ARCH 650: Circular Building Economy

Spring 2024
Monday/Wednesday 8:30 – 9:50 Central King Room 314
John Cays
email - cays@njit.edu or call 973-596-6275
Friday afternoons by appointment in Weston 347

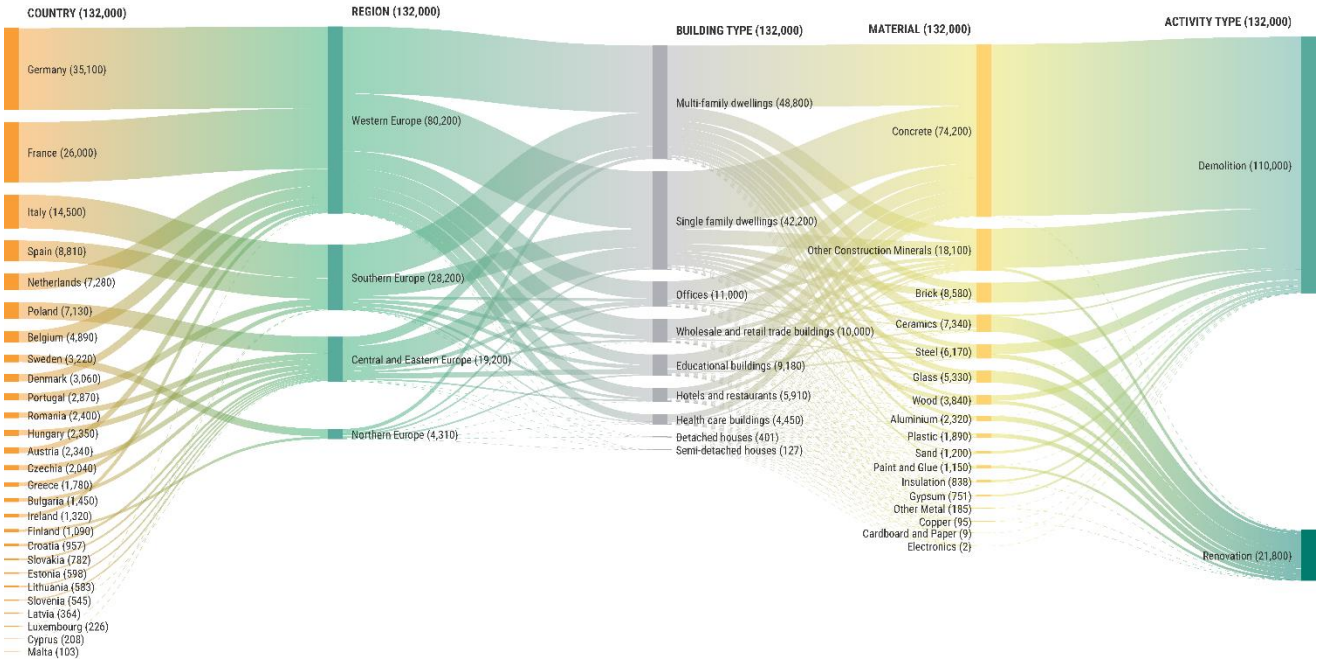

Figure 1. Amount of building typologies in the modelled EU building stock by country, region, type of building and material, 2021 economy (Modelling the Renovation of Buildings in Europe from a Circular Economy and Climate Perspective Report, 2022)

Prerequisites:
Facility with 3D design modeling software and its database functionality. (Revit, Solidworks, etc.)

Course Overview:
This course is guided by the following precept: *We must accept responsibility for the consequences of our design decisions upon both human well-being and the long-term viability of natural systems.*

This course explores the principles, applications and current limits of circular economy (CE) concepts generally and specifically within the fields of architecture and construction. Students will examine sustainable design strategies, circular material flows, and innovative construction methods to minimize environmental impact and promote a regenerative approach to the built environment.

We will be leveraging the pioneering work done through the Ellen MacArthur Foundation and looking at the origins of CE in architecture referring to the writings not only of William McDonough and Michael Braungart but also by the originator of the concept, Swiss architect, Walter Stahl. After more than 50 years since he wrote a seminal paper on the topic, Stahl continues to develop CE in theory and in practice supported by the Ellen MacArthur Foundation.

Macquarie University Innovation Hub © Murray Frederick (Arup, 2022)

Business in the United States is pivoting to acknowledge itself as an ecological driver to respond to and take advantage of major legislative changes such as the Inflation Reduction Act (I.R.A.) enacted 50 years after the initial establishment of the EPA. Rapidly improving technological tools proliferate just as consumer markets, increasingly skeptical of "green washing," are demanding safe, effective *and* sustainable goods and services. The federal government is currently supporting CE innovations and is offering significant funding over the next 9 or so years to help transform the national economy to a circular one. The architecture, engineering, construction, building operation industry accounts for more than 40% of all global material use and generates over 35% of waste. One way for architects to understand and accurately shape an effective climate crisis response is to use emerging tools and techniques to visualize, quantify, and compare design alternatives. Guided by the judicious application of various sustainable design framework methods we can simulate and reduce each project's environmental impact. In this course you will practice with both the CE framework and BIM plug-in tools applied to an existing project

National Architectural Accrediting Board Shared Values:
The following foundational "Shared Values of the Discipline and Profession" which affect the education and development of architects are integral to many aspects of this course. These values are also part of the School's long-range planning.

Design: Architects design better, safer, more equitable, resilient, and *sustainable built environments.* Design thinking and integrated design solutions are hallmarks of architecture education, the discipline, and the profession.

Environmental Stewardship and Professional Responsibility: Architects are responsible for the impact of their work on the natural world and on public health, safety, and welfare. As professionals and designers of the built environment, we embrace these responsibilities and act ethically to accomplish them.

Knowledge and Innovation: Architects create and disseminate knowledge focused on design and the built environment in response to ever-changing conditions. *New knowledge advances architecture as a cultural force, drives innovation, and prompts the continuous improvement of the discipline.*

Leadership, *Collaboration,* and Community Engagement: Architects practice design as a collaborative, inclusive, creative, and empathetic enterprise *with other disciplines,* the communities we serve, and the clients for whom we work.

Lifelong Learning: Architects value educational breadth and depth, including a thorough understanding of the discipline's body of knowledge, histories and theories, and architecture's role in cultural, social, *environmental,* economic, and built contexts. The practice of architecture demands lifelong learning, which is a shared responsibility between academic and practice settings.

This elective course supports the professions stated shared values. While this course does not satisfy specific NAAB Program or Student or Program Criteria, the core topic of sustainable architecture is central to the School of Architecture's approach to addressing one of the sub criteria of:

SC.5 Design Synthesis—How the program ensures that students develop the ability to make design decisions within architectural projects while demonstrating synthesis of user requirements, regulatory requirements, site conditions, and accessible design, and *consideration of the measurable environmental impacts of their design decisions.*

Course Academic Objectives:
By the end of this seminar, students will be able to:

1. Understand Circular Economy Principles:
   - Define and explain the core principles of circular economy.
   - Analyze how circular economy concepts differ from linear economy models.
2. Explore Sustainability in Architecture and Construction:
   - Evaluate the importance of sustainability in the context of architecture and construction.
   - Investigate the environmental impact of traditional construction methods and materials.
3. Examine Cradle to Cradle (C2C) Design Philosophy:
   - Understand the principles of Cradle to Cradle design and its application in architectural projects.
   - Analyze case studies of successful C2C projects.
4. Master Circular Design Principles:
   - Apply circular design principles in architectural projects such as designing for disassembly and adaptability.
   - Incorporate biomimicry and nature-inspired design elements into architectural concepts.
5. Explore Circular Material Selection:
   - Investigate sustainable material selection criteria.
   - Compare and contrast recyclable and biodegradable materials for architectural use.
6. Understand Circular Construction Techniques:
   - Evaluate the benefits of prefabrication and modular construction in a circular economy.
   - Explore deconstruction and reuse strategies for building components.
7. Apply Circular Economy Principles in Real-World Scenarios:
   - Work on individual and/or group projects applying circular economy principles to a real-world architectural scenario.
   - Develop problem-solving skills to address challenges in implementing circular practices
   - Assess the role of Building Information Modeling (BIM) in circular design.

Course Requirements:

1. Students will review and provide feedback on main concepts of "circular economy" as they relate to building design through assigned weekly readings in the main texts and two illustrated presentations on their reading during the semester. Students will supplement the primary text with bibliographic resources from two literature scans to inform their own thinking and presentations anchored by the main text.

2. They will produce examples of approaches to answer or elucidate sustainable development CE best practices in the form of illustrations, graphs and/or annotated design documents.

3. Students will work either independently or in groups on the basic documentation and analysis of an existing building design of their own and develop a plan for improvement with clearly defined and transparently reported comparative metrics.

Grading:

1. Literature Scans 20%
2. Think Pieces 15%
3. Presentations on primary readings 30%
4. Individual or Group Final Project: 35%

NJIT uses the following grades in graduate level courses:

A "Excellent"
B+ "Good"
B "Acceptable"
C+ "Marginal Performance"
C "Minimal Performance"
F "Failure

Important to note: The last day to withdraw from a course and have a "W" recorded on the official transcript is March 4.

Kepler/Canvas:

Kepler is now part of Canvas. Work will be automatically archived upon uploading in the Assignments page of Canvas. Students should upload in pdf format at the file size used for presentation. Please login at: canvas.njit.edu/ Additional In order to receive a passing grade you must upload at least your final or major assignments to the permanent Kepler repository which is accessed through Canvas.

In Canvas:

1. Go to "Modules"
2. Click on the Kepler link then "Load Kepler in a new window"
3. Click Authorize
4. Find your course and upload your files under the Assignments which are listed the same way they show in the Canvas Assignments tab.

Academic Integrity:

The NJIT Honor Code will be upheld at all times. The work you do and submit as your own is expected to be the result of your effort only. You may (are encouraged to) discuss the general course issues, however, cooperation should not result in one or more student having possession of any project element created by another student (unless as completed in an assigned group project.)

Bibliography:

De Wolf, Catherine, et. al. Ed. (2024) *A Circular Built Environment in the Digital Age* Springer Nature Switzerland AG, Cham, Switzerland. – Primary text available through a Creative Commons publication here
DOI: 10.1007/978-3-031-39675-5_15

Stahel, Walter, (2019) *the Circular Economy: A Users Guide,* Routledge, New York, NY.
– Primary text (available as e-book in the Littman Library)

Cays, John, (2021) *An Environmental Life Cycle Approach to Design: LCA for Designers and the Design Market*. Springer Nature Switzerland AG, Cham, Switzerland.

Elkington, John, (1998) Cannibals with Forks: The Triple Bottom Line of 21st Century Business. New Society Publishers, Gabriola Island, BC ; Stony Creek, CT

Srinivasan, R, Moe, K (2015) The Hierarchy of Energy in Architecture: Emergy Analysis, Routledge, London

Online Resources:

Ellen MacArthur Foundation link
Buildings https://www.ellenmacarthurfoundation.org/topics/built-environment/examples
Products https://www.ellenmacarthurfoundation.org/topics/circular-design/examples
Cities https://www.ellenmacarthurfoundation.org/topics/cities/examples

Circular Economy Action Plan. (2019). European Commission. Link

BuildingGreen. (2022). Sustainable building and design strategies. Link

Green Building Councils Worldwide. (2022). International network promoting sustainable building practices. Link

Weekly Class Schedule

1. **Wed., Jan 17** **Lecture:** Short Introduction to Arch 483: Circular Building Economics - Waste.
What are you Looking for? *In class discussion of what we think the circular building economy is and what it can and cannot accomplish.*
Assignment 1.1 Cursory wide literature scan and summary (10 pts)
Assigned Reading *Circular Economy: A Users Guide (CE)*, Chapter **1** The circular economy, roots and context

2. **Mon., Jan 22** **Lecture:** The circle and the line
In class discussion of Literature scan. Does circularity fix everything?
Due - Assignment 1.1: Cursory scan summary
Assignment 1.2: Focused literature scan topic – What CE principles do you want to apply in practice and why? (10 pts)
Assigned Reading: *A Circular Built Environment in the Digital Age (CBE)*, Chapter **1** From Building Information Modelling to Digital Twins: Digital Representation for a Circular Economy

Wed., Jan 24 **Lecture:** Architectural practice in the Anthropocene
Group **1a** - Presentations and leading discussions on CE Chapter 1
Assignment 2.1: Short think piece 1 "Energy's role in the circular economy" (5 pts)
Assigned Reading: *CE* Chapter **2** Circularity, sustainability and labour in the circular industrial economy

3. **Mon., Jan 29** **Lecture:** Current tools for tracking circularity – Industry Perspective (KPF)
Group **1b** - Presentations and leading discussions on CBE Chapter 1
Due - Assignment 1.2: Focused scan summary
Assigned Reading: *CBE* Chapter **3** Digitizing Building Materials for Reuse with Reality Capture and Scan-to-BIM Technologies
Select and prepare to present a BIM based project to query, evaluate, and modify throughout the semester

Wed., Jan 31 **In-class review of semester BIM/CE projects**
Group **2a** - Presentations and leading discussions on CE Chapter 2
Assigned Reading: *CE* Chapter **3** The circular industrial economy, a wealth of new opportunities

4. **Mon., Feb 5** **Lecture:** Economic pressures creating headwinds to closed-loop practices
Group **2b** - Presentations and leading discussions on CBE Chapter 3
Due - Assignment 2.1: Think Piece 1
Assigned Reading: *CBE* Chapter **4** – Artificial Intelligence for Predicting Reuse Patterns

Wed., Feb 7 **Lecture:** Who pays?
Group **3a** - Presentations and leading discussions on CE Chapter 3
Assigned Reading: *CE* Chapter **4** The era of "R": The owner decides locally

5. **Mon., Feb 12** **Lecture:** Applying the circular economy framework and tools to your own work
Group **3b** - Presentations and leading discussions on Chapter CBE Chapter 4
Assigned Reading: *CBE* Chapter **5** – From Data Templates to Material Passports and Digital Product Passports

Wed., Feb 14 **Projects outline progress review:** Data
Group **4a** - Presentations and leading discussions on CE Chapter 4
Assigned Reading: *CE* Chapter **5** – The era of "D": Economic actors recovering resource assets decide

6. **Mon., Feb 19** **Lecture:** The limits of CE or any sustainable (green) design framework

Group **4b** - Presentations and leading discussions on Chapter CBE Chapter 5
Assigned Reading: *CBE* Chapter **6** – Enabling Design for Circularity with Computational Tools

Wed., Feb 21 **Projects outline progress review:** Model parameters
Group **5a** - Presentations and leading discussions on CE Chapter 5
Assigned Reading: *CE* Chapter **6** – The point of sale, or factory gate, and liability

7. **Mon., Feb 26** **Lecture:** The digital workflow
Group **5b** - Presentations and leading discussions on Chapter CBE Chapter 6
Assigned Reading: *CBE* Chapter **11** – Digital Technology Use Cases for Deconstruction and Reverse Logistics

Wed., Feb 28 **Projects outline progress review:** How will you show what you have compared?
Group **6a** - Presentations and leading discussions on CE Chapter 6
Assigned Reading: *CE* Chapter **7** – The invisible liability loop, labour and the role of policy

8. **Mon., Mar 4** **Lecture:** The soft supports – utilizing plugin tools to assess circularity
Group **6b** - Presentations and leading discussions on Chapter CBE Chapter 11
Assigned Reading: *CBE* Chapter **12** – Blockchain Technology for a Circular Built Environment

Wed., Mar 6 **Projects outline progress review:** Case study
Group **7a** - Presentations and leading discussions on CE Chapter 7
Assigned Reading: *CE* Chapter **8** – The Performance Economy, industry adopting the circular industrial economy as default option
Assignment 2.2: Short think piece 2 "Commentary on building economy" (5 pts)

9. **Mon., Mar 11** **Spring Recess**
Wed., Mar 13 **Spring Recess**

10. **Mon., Mar 18** **Lecture:** Case studies in framework development: CE's relationship to the wider set
Group **7b** - Presentations and leading discussions on Chapter CBE Chapter 12
Assigned Reading: *CBE* Chapter **13** – The Role of Digital Building Logbooks for a Circular Built Environment

Wed., Mar 20 **Individual project progress presentation and review: 1**
Group **8a** - Presentations and leading discussions on CE Chapter 8
Assigned Reading: *CE* Chapter **9** – Radical innovation to enhance stock management

11. **Mon., Mar 25** **Lecture:** The soft supports – utilizing plugin tools to assess circularity
Group **8b** - Presentations and leading discussions on Chapter CBE Chapter 13
Assigned Reading: *CBE* Chapter **14** – Circular Business Models for Digital Technologies in the Built Environment
Due - Assignment 2.2: Think Piece 2

Wed., Mar 27 **Individual project progress presentation and review: 2**
Group **9a** - Presentations and leading discussions on CE Chapter 9
Assigned Reading: *CE* Chapter **10** – Outlook

12. **Mon., Apr 1** **Individual project progress presentation and review: 3**
Group **9b** - Presentations and leading discussions on Chapter CBE Chapter 14
Assigned Reading: *CBE* Chapter **15** – Digital Transformation of the Built Environment Towards a Regenerative Future
Assignment 2.3: Short think piece 3 "Written analysis of project circularity" (5 pts)

	Wed., Apr 3	**Individual project progress presentation and review: 4**
		Group **10a** - Presentations and leading discussions on CE Chapter 10
13.	Mon., Apr 8	**Individual project progress presentation and review: 5**
		Group **10b** - Presentations and leading discussions on Chapter CBE Chapter 15
	Wed., Apr 3	**Individual project progress presentation and review: 6**
14.	Mon., Apr 15	**Class discussion on final presentation standards**
	Wed., Apr 17	**Complete presentation check list**
15.	Mon., Apr 22	**Course terminologies and concept review**
	Wed., May 1	**Reading Day - No class**
16.	TBA, May 17-23	**Final individual or group presentations**
		Due – Assignment 3: Final project documents due and presented
		Due - Assignment 2.3: Think Piece 3