Clay-AI: The materiality of artificial intelligence beyond the digital

UNIVERSITY OF WATERLOO | SCHOOL OF ARCHITECTURE

Arch 684_003 | Winter 2023

Course Description	Since stability.AI's release of their open-source stable diffusion model in August 2022, creative AI-generated images have proliferated amongst artists, architects, creatives and pop culture alike. This elective will explore the emergent implications of AI on architecture through both thinking (architectural history theory) as well as making (through craft and materiality, focusing on ceramics). Students will be introduced to creative artificial intelligence and learn how to use Stable Diffusion models, text prompt engineering, as well as develop their own image datasets to fine-tune diffusion models through Google Collab notebooks and automatic1111. Students will explore how to integrate these new AI tools into the architectural design process through two lenses: thinking and making. 1) Thinking: Bringing together computer scientists, architectural historians and library information technologists, we will contextualize contemporary developments in AI through a techno-architectural history lens drawing parallels to the advent of the camera and the rise in popularity of photography in the 18th and 19th century. 2) Making: Simultaneously, we will approach questions of authenticity, authorship, agency, labour, and ethics in AI by thinking through making. Students will use diffusion models to produce human-AI generated designs for architectural ceramics. In so doing, students will confront the disjunctions between the quasi-photorealistic quality of AI-generated images and the physical materiality and tectonics of clay. Reflecting on the ceramic works produced, we will critically examine this new design method to understand its opportunities and limitations for human creativity in architecture.
Faculty	Professor Linda Zhang <linda.zhang@uwaterloo.ca> Office Hours by appointment
Course Hours + Location	Tuesdays 9:30 AM - 12:20 PM ARC 2026
Class Discord	Invite link: https://discord.gg/j6Js6QE8U

Territorial Acknowledgement	We acknowledge that the School of Architecture is located on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. The University is situated on the Haldimand Tract, the land promised to the Six Nations that includes 10 kilometres on each side of the Grand River. https://uwaterloo.ca/engineering/about/territorial-acknowledgement
Learning Objectives	By the end of the course, students will: ● Develop technical skills and methodologies for using AI (specifically stable diffusion) in architectural design. This includes text prompt engineering, text-to-image generation, image-to-image generation and finetuning ● Develop proficiency in translating digital AI designs into physical and material spaces working with both lighting and photography techniques as well as materiality (with a focus on clay). ● Develop basic competency in architectural model making, ceramic hand building and glazing ● Develop a unique and theoretical position on the role of AI in architectural design, and explore how AI might open up new alternatives to design including non-western approaches and counter-normative approaches

Required Text

Students are required to read at least one text from each of the following sections.

Introduction to AI

- [1] A brief history of AI: how to prevent another winter (a critical review) by Toosi, Amirhosein ; Bottino, Andrea ; Saboury, Babak ; Siegel, Eliot ; Rahmim, Arman (2021)
- [2] “Patterns of AI History” in Artificial Intelligence: Machine Learning Human Dreams by Deutsche Hygiene-Museum Dresden (2021)

Introduction to Stable Diffusion

- [3] From GANs to Stable Diffusion: The History, Hype, & Promise of Generative AI by Sameer Farooqui (Nov 25, 2022)
- [4] The Illustrated Stable Diffusion by Jay Alammar (Oct 4 2022)

Contextualizing AI: History of Photography and Emergent Technologies

- [5] “In Plato’s Cave” in On Photography by Susan Sontag (1977)

Introduction to Art and Stable Diffusion

- [6] What is generative AI, and why is it suddenly everywhere? Between ChatGPT and Stable Diffusion, AI suddenly feels mainstream bY Rebecca Heilweil (Jan 5, 2023)
- [7] “The golden age of AI-generated art is here. It’s going to get weird” by Tom Faber in The Financial Times (29 October/30 October 2022)

Architecture and AI

- [8] “AI’s deployment in Architecture” in Artificial Intelligence and Architecture: From Research to Practice by Stanislas Chaillou (2022)
- [9] Can Machines Hallucinate Architecture? AI as Design Method Campo, Matias ; Leach, Neil Architectural design (2022)
- [10] Architectural Plasticity: The Aesthetics of Neural Sampling by Immanuel Koh
- [11] On GANs, NLP and Architecture: Combining Human and Machine Intelligences for the by Jeffrey Huang
- [12]“The Future of the Architectural Office” in Architecture in the Age of Artificial Intelligence: An Introduction to AI for Architects by Neil Leach (2022)

Ethics and AI:

- [13] Chimeras: Inventory of Synthetic Cognition, edited by Ilan Manouach and Anna Engelhardt (2022)
- [14] “Black Psychic and Machinic Alienation” in The Black Technical Object: On Machine Learning and Black Aspirational Being by Ramon Amaro (2023)
- [15] “Creatives Fight Back: Artist are rebelling against AI-drive imitation” in The Batch, Issue 172 (23 November 2022)

- [16] “An A.I.-Generated Picture Won an Art Prize. Artists Aren’t Happy” in The New York Times (2 September 2022)

Supplemental Readings and Resources

- What is AI? Basic Questions with John McCarthy, Stanford University
- Stable Diffusion Public Release (August 22 2022)
- AI & Creativity: Using Generative Models to Make New Things by Doug Eck at 2017 Machine Learning Conference
- “AI is Coming for Commercial Art Jobs. Can it be stopped?” by Rob Salkowitz in Forbes (16 September 2022)
- Biotech labs are using AI inspired by DALL-E to invent new drugs by Will Douglas Heaven, Technology Review (Dec 1 2022)
- Stable Diffusion 2.0 Out, Adding a New Dimension of Depth — Here’s Why It Matters by Bilawal "Billyfx" Sidhu (Nov 23 2022)

Course Requirements

This is a project-based course delivered through in-class learning experiences, lectures, formal and informal critiques, and presentations. This is NOT a techniques course. We will be talking about higher-level theories and procedures during class. On occasion, the professor may demonstrate various techniques and technologies, but the course will focus on critical analysis and discussions.

In this course the student is expected to:

1. attend all scheduled class times;
2. be punctual for classes;
3. participate actively in all critique sessions and class discussions

Assessment/ Due Dates

Project	**Week**	**Due Date**	**Percentage**
Exercise 1A (text prompt engineering)	2	Jan 17	10%
Exercise 1B (model photography)	5	Feb 7	15%
Exercise 2 (CLAY-AI)	9	March 7	20%
Exercise 3A (Fine-tuning)	13	April 4	25%
Exercise 3B (AI Design Manifesto)	13	April 4	15%
Reading Discussion	1-13	All term	15%

Course Delivery Platforms & Communication	All online submissions on LEARN and miro.com are due by the start of class unless otherwise specified in the assignment outline. You are responsible for knowing your deadlines (as outlined above) as well as their timely submissions. Deadlines may not be communicated in every class, and notifications will not be sent out for late/missing submissions.
Digital Submissions	Students must make and maintain regular backups of their digital files and documentation material. Lost or corrupt files will not be accepted as an excuse for late project submissions. Digital Submissions will be required for all assignments, as individual students or groups, throughout the term. All files must be submitted in readable pdf and jpg/tiff/png formats to LEARN and miro.

Miro Links

Exercise 1A: https://miro.com/app/board/uXjVP07n9Ec=/?share_link_id=111452184033
Exercise 1B: https://miro.com/app/board/uXjVP079wcI=/?share_link_id=767715471057
Exercise 2: https://miro.com/app/board/uXjVP079wc0=/?share_link_id=976296923059
Exercise 3A: https://miro.com/app/board/uXjVP079wcg=/?share_link_id=316353318781
Exercise 3B: https://miro.com/app/board/uXjVP079wdM=/?share_link_id=27984010202

Topics & Schedule*

**subject to change with consultation with the class responding to the evolving COVID-19 situation*

Module 1	**Introduction to Creative AI: Stable Diffusion and Text Prompt Engineering**	
W1	**January 10**	**Intro Lecture** Exercise 1 Issued [In class work session] + individual desk crits
W2	**January 17**	**Guest Lecture: Jae Seo + Fangmin Wang | Introduction to GANs and Stable Diffusion** Exercise 1A Due (mapping text prompt to image) Exercise 1B Issued
Module 2	**Historical and Theoretical Frameworks for AI**	
W3	**January 24**	**Reading Discussion 1 + 2** **Deskcrits:** Exercise 1B 60% check off
W4	**January 31**	**Reading Discussion 3, 4 + 5** **Intermediate Pin-Up:** Exercise 1B 80% check off **Guest Lecture: Peter Sealy | 19th Century Photography and AI (11:10am - 12:30pm)**
W5	**February 7**	**Final Pinup:** Exercise 1B Due (1:10 models) **Exercise 2: Clay Tutorial + Workshop** Exercise 2 Issued (Clay AI)
Module 3	**CLAY AI and Finetuning**	
W6	**February 14**	**Reading Discussion 6 + 7** **Exercise 2: Glazing Introduction** [In class work session] + individual desk crits **Guest Critic: Meng Li (From 11am)**
W7	**February 21**	READING WEEK (NO CLASSES)
W8	**February 28**	**Reading Discussion 8 + 9** **Exercise 2: Glaze Tutorial + Workshop** [In class work session] + desk crits
W9	**March 7**	**Reading Discussion 10** **Guest Lecture: Jae Seo | Fine Tuning & Stable Diffusion & Automatic 1111 (text2img | img2img)** Exercise 2 Due March (Photographs for fine tuning training) Exercise 3A Issued (Fine Tuning)
W10	**March 14**	**Reading Discussion 11 + 12** **Exercise 3: Clay Handbuilding Workshop** [In class work session] + trouble shooting
W11	**March 21**	**Reading Discussion 13 + 14** Intermediate Pin-up (AI images) / Class Discussion **Guest Critic: Meng Li (9:30-12:20p**
W12	**March 28**	**Reading Discussion 15 + 16** [In class work session] + individual desk crits Exercise 3B Issued
W13	**April 4** (Last day of classes)	**Final Pin-up + Class Discussion / Reflection** Exercise 3A and 3B Due (Fine Tuning + Manifesto)

COVID-19 Special Statement	Given the continuously evolving situation around COVID-19, students are to refer to the University of Waterloo's developing information resource page (https://uwaterloo.ca/coronavirus/) for up-to-date information on academic updates, health services, important dates, co-op, accommodation rules and other university level responses to COVID-19. If course activities are disrupted due to COIVID-related UW mandated restrictions, the course will continue, albeit in an online environment. If in-person attendance is restricted or eliminated entirely we will pivot to using MS-TEAM to carry out remote class meetings. Students who may be absent due to self-isolation requirements will be able to join the class remotely. This is a special consideration extended to those required to self-isolate by public health guidelines. Students must inform the instructor of this at least 24hrs prior to class meetings so that online access can be arranged. The course will also pivot to online meetings if the instructor faces any self-isolation requirements.
Fair Contingencies for Emergency Remote Teaching	We are facing unusual and challenging times. The course outline presents the instructor's intentions for course assessments, their weights, and due dates in Winter 2023. As best as possible, we will keep to the specified assessments, weights, and dates. To provide contingency for unforeseen circumstances, the instructor reserves the right to modify course topics and/or assessments and/or weight and/or deadlines with due and fair notice to students. In the event of such challenges, the instructor will work with the Department/Faculty to find reasonable and fair solutions that respect rights and workloads of students, staff, and faculty.
Late Work	Assignments that are handed in late will receive an initial penalty of 5% on the first calendar day late and a 5% penalty per calendar day thereafter. After 5 calendar days, the assignment will receive a 0%. Only in the case of a justified medical or personal reason will these penalties be waived, and only if these have been officially submitted to the Undergraduate Student Services Co-Ordinator and accepted by the Undergraduate Office. Students seeking accommodations due to COVID-19, are to follow Covid-19-related accommodations as outlined by the university here: (https://uwaterloo.ca/coronavirus/academic-information#accommodations).

Passing Grades	The standard minimum passing grade in each ARCH course is 50% with the following exceptions: the minimum passing grade is 60% for all studio courses (ARCH 192, ARCH 193, ARCH 292, ARCH 293, ARCH 392, ARCH 393, ARCH 492, and ARCH 493). Grades below the specified passing grade result in a course failure.
Mental Health Support	All of us need a support system. We encourage you to seek out mental health supports when they are needed. Please reach out to Campus Wellness (https://uwaterloo.ca/campus-wellness/) and Counselling Services (https://uwaterloo.ca/campus-wellness/counselling-services). We understand that these circumstances can be troubling, and you may need to speak with someone for emotional support. Good2Talk (https://good2talk.ca/) is a post-secondary student helpline based in Ontario, Canada that is available to all students.
Equity, Diversity and Inclusion Commitment	The School of Architecture is committed to foster and support equity, diversity and inclusion. If you experience discrimination, micro-aggression, or other forms of racism, sexism, discrimination against 2SLGBTQ+, or disability, there are several pathways available for addressing this: A) If you feel comfortable bringing this up directly with the faculty, staff or student who has said or done something offensive, we invite you, or a friend, to speak directly with this person. People make mistakes and dealing them directly in the present may be the most effective means of addressing the issue. B) you can reach out to either the Undergraduate office, Graduate office, or Director (Maya Przybylski). If you contact any of these people in confidence, they are bound to preserve your anonymity and follow up on your report. C) You can choose to report centrally to the Equity Office. The Equity Office can be reached by emailing equity@uwaterloo.ca. More information on the functions and services of the equity office can be found here: https://uwaterloo.ca/human-rights-equity-inclusion/about/equity-office. D) Racial Advocacy for Inclusion, Solidarity and Equity (RAISE) is a student-led Waterloo Undergraduate Student Association (WUSA) service launching in the Winter 2019 term. RAISE serves to address racism and xenophobia on the University of Waterloo campus with initiatives reflective of RAISE's three pillars of Education and Advocacy, Peer-to-Peer Support, and

Community Building. The initiatives include but are not limited to: formal means to report and confront racism, accessible and considerate peer-support, and organization of social events to cultivate both an uplifting and united community. You can report an incident using their online form.

Academic integrity, grievance, discipline, appeals and note for students with disabilities:

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the

first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit the alternate assignment.

Collaborative Work	Professional practice in architecture, design or engineering takes place through close collaborations between teams of people. Identifying effective ways to communicate, assign responsibilities, identify milestone and achieve objectives are essential skills to succeed in professional practice. For this reason, the studio will require students to work in teams. This collaboration should allow for intensive work and iteration to take place in parallel. Generally, the more iterations are pursued the stronger the work. Working in groups also means that you will be evaluated as a group – thus, pick your team wisely. As it will be presented in the course, working online with teams distributed across various continents has been standard practice over the last few decades. However, as difficulties might emerge, faculty will work with students to work through problems and make accommodations in group formations to support the production of high-quality work as needed.
Laptop and Software equipment	Laptops should be ready for in-class exercises. Students are required to have equipment and software tools ready (installed with appropriate license privileges) prior to class.
Student Notice of Recording	The course's official Notice of Recording document is found on the course's LEARN site. This document outlines shared responsibilities for instructors and students around issues of privacy and security. Each student is responsible for reviewing this document. Some lectures, seminars and presentations including questions and answers will be recorded and made available through official course platforms (LEARN and/or MS Teams). Students wishing not to be captured in the recordings have the option of participating through the direct chat or question and answer functions in the meeting platforms used.

Costs	The Clay-AI course is a material and AI-computing oriented investigation. The course requires intensive material explorations that have material costs as well as extensive AI processing that may have cloud storage costs (google drive) and cloud computing costs (google Collab). It is expected that participants can purchase required materials (as locally available) to support these explorations. Please budget $100 / student for the term for materials and $30 / student for the term for cloud storage and computing costs.