. Closed loops, reuse, recycling, and renewable materials are fashionable ideas in architecture and product design. In order to establish the new paradigm of circular design, this book introduces an urban and territorial dimension to the goal of transforming living spaces for resilience and sustainability. It proposes to use design-led research and design-thinking for analysis, concepts, strategies, and cooperative processes of transformation. Featuring case studies from all over Europe that relate creative narratives in urbanism to social and economic innovation, *Circular Design* aims to activate dynamic fields and networks of ideas, people, and spaces, oriented to circular principles.

jovis

Circular Design

Towards Regenerative Territories

Jörg Schröder
Riccarda Cappeller
Alissa Diesch
Federica Scaffidi

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MESSAGES

Circular Design: Design-led Innovation for Circular Territories

Jörg Schröder

Of the total waste generated in Europe, 36% comes from building construction and demolition (Eurostat 2020). A triple challenge for the aim of carbon neutrality is the energy consumed by production and demolition, the use of finite and carbon-based resources, and the energy wasted in transport. Market volatility and rising prices make it an urgent matter to rationalise materials and energy use. The issue of sustainable construction materials—which for the last seventy years seemed an infinite resource—is becoming a driver for change in architecture and in the whole construction economy, with the aim to reduce CO_2 emissions and climate impact (European Commission 2022a). Architectural research and practice is following other creative fields such as fashion, furniture, industrial, and product design to target the re-use of materials not only as a necessity of our time but as a thrilling field of creativity and expression of new aesthetics that strongly influences the economy. The Ellen MacArthur Foundation (2021a) claims that "design is fundamental to a circular economy". Designers promote "circular solutions", establish new circular business models, and see themselves as frontrunners in an "irresistible circular society" (Creative Denmark 2021). It is exiting to detect new links between design disciplines and economics, material, social, and cultural sciences. The design sector—of which architects are a part—is extending the concept of "recycling" to "upcycling" and finally to "designing for reassembly", attempting in the design process to include a further use for the original product.

This essay—and this book—goes one step further to look at the links between circularity principles, design, and city-making, in order to develop a systematic approach. It asks what a circular design paradigm could mean, how precisely it could support climate neutrality, and how it is bound to the sustainability of cities and quality of life. We begin with the topic of waste and resources: would it not be better re-use whole buildings, urban areas, and even cities instead of disassembling them for recycling? Should we take a more comprehensive approach than simply focusing on material recycling, concen-

Architecture and buildings are at the forefront when we discuss how to achieve climate neutrality, how to transform cities and territories, how to achieve inclusion. Here, links between circularity, design, and city-making emerge as one of the most promising generators of innovation.
This outline shows that a circular design paradigm needs to start from an urbanistic perspective and why circular design can make cities more liveable.

trating instead on a carbon-free and circular way to design, install, live, and think about space? This essay focuses on the implications of an overall circular approach to city-making, to dealing with urban spaces and urban elements. It highlights the role of design in this process, since circularity in cities is bound to material, spatial, and cultural experience. The objective is to define a combined circular-design approach to the way we analyse, interpret, and project the structure, shape, vitality, and meaning of cities, and the ideas, processes, and mechanisms that shape their transformation. Since design circularity is addressed in different disciplines and diverse scientific, political, and societal discourses with different definitions, roles, and perspectives, the aim of this outline is to contribute to a more systematic understanding of circular design, and to relate it to city-making. Urban design and planning is reaching out to new interdisciplinary linkages, highlighting the conceptual and concrete impact of material culture, visioning, shaping space, and organising processes of change.

This essay looks not only at architecture and urbanism, but also at a wider range of creative disciplines for climate-neutral cities, in dialogue and collaboration with other sectors and society.

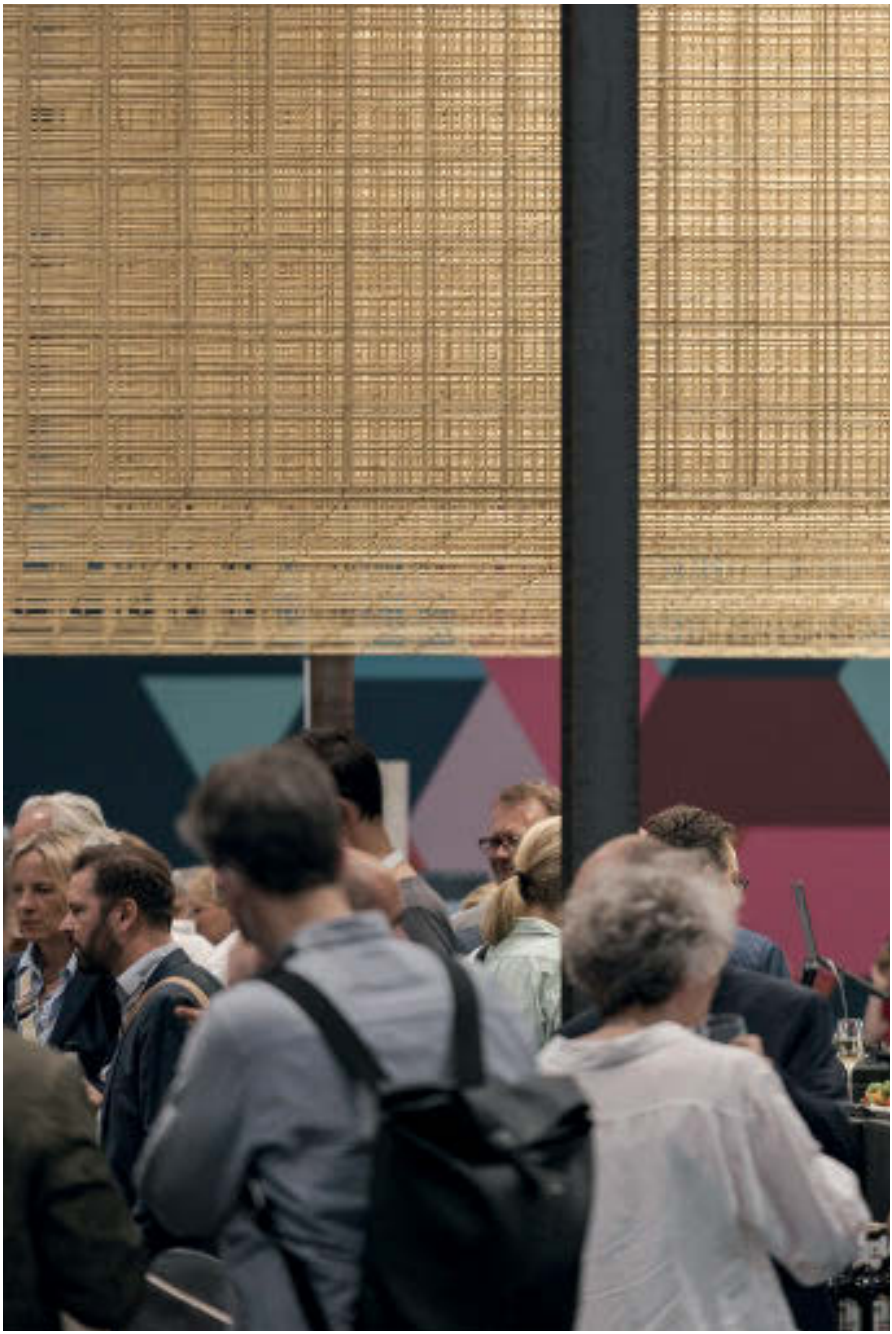
Methodology

The focus of the research offered in this essay is on urbanism and architecture, with links to other creative disciplines, to material and natural sciences, engineering, economics, social sciences and humanities. Based on a discussion of decarbonisation and the questions it raises for the role of cities, city-making, and liveability, the essay offers an outline that reviews current concepts and research on circularity, design, and city-making, in order to identify and condense the main characteristics for a circular design paradigm for urban and territorial innovation. Discussed in dedicated essays in this book are novel approaches that connect experience with exploration, a new role for the creative and cultural sector in decarbonisation, and social innovation that merges activism, entrepreneurship, and public action. The use of studio work in the university as a "mirror" for theories and research follows at the end of this essay. In the outlook, further considerations for research in architecture and urbanism are offered.

Decarbonisation and cities

Nearly 40% of CO_2 emissions worldwide come from the construction, use, and demolition of buildings (UN 2020). Also other

ressource.architektur
Golden structural steel mats lifted into the air by steel frames, leaving an open space below: the installation ressource.architektur at the Real Estate Fair in Hanover transforms current debates on building and the city into a spatial experience. The nearly 3 tonnes of steel used for the installation is the amount per person needed for reinforced concrete in conventional new construction in the 400,000 new homes for which the federal government is aiming. For reinforced concrete alone, 6 tonnes of C02 are emitted per person. At the same time, Europe wants to become the first climate-neutral continent, is aiming for sustainable cities, is striving for a radical change in building with the New European Bauhaus and is just discovering the issue of sovereignty and security of production chains. How does this go together? ressource.architektur prominently addresses the redesign of cities through the creative reuse of existing buildings.
ressource.architektur was installed as a design build project by students from Leibniz Universität Hannover LUH and Hannover University of Applied Sciences HsH, jointly developed with the Chamber of Architects of Lower Saxony, the Association of German Architects BDA, Bund Deutscher Baumeister BDB, the Association of German Interior Architects BDIA, the Association of German Landscape Architects BDLA and the Building Culture Network of Lower Saxony, together with the Faculty of Architecture and Landscape at Leibniz University Hannover and the Interior Design course at Hannover University of Applied Sciences. ressource.architektur was supported by a large number of sponsors from the building industry. Design of the installation: Malin Österheider, Max Passgang, Kimberly Rahn (all LUH), Paul Schomburg, Melanie Weber (HsH). Built with: Max Bender, Anna Bertram, Ferdinand Helmecke, Viviane Hilsenbeck, Lina Nikolic, Fabian Raue, Jannika Rehkopf, Helena Reinhard, Jean Sauerländer (all LUH), Vivian Ebeling, Lisa Faller, Vicky Frehe, Niklas Meyer, Amelie Miller, Antonia Reum, Niclas Thiry, Frithjof Wahl, Tessa Winkelmann (all HsH). Supervision: Prof. Jörg Schröder and Rebekka Wandt MSc (LUH), Prof. Bernd Rokahr and Prof. Tatjana Sabljo (HsH). Photo by Max Passgang.



CO_2-relevant topics are deeply linked to cities and living spaces, most prominently mobility. In order to make Europe the first climate-neutral continent, the European Green Deal needs to take these city-related topics into account. Several initiatives already address decarbonisation of buildings. For example, the EU strategy Renovation Wave (2020) aims at higher energy efficiency and decarbonisation through building renovation, and the EU strategic research and innovation partnership Built4People is addressing the sustainable transition of construction industries (2022) away from carbon. Security and sustainability, not only of the energy supply but also of material provision, production chains, and of the workforce, are further challenging factors.
The topic of social inclusion has gained additional importance due to high energy prices and inflation. Demand for housing is rising, and increasing social division is reviving the question of affordable housing and living. For example, of the 400,000 new housing units on the agenda of the German Federal Government, 100,000 are planned as social housing. However, sectoral initiatives and policies need to be set comprehensively in the context of urban transition towards sustainability. Current architectural and urban research highlights the importance of cities in the process of decarbonisation: cities are seen not only as a main stage where sectoral innovation and policies need to be coordinated, but also key to the acceleration of decarbonisation and increased quality of life for citizens through interaction and a sense of joint responsibility (Schröder 2020c). The EU Horizon mission for 100 cities to become climate-neutral by 2030 (2022b) is already addressing comprehensive cross-sectoral access to energy-efficient construction and renovation, sustainable mobility and decentralised energy production and storage. In a further step, a new focus on human-centred urban design and planning will be necessary, highlighting inclusion, empowerment, sharing, and activation, as well as new governance and financing models, and the broad and different aspects of digitalisation (JPI Urban Europe 2019). The innovative force—and, implicitly, the specific research approach—of the architectural and design disciplines is being addressed by the New European Bauhaus (European Commission 2022c), which calls for combining sustainability with aesthetics, technology with arts, and for an overall cultural change to realise climate neutrality.

Circular dynamics
Interest in circularity has been part of research into a shift towards sustainability since the 1990s (Camilleri 2018), when the open loops of linear material streams were detected as a major environmental problem and closed loops to contain human impact on natural

ecosystems were proposed. In 2015, the EU introduced a Circular Economy Action Plan to foster resource- and energy-sensitivity and the use of renewable and natural resources as a field for work and business opportunities and competitiveness. Today, with the aim of the European Green Deal to accelerate decarbonisation and with the demand for secure and sustainable production chains, the shift to a circular economy has become even more important. At the same time, circularity principles are being further extended. The impulse of a circular economy is understood to induce a radical turn in the whole economic and societal system of cities (Ellen MacArthur Foundation, ARUP 2018) since, in the framework of a "performance economy" (Stahel, 2006), greater societal impact and value can be achieved.

The research project "Creative Food Cycles" (Schröder, 2019b), for example, offers an understanding of the topic of food as a cross-cutting field of innovation for a circular economy, leading to a redefinition of design approaches in multi-actor innovation processes. It identifies pathways to combine territorial resilience, entrepreneurial social practices, and technological innovation in order to operationalise linkages between a circular economy and society, culture, and space. The methodology follows the Ellen MacArthur Foundation's definition (2017) that a circular economy needs to realise innovation in three dimensions: first, to design out waste from production processes; second, to be regenerative by design; and third, to decouple growth from finite resource consumption. A focus on city-making, as implied in this essay, leads to the sharpening of these dimensions of a circular economy in culture and society: to design waste-less and carbon-free life cycles of buildings and cities, as well as to keep houses in use and good repair; to relate the regenerative dimension not only to nature (Giradet 2015) but also to cities and communities, disrupting concepts of urban regeneration that aim at a static vision instead of regenerative processual qualities (Schröder 2020a); and to use circular principles to secure and gain wellbeing and prosperity in inclusive, accessible, and affordable ways.

Based on this consideration, the term "circular dynamics" (Schröder 2021a) can express, on the one hand, the idea of creating dynamic processes that will also impact other sectors in the city and, on the other hand, the idea of bringing about a dynamic cultural, economic, and social shift, not least through breaking barriers between production and consumption and establishing new expressions, rituals, and aesthetics. Based on material cycles—and on a new awareness of material culture—the concept of circular dynamics extends to other flows that are necessary to generate sustainability in the city: flows of energy, flows of transport, financial/investment flows, flows

of ideas, people, knowledge, abilities, culture, and values, and, not least, flows of space. The implication is, clearly, that cyclical thinking creates meaningful flows between local, supralocal, and global dimensions. It is about the overlapping, overlaying, and interference of cycles and flows from different sectors and scales, about fluidity and dynamics, and about bringing digital and material dimensions together. Thus, circular dynamics refers to open systems and "open habitats" (Schröder 2018) oriented towards sustainability—and to a networked idea of proximity and auto-sufficiency. Three examples can illustrate this definition: new financing and investment models (crowdfunding and sharing) not bound to a geographical border; new knowledge and research flows over distances; and multi-place living and working models that cross boundaries. Through addressing a multiplicity of flows, circular dynamics support systemic approaches to cities. They can trigger new perspectives on urban topics and establish coherent interrelations, for example between previously strictly separated perspectives on buildings—in a spatial-social and economic sense (building stocks), in a cultural sense (heritage), and in an ecological sense (resources)—towards a new logic of urban transformation for climate neutrality.

Circular territories

This essay now takes a territorial perspective in order to explore linkages between circularity, design, and city-making and to widen the spatial radius as well as the topical and methodological access. This entails including human living places beyond what is commonly defined as the city, i.e. an urban centre with more than 50,000 inhabitants. (Effectively, only 40% of Europeans live in cities; the other 60% reside in towns, suburbs, villages, smaller settlements linked into networks through cooperation, intersected by different forms of material and immaterial divisions and borders.) It also entails dynamic change due to parallel and contradictory processes of metropolisation, centralisation, extension, and diffusion of settlement (Soja 2012, Servillo 2016, Schröder 2017). At the same time, various forms of peripheries—urban, suburban, rural, remote—can be identified not only as a challenge for transition, but as a potential for overall sustainability and for innovation (Schröder et al. 2018).

Current new development of housing (mostly in small units) and industry zones is being applied to metropolitan agglomerations, but also to mid-sized cities and towns, leading to a current amount of about 60 hectares per day of new soil consumption in Germany: a major challenge for sustainability (Schröder 2020c). Furthermore, a territorial perspective can support the understanding of complex constellations formed by settlement patterns, infrastructures such as

transport and energy, and topography and natural factors and spaces, which are in constant flux. This complexity of constellations adds to the complexity of the task of territorial transformation towards sustainability and resilience (Viganò, Cavalieri 2019; Schröder 2020c). A territorial perspective based on concepts of urbanism has the advantage of offering a relational understanding of space (Secchi, Viganò 2009; Schröder 2017) in terms of changing interactions between space and society. It can support the understanding of the interplay of structural, material, imaginative as well as social, cultural, economic, ecological factors for analysis and for the projection of pathways of transformation. Relecting Castell's definition of a city "not [as] a framework, but a social practice in constant flux [...] a source of contradictions" (2005), the concept of space as an active agent (Schröder 2021b) allowing interaction between actors and space, as well as between values, cultural beliefs, lifestyles, is identified as playing an important role in territorial innovation processes.

Contributions to research into circularity in relation to territorial and urban transformation have come, until now, from three sides: first, concepts of resource and energy flows, which have been termed "urban metabolism" (van Timmeren 2014, Wachsmuth 2012, Grulois et al. 2018) or "circular cities" (Williams 2019, 2020) are addressed in a management and infrastructural approach, extended to eco-systemic thinking, the role of nature, ecological regeneration, and the topic of health (Furlan et al. 2022). Second, a circular economy is addressed in the context of economic development focused on circular business models, creative milieus and networks, upscaling, and innovation processes (Bourdin et al. 2021). Third, a circular approach to building construction for closed material cycles, disassembly methods, and so-called "urban mining" (Heisel, Hebel 2021) or the use of digital tools for the organisation of the material environment, setting up new market mechanisms and innovating public procurement in regard to used construction materials (Office Rotor, see Vanderstraeten 2021) are implying a decidedly passive understanding of the city. In most cases, circular approaches remain sectoral, very small-scale, and fixed on material questions, not including a broader vision of Circular Dynamics. In particular, more holistic approaches to territorial governance in conjunction with circularity and life-cycle-thinking are lacking (Amenta, Russo, van Timmeren, 2022, p. VI).

One of the few research contributions to conceptually link urban metabolism, circular economy, and territorial resilience proposes the concept of "circular land" for the Sicani area in Sicily (Carta 2017a, 2017b), stressing the necessary interaction between territorial governance, urbanism, and evaluation. If we understand human living places—settlements and the built environment—as the main

stage for transformation, where different sectoral (and disciplinary) aspects converge, their future as "circular territories" needs to be based on circularity-activating concepts. Starting from an urbanistic and territorial perspective, such concepts can then contribute to creating development pathways (Schröder, Ferretti 2018), based on relational logics and the territorial potentials (and limitations) they need to take into consideration. To achieve a comprehensive approach to circular territories, economic, social, ecological, cultural, and spatial agency need to be combined, taking a people-centred view that starts from everyday life, living spaces, urban spaces, daily movements, economic activities, social and cultural factors and activities, and cultural beliefs, working with a relational understanding of space and actors. In the logic of a place-based approach to territorial policies (Barca et al. 2012), strategies, plans, and policies at different levels can then be effectively oriented towards circularity. The shift from the concept of mitigation of climate change to a focus on urban transformation towards resilience and sustainability (Wolfram 2016)—calling for systemic change—is giving importance to working with capacities of space and society for transformation. Adaptivity, redundancy, and robustness of strategies and tools in territorial governance can be identified as important qualities (Schröder 2021a). Based on these considerations, concepts towards circular territories can be articulated as space-oriented and actor-oriented.

Space-oriented concepts (space as active agent)

Circular spaces: A concept addressing the target of Net Zero Artificialisation (Schröder 2020b), preventing further extension and diffusion of urban structures, infrastructures, and social tissues, as well as eco-systemic and biodiversity damage. Circular spaces are those where soil-sealing (the destruction or covering of the ground with an impermeable material) is avoided, and thus contribute to circular transformation—possibly through market mechanisms similar to CO_2 certificates. They also consider the density and spatial qualities of newly built or re-built areas. Hence, this concept gives a decidedly new perspective to approaches to limit soil sealing or aiming at compactness over the last 20 years.

Circular transformation: A major concept for urban activation and intensification through urban projects under the Net Zero Artificialisation target. It aims to put circular objectives in the foreground and therefore to recycle areas and buildings beyond metropolitan centres; to think twice before tearing down existing buildings; to imagine and organise new, much more diffuse, systemic, small and large-scale

Circular Territories

Transformative communities

Circular spaces

Circular transformation

Qualitative density

Circular proximity

Circular real estate

Enabling mobility

Circular construction

Circular innovation

Circular planning

Circular Design

merges cycles (material, actors, capital, knowledge)

combines inventing, making, using

people-oriented, performative, involving, communicative

sets spaces into cycles, accelerates cycles, starts new cycles

drives a cultural shift, imagination, and aesthetic

fosters a new economy to decouple prosperity from resource consumption

realises climate neutrality through regeneration

works with design loops and human feedback

oriented to liveability and just transition, accessibility and and inclusiveness

aimed at a material and digital culture

trans-scalar in analysis, interpretation, and projection

works with experimentation, prototyping, and testing

forms of transformation strategies; and, in particular, to contribute to regenerative processes for places, economy, society, and nature. This not only means setting recycled buildings and areas into new multidimensional cycles, but supporting the acceleration of cycles, linking sectoral cycles, and even starting new cycles.

Qualitative density: A conceptual answer (Schröder 2021c) to current territorial concentration processes (not only in metropolitan centres, but also in smaller cities and towns) in order not to extend infrastructural systems. It is qualitative in relation to the territorial context (calling for new density models for urban fringes, smaller cities and towns) and in terms of fostering the advantages of social and cultural density for quality of life.

Circular proximity: This combines the targets of mixing (in functional and social composition, in activities over time), accessibility (in social terms and in regard to sustainable mobility) with social and cultural infrastructures and public spaces, and orients them towards circularity. It aims to contribute to new sustainable cycles and to use new cooperation and sharing models (e.g. in energy such as district heat-electricity provision and storage) or in the community, housing, or shared work spaces).

Enabling mobility: A concept to move into the foreground, not the transport infrastructure, but foot, bike and public transport, to consider the movements of people as well as the movement of goods, to use digital innovation and new electric technology, and to support circular transformation, qualitative density, and circular proximity, working with new life and work models, in particular for peripheries.

Actor-oriented concepts (for the activation of space)

Circular innovation processes: A concept to orient territorial innovation and traditional strategies in regional economic development towards circular sustainability and innovation, e. g. fostering business models, entrepreneurship, skills, knowledge, upscaling, innovative milieus and networks, targeted investments and financing, targeted clustering and links to research and education—and to coordinate with space-oriented concepts. And they aim to foster new roles for cultural and creative industries (CCI) as drivers of innovation in other sectors and for a cultural shift to sustainability.

Transformative communities: New organisational and financial forms of community organisation (co-working, co-living, prosumer

models, community land trusts, etc.) that are oriented to foster and enhance sustainable transformation and to adopt circularity principles using digital innovation, sharing models, crowdfunding etc.

Circular construction economy: Oriented towards decarbonisation, energy-saving in all processes, use of renewable and natural materials, including a change in business models, entrepreneurship, clustering, procurement procedures, but also in knowledge, abilities, education, life-long learning for all involved actors.

Inclusive real estate: New sharing and ownership models, improved accessibility and inclusiveness that contribute to a circular access to urban and territorial development; new business models in real estate enhancing a circular economy (Ellen MacArthur Foundation 2021b).

Circular planning framework: The revision, adaptation, and extension of regulatory, legal, technical, and funding frameworks for a circularity-driven transformative approach to the built environment—a very critical point, since most of our regulatory background comes from and is still guided by the influence of modernist ideas, e.g. functional zoning, carbon-based engineering, and over-regulation.

Design for urban strategies and territorial governance

Already for the definition of these concepts for circular territories—and not just for their implementation—the character, role, and meaning of design for urban strategies and territorial governance needs to be revised. While design is a central element of theories in urbanism (i. e. urban design and planning), discussions about design are not really part of conventional planning theory, even if for several years traditional forms of plans have been replaced with more adaptive and integrative formats that adopt design approaches to organisational processes (e.g. Healy 2006; Neuman, Zonneveld 2021; Schröder 2021b). New participatory, activating, and cooperative approaches to policies, strategies, and projects are already referring to design thinking, even with the danger of provoking unrealistic expectations of participants in processes on urban and territorial scales under the label "co-design", which rely on a background of service-design theories (Wilson, Tewdwr-Jones 2022; Steen et al. 2011). Theories and concepts for spatial strategies and governance, with new tools such as contracts, stakeholder, and citizen involvement, cross-sectoral approaches, and decision support systems, offer several opportunities to include diverse concepts of design, ranging from service design to urban and architectural design.

A tentative framework for design in a territorial dimension (Schröder 2017) can be summarised in six dimensions:

- Explorative: systematic scenario building, e.g. adopting the agency and capacity of mapping as research tool (Schröder, Ferretti 2018; Corner 1999).
- Visionary: integrated and systematic design visions that interpret the existing structure and project towards desirable futures (Secchi, Viganò 2009; Phelps 2021).
- Coordinative: new formats and processes of spatial strategies, protocols, agendas (Schröder 2021b).
- Human-centred: the contribution of design in architecture and urbanism to place-based (Barca et al. 2012), site-specific (de Meulder, Marin, Shannon 2022) and human-centred factors in territorial governance.
- Multi-scalar: opening up information regarding development paths, spatial potentials, and limitations (Schröder, Ferretti 2018), not least referring to the concept of the "territory as palimpsest" (Corboz 2001), the understanding of territorial and urban contexts as historical layers.
- Projective: innovative projects—linked to places and space—for urban and territorial governance (Palermo, Ponzini 2010), and their interplay with processes of social interaction and decision-making (Steinitz 2012).

Circular design: background

The term "circular design" has been in use for several years in research and in the practice of product design, fashion, and furniture design, with a focus on the recycling of materials. A comprehensive overview in research is lacking; the literature offers quite limited sectoral and geographical studies, and only in a few cases is research into creating material cycles combined with new circular business models (e.g. in the field of fashion: Ellen MacArthur Foundation 2021a). IAAC in Barcelona can be seen as a frontrunner in relating Circular Design to architecture (Markopoulou 2019), with a strong technological and interdisciplinary cooncept, e. g. merging biological processes with building elements, inspired by the "cradle to cradle" concept (McDonough, Braungart 2002). At the same time, product design recalls its modernist vocation for a better life and better cities (Maldonado 2019) and promotes its role as a "strategic tool" for urban transition, equality, and quality of life (Helsinki City of Design). This includes the move from linear design—structuring information, finding the design solution, creating form—to iterative loops of design with human feedback, involving coding, programmes, protocols,

profiles, data analysis, but also new rituals, relations, desire, conflicts (Schröder 2021b). The approach of IAAC extends the conventional understanding of design as a limited part of architectural processes (the phase of drafting a concept) to design as an activity that includes making and works with models, prototypes, protocols—thus fabrication innovates design (and vice versa).

Design thinking, design research

"Design thinking" is a term that has become popular in management and economics in the last years. Linked mainly to theories of product and service design (Brown 2009), "design thinking" in this popular sense can be adopted to different sectors and tasks as a creative problem-solving approach that aims at positive impact and (disruptive) innovation. Its characteristics are the orientation to users and to outputs, commonly referred to as "solutions", and short iterative cycles of invention, realisation, and testing. "Design thinking" seems bound to specific cases; an "upscaling" of "solutions" is mostly understood as an aim to increase numbers and range. In this conventional form, design thinking remains a management technique. The relation of design to research is, in comparison, much sharper and clearly evolved in architecture and urbanism. As Nigel Cross puts it, architecture is to be understood as a "design discipline" (2012) characterised by "designerly ways of knowing and thinking". This definition overcomes the modernist impetus to "scientise" design. In the meantime, design research in architecture is established with adapted theory and transfer (Fraser 2013, Buchert 2014, Luce et al. 2022). It can be seen as the "missing link" in the specific constellation between theory and practice of the architectural disciplines, offering a theoretical framework for cognition-oriented, problem-oriented, and practice-related fundamental research. This is characteristic of the architectural disciplines, and of the specific multi-actor innovation ecosystems between academia, offices, and a broad range of stakeholders (public bodies, enterprises, civil society and cultural organisations).

Thus, the architectural disciplines have already developed a scientific understanding of design thinking that can be summarised in three points: First, a theoretical fundament is actively shaped, since "innovation lies in the convergence between the transformation of ideas and things" (Fagnoni 2016). Second, design thinking refers not only to "production" but also to "creation", in the sense of Aristotle's distinction between praxis and poiesis (Jaeger 1957), thus addressing a decidedly larger range of values. And third, design thinking addresses space and context, and thus the ability to comprehensively bundle and merge a multiplicity of sectoral, scalar, and social aspects is a major characteristic. It is the synthesising power of

architectural design thinking that makes it particularly appealing and effective for transforming the complexity of cities and territories, not only as systems, but also as spaces (Schröder 2021a)—hence, as material as well as a cultural and social construction (Rossi 1966). Similar to the realisation of the last years—due to the challenge of climate change—that architecture is in fact a research discipline—created academically for urban expansion in the nineteenth century—its common and self-understanding as creative discipline is changing radically. Architecture was once seen as the creation of something new. Now, we follow the mission "to recycle is to design", as Mosè Ricci (2016) wrote. The impact of this shift not only for architects themselves but for the common image of architecture could not be more disruptive. And it is not only about using recycled materials or converting existing buildings ("re-use", Stockhammer 2021): the novelty lies in setting them into meaningful cycles and creating new cycles towards sustainability—the major conceptual result of the Italian National Research project PRIN "Re-Cycle" (Ricci, Schröder 2016; Schröder et al. 2017). Effectively, if we seriously aim to create circular spaces with net-zero soil consumption and the circular transformation of cities, it is quite clear that we have to overcome the strong traditional borders between new construction and renovation/conversion in research and practice, mindsets, and ways of acting. For everything they do, architects will always need to combine their knowledge and abilities to work with the existing as well as to add, transform and extend with new spatial ideas. The creative mission of circular design is to install space. Obviously, this comprehensive and holistic approach contradicts the ongoing specialisation in the architectural disciplines. In this sense, circular design is a call to valorise, research, teach, and learn the comprehensive and strategic qualities of architectural thinking and work with new eyes.

Circular design towards circular territories

As a working definition, circular design seeks innovative ways to set space into cycles towards sustainability, and to contribute towards circular territories as a paradigm for urbanism and architecture, but also as an impulse for discussions in other design fields, in territorial governance, and in collaboration with other disciplines and society.

Thus circular design

1. combines processes of inventing, making, and using
2. is people-oriented, performative, involving, communicative
3. sets spaces in sustainable cycles, accelerates cycles, starts new cycles
4. connects sectoral cycles