Waterloo Architecture
ARC 510 Introduction to Interactive Systems: Reactor Cells
Philip Beesley, Matt Gorbet and Michael Lancaster
Tuesdays 6-9 pm
Loft Gallery at 6 Melville Cambridge & online

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In the Responsive Architectural Components elective we will explore potential forms and problems in emerging interactive architecture, designing physical construction cells that can combine together to form responsive architectural fabrics. This course will support introductory design explorations that include physical scaffolds based on combinations of repeating geometric units, and responsive components combining simple electronically active controls with reactions that could include patterns of light, sound and motion.

The practical research of the Living Architecture Systems Group (LASG) www.lasg.ca will support the course. LASG kits and patterns will be provided to each student, for use as a basis for design exploration. Students are equipped with simple kits including geometric assembly and electronic controls. The course will be structured in three assignments that follow progressive development of the design of individual prototype cellular construction systems, programmed for both electronically generated and passive kinds of responsive behaviour. You will be asked to work within groups of three for these assignments. In order to support collective learning, 'Creative commons' open-source sharing will be included as a standard. This approach encourages individual students and groups to refer to preceding work and to integrate it within their own design explorations, progressively building upon evolving knowledge and skill within the class.

Visiting researchers and creators from the Living Architecture Group would support the evolving work. A set of short demonstrations will be offered, introducing students to technologies including electronically controlled responsive components, scripting for behaviour controls, polyhedric geometric arrays that can form scaffolds for active components, and compliant distributed design methods.
In parallel, a set of short readings will provide a context of cultural precedents including design philosophy and theory, and dynamics of far-from-equilibrium environments. New interpretations of physics using conceptions of dissipative adaptation relevant to responsive architectural scaffolds will be illustrated.

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Assignments

1. **Emotional Cell Systems**
   Assigned: Tuesday Sept 13
   Due: Monday Oct. 3, 9 pm on LEARN
   Review: Tuesday Oct 4: with Matt Gorbet & Michael Lancaster

2. **Sentient Cells**
   Assigned: Tuesday Oct. 4
   Due: Monday Oct 31, 9 pm on LEARN
   Review: Tuesday November 1

3. **Integrated Fabric Systems**
   Assigned: Tuesday Nov 1
   Due: Monday Dec 5, 9 pm on LEARN
   Review: Tuesday Dec. 6

Course Schedule

- Meeting 1, Tuesday September 13: Living Architecture Systems & LASG Kit introduction; launch Behaviour Assignment One, construct introductory kit samples
- Meeting 2, Tuesday September 20: Develop Behaviour
- Meeting 3, Tuesday September 27: Additional Develop Behaviour with Matt Gorbet
- Assignment One Behaviour due: Monday Oct. 3, 9 pm
- Meeting 4, Tuesday October 4: Review Assignment One Behaviour with Matt Gorbet & Michael Lancaster; launch Assignment Two Controllers & Mechanisms
- Tuesday Oct. 11: Reading Week, no classes
- Meeting 5, Tuesday October.18: Introduction to Sentient Cells with Michael Lancaster
- Meeting 6, Tuesday October. 25: Sentient Cells Controllers & Mechanisms additional development
- Assignment Two Sentient Cells due Monday November 8, 9 pm
- Meeting 7, Tuesday November 1: Review Assignment Two Sentient Cells, launch Integrated Fabric Systems with Michael Lancaster
- Meeting 8, Tuesday November 8: Integrated Fabric Systems development with guest LASG consultants
- Meeting 9, Tuesday November 15: Integrated Fabric Systems additional development
- Meeting 10, Tuesday November 22: Integrated Fabric Systems additional development
- Meeting 11, Tuesday November 29: Integrated Fabric Systems additional development
- Assignment Three Integrated Fabric Systems due: Monday Dec. 5, 9 pm
- Meeting 12, Dec. 6: : Review Integrated Fabric Systems with Matt Gorbet, Michael Lancaster

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GOVERNING DETAILS

Evaluation
Review comments will typically be offered within class reviews scheduled as the completion of each class assignment. In addition to verbal evaluation provided via reviews of the assignments, each assignment will be individually graded. Assignments will be evaluated based on clarity of ideas and creative approach, depth and ambition, and quality of documents. General criteria include completeness relating to assigned requirements, and participation in the class may would affect evaluation of each of these criteria.

Each evaluation will be expressed in the form of numeric grades calculated by assessing three criteria, weighted equally, as follows:

- Conceptual quality: clarity, precision, demonstration of insight and analysis
- Depth and Ambition: substance and range of high quality research and creation
- Craft quality: quality of communications including text, visual documents and design

Proportion of final grade

Assignment 1 30%
Assignment 2 30%
Assignment 3 40%

A detailed grade breakdown will be provided for each assignment together with the total assigned for the course.

Your Availability
Keep your schedule clear of conflicting commitments during scheduled course periods. Maintain availability for individual and group meetings. Be in full attendance for 6 pm-9 pm on studio days as indicated in this outline and subsequent detailed schedules. Class focus is required: no external work during meetings and lectures. Attend all scheduled lectures and meetings.

Seminar Form
The course will be organized as a seminar that involves active discussion and exchange between member students. This approach asks for active participation.

Submissions and Online Communication
The course will use the ARCH 510 Introduction to Interactive Systems section of LEARN for formal course submissions. Enter the LEARN site by using your 'UWDir' ID and password. You will be asked to make digital submissions of assignments on that site.

Informal group discussion will be administered using an online 'Basecamp' space. This software will be demonstrated during the startup phase of the studio. Each individual will be provided an individual login.

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Creative Commons Open-Source Intellectual Property
In order to foster collaborative development of the design systems introduced within this introductory course, a creative-commons standard will be used for your design work. See https://creativecommons.org/licenses/.

Attribution-NonCommercial-ShareAlike
CC BY-NC-SA

This license lets others remix, adapt, and build upon your work non-commercially, as long as they credit you and license their new creations under the identical term. The kit components and patterns provided you by the LASG are governed by the licenses indicated within those materials.

Late Work and Absence
A doctor's note is required to excuse absence or lateness because of illness. In the case of illness or other special circumstance, notification should be given to the instructor and the Program Office as soon as possible and before the deadline in question.

Submit your work on time. Assignments are due at the specified time and date. All assigned parts of the work must be completed. For submissions administered with evening deadlines, grade penalties for lateness would be assessed at 5% up to midnight, and 5% next day and each day afterward. 'Days' begin at midnight each day, and include weekends and holidays.

University Standards
Academic Integrity: To create and promote a culture of academic integrity, the behaviour of all members of the University of Waterloo is based on honesty, trust, fairness, respect and responsibility.

Waterloo standards include the following:
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, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm

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Appeals: A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals, http://
www.adm.uwaterloo.ca/infosec/Policies/policy72.htm

Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, 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 the OPD at the beginning of each academic term. Once registered with OPD, please meet with the professor in confidence to discuss your needs.

RESOURCES:
On campus course resources as listed below:
Architecture Computing & Media:
https://uwaterloo.ca/architecture/resourcesservices/architecturecomputing-media
https://uwaterloo.ca/architecture/resources-services/workshop

Links:
http://www.rhino3d.com/
http://www.grasshopper3d.com/
http://www.tsplines.com/
http://wiki.mcneel.com/labs/panelingtools
http://designreform.net/
http://www.pinterest.com/lonatheorema/architecture_patterns/

ARC 510 Introduction to Interactive Systems:
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Assignment One

EMOTIONAL CELL SYSTEMS

Assigned: Tuesday Sept 13
Due: Monday Oct. 3, 9 pm on LEARN
Review: Tuesday Oct 4: with Matt Gorbet & Michael Lancaster
Post material on MIRO

Working in assigned groups, produce a short video presentation that evokes *emotional* behaviour patterns within arrays of cells. Use simple functions derived from the software-based systems of the Smart Actuator Interface and its accompanying Mapper control sketchpad.

Include the following:

a) .mp4 video animation using any combination of software animation, stop-motion, flip-chart animation dynamics.
Accompany the video with a short package of illustrations as follows:

b) diagram showing system relationships;

c) specs and settings discussion for the above;

d) precedents including references, imagery, related video clips

Present the video and documents in a presentation, maximum ten minutes including the video, to the class.

Required Reading:

Vehicles: Experiments in Synthetic Psychology by Valentino Braitenberg, MIT Press, 1986
Read: Introduction and text up to page 49. Reading due complete: 6 pm Tuesday Sept. 20.
These imaginative thought experiments are the inventions of one of the world's eminent brain researchers. They are "vehicles," a series of hypothetical, self-operating machines that exhibit increasingly intricate if not always successful or civilized "behavior." Each of the vehicles in the series incorporates the essential features of all the earlier models and along the way they come to embody aggression, love, logic, manifestations of foresight, concept formation, creative thinking, personality, and free will. In a section of extensive biological notes, Braitenberg locates many elements of his fantasy in current brain research.

Assignment Two

SENTIENT CELLS

Assigned: Tuesday Oct. 4
Due: Monday Oct 31, 9 pm on LEARN
Review: Tuesday November 1
Note: preliminary draft. This assignment may be revised to suit class progress.

Working in assigned groups, design a performance of physical expressive behaviour using the components of the LASG kit and employing small interconnected groups of physical cells. Configure and demonstrate functional individual interactive cells and groups showing composite cell-to-cell behaviours. Produce a short video presentation that records your performance.

A kit containing electronic controllers, actuators and sensors, mounts and scaffold components has been provided to each member of the class. The components of this kit can be combined to make functional physical electronically controlled interactive systems. The software systems that have been introduced to you during the first classes of the course are designed for integration with the physical kit. Use this kit combined with the related software as the basis of your exploration.

Within your group of three, combine your three kits and arrange them for grouped functions that include cycles of sensor stimulations coming from adjacent cells and actuator behaviours triggered following this stimulation.

Compose a physical expressive performance using the physical devices. Include the control functions provided by the software-based systems of the Smart Actuator Interface and its accompanying Mapper control sketchpad to orchestrate parts of your performance. If you wish, you may modify and extend the physical devices*.

Accompany this presentation with images and diagrams that document and extend your designed performance.

Include the following:

a) Approx.30 second .mp4 video that records the physical behaviour of your grouped cells. You may, if you wish, also include animation and other video content including simulations.
Accompany the video with a short package of illustrations as
follows: b) diagram showing system relationships;

c) drawing showing physical arrangement of components, including cabling. Include annotations and labels.

d) Behaviour description, including specifications and settings documenting the configuration of the controllers;

e) references including imagery, related video clips

Use the collective pin-up space of Miro to make all parts of your presentation visible for review.

Assignment Three

INTEGRATED FABRIC SYSTEMS

Assigned: Tuesday Nov 1
Due: Monday Dec 5, 9 pm on LEARN
Review: Tuesday Dec. 6
Note: preliminary draft. This assignment may be revised to suit class progress.

Required Final Submission Contents

1. Video recording containing film, including title, content and end credits. Minimum length (without title & credits) 30 seconds; longer welcome.

2. Diagram(s) and Drawing(s)

3. Text

Recap of Preceding Development

In Assignment One you explored elemental kinds of interactive system components and behaviours, using the Smart Actuator Interface ('SAI') Living Architecture Systems kit with its custom envelope-controls and Mapper software. Principles of 'emergent' distributed behaviour and primitive affects were reviewed. We discussed how certain patterns might approach human emotional expressions. In Assignment Two, you extended this exploration by translating it into physical scaffolds, mechanisms, sensors and actuators. Composite cells were developed that contained electronically controlled patterns of behaviour working in series. The physical components provided within the LASG kit were used to support your development of skeletal scaffolds that housed mounting plates and physical extensions. Projections of light and motion created by the behaviours of your constructions were explored, within your constructions and extending outward over surrounding spaces.

In this final assignment, you will be asked to build directly on your initial explorations by combining groups of individual cells into large arrays that create architectural fabric structures expressing emergent behaviour

Final Assignment Summary

For your final work in the course, expand and refine the work you have produced in the course. Expand the work by multiplying individual groups of cells, creating a distributed **fabric** array with dynamic, expressive behaviour. Multiply your grouped cells and link them together Explore **emergent** behaviour that combines large numbers of cells behaving together.

Refine the work by freely adapting and remanufacturing kit parts, using *tinkering* craft. This refinement may, if you wish, include additions and replacements of kit elements with your own devices, structural and mounting systems, and physical modifiers for sensors and actuators.

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Assignment Three (continued)

Physical and Virtual Development
These expansions and refinements may be physical (i.e., building functional physical constructions), and virtual (i.e. drawing, modeling and animating digital and analogue image, sound and light sequences), or combinations of physical and virtual media. As an integration and expansion of prior work, you may wish to include prior video, drawings and constructions.

Create an architectural performance, expressed in a short film.

Accompany this work with at least one diagram and one three-dimensional drawing that documents the systems and physical constructions operating within the performance.

Title your creation. Compose precisely-worded text that describes your performance. Include a description of the expression, together with documentation of the rigging and controls that you have composed.

Sources and Process
Consistent with the collective 'laboratory' research of this course, and so long as you fully cite and credit your sources, you are welcome to adapt and extend the work of others outside the course, and also the work created in previous assignments by others. Work with your assigned groups. However, while the short time remaining naturally limits changes and new arrangements, you may, if you wish, extend your work by collaborating with others in the class.

Use Basecamp to coordinate group arrangements if needed.